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Pomona College Journal of Economic Botany

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The pages of this quarterly are at the service of active workers in Economic Botany, as related to Subtropical Horticulture, from any part of the World.

Especially is this Journal offered in exchange for all botanical and horticultural journals, all proceedings, transactions, bulletins, and reports of societies, gardens, laboratories and herbaria.

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Pomona Journal of Economic Botany
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POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

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Foreword

THIS JOURNAL has been established first and foremost in the interests of the scientific development of the new Subtropical Horticulture, and of a more scientific knowledge of the many plants which have made and will make Southern California one of the richest garden spots on Earth, and which promise great possibilities also for other similar regions.

In the recent rapid growth of the vast subtropical regions lying between the distinctively temperate areas and the well defined tropics, a flood of new plants has been pouring in from farther north as well as from all of the Tropics of the World. Trees, shrubs, and herbs from the North are comparatively well known, but exact knowledge concerning the myriads of valuable things constantly being imported from farther south and from other foreign lands is always a great desideratum. There is very acute and special need in this connection for all of that more exact knowledge which comes under the general head of Economic Botany. The call for this work is constant and urgent from growers, planters, amateur fanciers, greenhouse-men, nursery-men, seed-men, importers, experimenters and botanists.

Coming with these new plants are many little known fungous and bacterial diseases which, under the new conditions, frequently accomplish most dire and alarming results. In these and other matters, Subtropical Horticulture possesses a multitude of serious problems, both old and new, which are all its own.

This JOURNAL will be dedicated to the publishing of the best obtainable new and original results along all of these lines, and our contributors will include some of the most practical, capable, and energetic students and investigators in the country, and we shall also select for it some of the best results that we are able to produce here at Pomona College. We shall, so far as possible, avoid the extremely technical, and employ every effort to make the JOURNAL thoroughly readable and clearly and abundantly illustrated. Though always it should be remembered as true, just as in other lines of modern human effort, *that the safest, best, and most successful practice, is ever that which is based upon detailed and fundamental technical knowledge.*

None of those interested in this enterprise have the slightest expectation of the JOURNAL ever becoming a paying proposition, though they hope ultimately to make it self supporting. Its primary function is that of an effective educational tool, and an active influence in building up safer, more extensive, and more remunerative scientific horticulture for subtropical regions, and a more complete and thorough Economic Botany for all of the plants in question.

The subscription price has been placed at a merely nominal figure, in order that the JOURNAL may be within the ready reach of all. We shall make definite plans always to offer returns in far greater values, not only to residents throughout the subtropics, but also to warm-house interests, plant fanciers, horticulturists, and economic botanists the world over. Each year's volume of four numbers will be complete by itself, and each year undertaken will in any event be completed, but any given year will be undertaken only when sufficient funds are in sight to cover its bare running expenses. Many notable friends of this work tell us that *without doubt* steady support for so important an undertaking will be forthcoming.

A. J. COOK
C. F. BAKER

The Avocado in Southern California

BY F. W. POPENOE*
PASADENA, CALIFORNIA

That the avocado will succeed in Southern California has been proved conclusively by the seedlings planted fifteen to twenty-five years ago which are now bearing, and by more recent experiments with budded trees; and the establishment of an avocado industry in the immediate future is assured. As to whether we shall proceed at once to the production of the best fruits or whether the loss of much money and time with the incident disappointment to all concerned shall be caused by the planting of inferior varieties is the vital question at this moment. It is to the solution of this problem that the earnest endeavor and careful efforts of all our nurserymen should be directed, and it is in the hope that some help may be given in eliminating wasteful efforts that this article is written.

For centuries the avocado has been grown in Mexico and other tropical countries, propagated only by seed. Like other fruit trees grown from seed, it comes true in but a very small percentage of cases. This has led to the existence of a wide range of varieties. All avocados so far fruited in California are these mere chance seedlings, most of them of indifferent value and not worth propagation on an extensive scale. There are many varieties of good size and flavor, fruiting in Mexico and other parts of the tropics, which will doubtless succeed here as well as the smaller and inferior ones. Some of these Mexican varieties are of such superior quality as to leave nothing to be desired.

It is therefore manifestly the part of wisdom for California planters of this fruit to proceed with intelligence and accept nothing but the best. Attracted by prospective large returns some investments of a doubtful character are already being made. There is really no excuse for this.

Investigation and care will lead anyone in the right path. There will be no demand for seedling or inferior fruits once a superior avocado is to be found plentifully in our markets. Nor need there be delay or groping in the dark for these superior varieties. At our very door lies a boundless experimental garden in which for centuries the avocado has been grown, where countless varieties have originated, and where now are growing hundreds of thousands of trees from among which we have only to select the best.

By taking advantage of this opportunity California can obtain in a comparatively short time the choicest varieties, which it would take years of time and a large expenditure of money to produce by the ordinary methods of plant breeding, carried on here.

The results presented in this preliminary paper on this subject have been worked up in the Biological Laboratory of Pomona College, and acknowledgments are here made for the facilities placed at my disposal there and the constant and kindly assistance extended to me.

*Special student in Pomona College.

TYPES GROWN IN CALIFORNIA

Broadly speaking, the avocados which have fruited here so far may be divided into two classes; those of Mexican origin, which include all the smooth and thin skinned varieties, and those of Guatemalan origin, which are easily distinguished by their very thick skins and rough exterior. This is not saying, of course, that all avocados can be divided into these two classes.

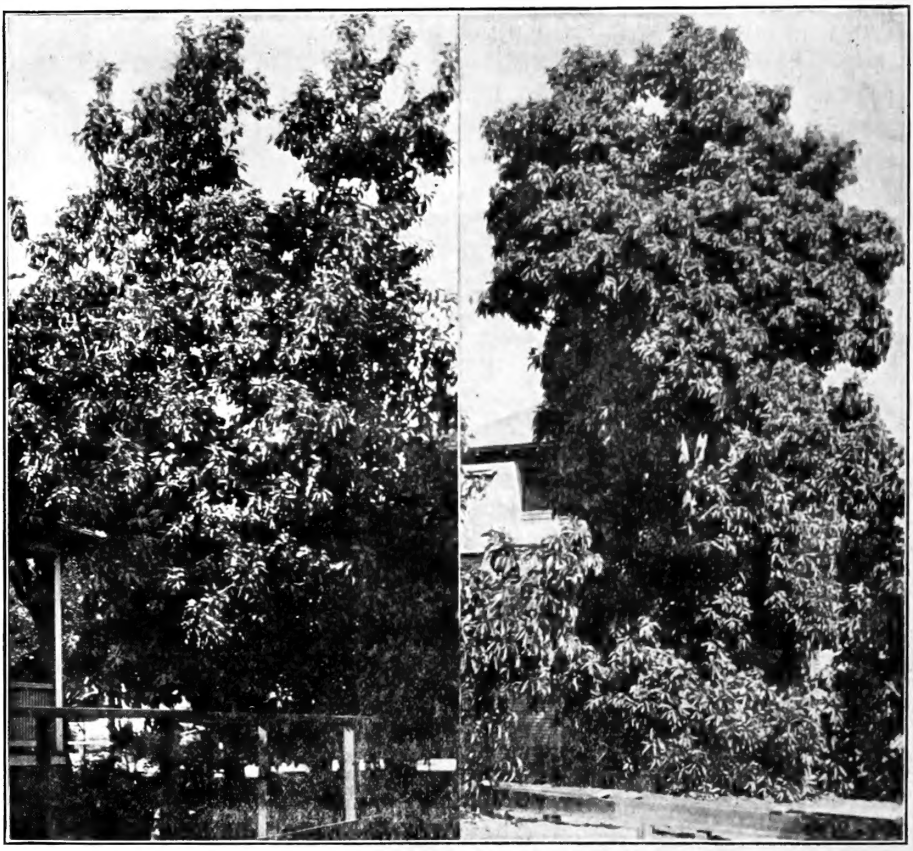

Figure 1. At left the parent tree of the Blake Avocado, growing at Pasadena, age eight years; this tree would be of good form if topped. At right, parent tree of the Walker Avocado growing at Hollywood, age fourteen years, the tree showing a very bad form for a cultivated Avocado.

Of the Mexican type many trees may be found scattered all over the southern end of the state, most of which have been grown from seed obtained from Monterey and other points in northern Mexico. The famous Chappelow tree is the oldest and best known of the lot.

Most of these Mexican varieties produce fruits of small size, dark purple in color, but of good quality, and are preferred by many to the large green

fruits, it being the belief that they are richer and of better flavor than the larger varieties.

They are also somewhat hardier than the larger varieties and would probably be valuable in locations where the latter would not thrive.

For home use these varieties will always be desirable, but as a commercial fruit they are out of the question altogether. They are too thin skinned to stand shipment, and would probably not take at all in American markets in competition with the larger, thick skinned fruits.

A few varieties of Mexican origin and green in color are now grown here which are larger than the purple varieties, but these also are thin skinned and of little more value commercially than the purple ones, although the quality is all that could be desired in some cases. To be profitable commercially, the fruit will have to be thick and tough skinned, so as to stand shipment, and as yet no Mexican variety which has fruited here has this quality.

Outside of the Mexican varieties the only other type known to have successfully fruited here is the Guatemalan. The trees of this type are probably all descendants of the old Miller tree, the seed of which was brought from Guatemala and planted at Hollywood over twenty-five years ago. Numerous seedlings have been grown from this tree, several of which are now bearing. The Walker tree is the best known of these, and is the most prolific tree known here, its crop every year running into the thousands. From the behavior of these trees it seems certain that this type is admirably adapted to this climate, a fact of the greatest importance to the future of the industry here.

In his bulletin on the avocado, Collins speaks of the avocados of Guatemala as forming a very distinct group, the most peculiar characteristic of which is the unusual thickness and toughness of the skin, and he considers them the most promising of all types from a commercial standpoint. It is particularly fortunate, then, that this type has been tested here and its adaptability proved, for the way has been paved for the introduction of numerous forms of the type with practical assurance of success. Another noteworthy point in regard to this type is the fact that all of the local trees are spring bearers, this point alone making them of great value. Being spring bearers their blooming season is considerably later than the fall bearing Mexican sorts, so that danger of the crop being destroyed by late frosts is almost eliminated. Already we have several varieties of this type that are well worth growing, of which the Lyon is the most promising, it being the finest avocado yet produced in California, of good size and excellent quality. This variety has just come into bearing, and therefore is little known as yet, but its prolificacy and good qualities promise to place it in the lead of the local varieties. The trees of the Guatemalan type are easily distinguished from those of the Mexican type because more spreading, particularly when young, and the leaves are more lanceolate.

It has been the general impression that the South American type which is grown in Florida would not succeed here, but this remains to be proved.

Budded trees of many Florida varieties are being tested in Southern California, and the Bureau of Plant Industry expects to send out a large number this spring for trial. One large tree at Sherman which was worked over to the Trapp variety flowered this year for the first time, and numerous other trees are becoming old enough to bear and will be watched with interest for the next few years. This type is certainly more tender than the Mexican, but the past few winters have shown that some varieties at least will stand our average winter temperature without injury. Future experience will likely confirm the present belief that this type will succeed in many locations here.

Numerous seedlings of Hawaiian, Cuban, and West Indian varieties have been grown, but as yet these have not come into bearing. Budded trees will have to be tested before anything definite can be said of their adaptability.

It has been stated that the avocado would not succeed in the hot and dry

Figure 2. At left the parent tree of the Ganter Avocado growing at Whittier, Cal., age eight years; at right the parent tree of the White Avocado, growing at Santa Barbara, age twelve years.

interior parts of California. Trees are known to have grown without injury as far into the interior as Redlands and Riverside, and have fruited heavily at Pomona and San Fernando, and should be tried at Imperial.

PROPAGATION

BY SEED. This is the simplest method, and the one most practiced in California up to the present time. The seeds of most varieties are obtainable during late summer and autumn, and should be planted as soon after removal from the fruit as possible. It has been found to hasten germination greatly if the seeds are buried in moist sand or sawdust for a period of two to four

weeks before planting. During this time they should be occasionally examined, and when they show signs of germinating they can be taken out and planted in pots. After this treatment they will start to grow very promptly and it has the added advantage that only seeds that are sure to grow are planted, and no labor is wasted. For most seeds a four inch pot is large enough. The seeds should be placed in the pot pointed end up, or in the case of the round seeded varieties, the end toward the stem of the fruit, and about one-fourth of the seed left exposed above the surface of the soil. A good rich soil is essential to the best development of the young plant, and should be kept thoroughly moist, but care should be exercised to avoid standing water in the pots, as this is fatal to either the seed or the young tree. While the young trees should be grown in a warm situation, the direct rays of the sun should be avoided. If the seeds have not been buried in moist sand before planting they will often be slow in germinating, especially if not grown under glass. Many of the seeds planted in the fall in a lath house do not come up until the following spring. After the young trees have made a growth of eight to twelve inches they should be shifted into larger pots or cans, if it is desired to carry them on in this way, or set out in the nursery to be grown until of suitable size to bud.

BY BUDDING. It is only during the past season or two that much attention has been given to budding the avocado in California, although previously a few nursery-men most interested in this fruit had tried it. Having no experience of their own in the budding of this particular tree, most of those who have budded during the past year or two have simply applied the methods they would use for citrus fruits, while a few others have followed the instruction given in various publications by those who have experimented in Florida. In all cases the results have proved the budding of this fruit to be no more difficult than that of the citrus fruits, and when a little more experience has been acquired the operation will be performed with as much assurance of success as with the orange.

For commercial purposes plants are grown in pots until about twelve inches high, when they are set out in nursery rows three and one-half to four feet apart, and fourteen inches apart in the rows. Here they are grown and budded and allowed to remain until of saleable size, when the trees are balled, or transplanted into pots, and allowed to become established before being sold.

The method of budding is practically the same as used for the orange. In regard to such points as the best size of stock and buds, and season for carrying on the work, there has, however, been some uncertainty.

Experiments have been carried out locally on stocks ranging in diameter from about one-fourth of an inch to over one inch, with budwood of all sizes, from the young and tender tops to well matured wood of the previous season's growth. Results lead to the conclusion that for small stocks, such as will be obtained during the first summer's growth of the seedling tree, buds from young wood of the current season's growth are the only ones which will give good results. On older trees, mainly two-year-olds, the

buds from older wood seem to take better, but are liable to drop after taking, leaving a blind bud.

The experience of P. J. Wester, in charge of the avocado investigations of the Bureau of Plant Industry, is unquestionably the most valuable to be had on this subject. Under date of January 4, 1911, he writes me as follows: "In 1906 I published an article in the Florida Agriculturist that has been reproduced in many papers, but which does not now wholly represent my views on the subject. The stock should be the size of a lead pencil, in vigorous growing condition with sap flowing freely, and young budwood,

Figure 3. Parent tree of the Harmon Avocado, growing at Sherman, Cal. This tree is thirteen years old, and shows a fine orchard form for an Avocado.

i. e., that from the current year's growth, with well developed buds, used. Do not use old and hard budwood, as such buds after taking frequently drop. Cut the buds large, and cover entirely with waxed tape. The last point may not be so important in California's dry climate. Continued experimentation since I wrote the above mentioned paper shows that budding may be practiced any month of the year, provided the stock is in condition, though for nursery practice I would not bud in August, September, October or November."

Regarding the best season to bud, it seems to be the concensus of opinion here that October and November, which are mentioned by Mr. Wester as undesirable months, are as good a season as any, if not the best of the whole year. This is probably owing to the climatic conditions of Southern California being different from those of Florida.

Three weeks after insertion the buds will have taken and the trees should be lopped back to several inches above the bud. The buds will then start into growth, and when a growth of eight to twelve inches has been made the stock may be trimmed back to the bud.

Edgar Harman, of Sherman, has done considerable experimental budding and what he says will be of value to those contemplating doing this work. The seeds are started under glass and as soon as the plants are two inches high they are set in pots and placed in a protected place in the open. When they have grown to the diameter of three-eighths to one-half of an inch, they are budded. Mr. Harman considers that this operation can be performed successfully any month of the year except July and August. Young and tender budwood is used and the buds cut from three-fourths to one inch long. Waxed cloth is used for wrapping, and the buds are not wrapped very tightly. As soon as the buds swell, which should be in about three weeks, the top of the stock is lopped over at about the fourth leaf above the bud, and a little later on it is cut clear off. When the bud has started into growth the top is cut back to a level with the bud. The sap must be flowing freely at the time of budding to insure success.

C. P. Taft of Orange has probably had more experience in growing and budding the avocado than any other person in California. He says: "I am inclined to regard the months of October and November as the best for budding, though I think there is a short period in the spring when considerable success can be had. The buds I put in my three-year-old orchard last fall have done well and are making a fine growth. About 25% of the buds on stock in cans succeeded. Those put in during the warm summer months were an almost total failure."

In April, 1909, D. W. Coolidge of Pasadena budded about 150 two-year-old seedlings growing in the open ground at Hollywood. The buds were taken from well matured wood of the previous year's growth, and waxed cloth was used for wrapping. Fully 90% of these buds took, but quite a number dropped their buds after having taken. However, fully 75% of the buds inserted developed into trees. Mr. Coolidge has made several attempts to bud stock grown in cans, but with no success, probably because trees thus grown are not sufficiently vigorous.

William Chappelow of Monrovia, owner of the original Chappelow tree, states that he proceeds exactly as in budding citrus fruits, and has budded at all seasons of the year with about equal success.

Large avocado trees which are unproductive should be cut back and budded over to some good variety. The method is simple, and as described has been practiced very successfully by Mr. Harman. The large limbs are all cut back close to the trunk, and the cut ends covered with white lead to

prevent bleeding. In a short time numerous sprouts will make their appearance; all of these should be kept cut off but three or four of the most promising, selected on different sides of the tree so as to form a good head. In a short time they will be large enough to bud, and should be budded in the same way as small seedlings. The wraps must be loosened every four or five days, as the sprouts make a very rapid growth. After the buds have made a growth of several inches the stocks may be cut back and the buds allowed to develop into the new tree. In two years time a good sized head will be obtained.

Figure 4. Avocado tree of the Mexican type growing at Redlands, Cal., showing what the Avocado may become when not pruned or cut back.

The best material for budding tape is cheap cotton cloth which will tear easily. The method of preparing it is described by Mr. Wester as follows: "Rip up the cloth in strips of desired widths, say six inches, and roll these tightly on stout iron wire as long as the width of the strips. Several strips may be rolled on until the roll is one inch in diameter; tie a string around the roll at each end to prevent unrolling while being boiled in the wax. A

good wax is made by boiling together two pounds beeswax, two pounds rosin, and half a pound of good lard; when in boiling state put in the rolls of cloth and let them remain for fifteen minutes, when they are taken out and cooled before being stored away. The iron wire is more desirable than sticks of wood, as the weight of the wire will keep the roll below the surface of the boiling mass. Another advantage in using the wire is that if the sticks are not quite dry the water, as it is converted into steam, will cause the contents to boil over."

INARCHING has never been practiced in California, but J. L. Hickson, of Miami, Florida, a large and successful grower of the avocado, states that he propagates entirely by this method, as he considers it produces a stronger and better growth than budding. However this may be, the method is slow and laborious, and trees cannot be produced in sufficient quantities to make it commercially practicable here.

GRAFTING has been performed successfully in a few instances, but has not been attempted to any great extent as yet.

CUTTINGS have been very successfully rooted by being placed in clear sand in a lath house, but it is doubtful if this method of propagation produces as strong a plant as the others.

ORCHARD PLANTINGS

It is only within the last year or two that orchard plantings of the avocado have been made in Southern California, and then only in very small acreages, but the next few years will see the territory devoted to the culture of this fruit on a commercial scale greatly increased.

The trees may be planted at the same distance apart as orange trees, or if space is available at a somewhat greater distance. Budding seems to dwarf the tree, and budded trees will require much less room than seedlings. In either event the trees should not be allowed to grow to an unlimited size, but should be pruned like deciduous fruits, allowing only the strongest branches to develop and form the head of the tree, and all weak and undesirable growths cut out each year. The top should be kept cut back to facilitate picking the fruit, and not allowed to grow to an unlimited height as has been done with all the seedlings grown here.

Transplanting should be done in early spring, before the trees have started into new growth.

During the first year or two of its growth, the tree is more tender than when larger, and in locations subject to heavy frosts should be protected during the winter by some covering. Palm leaves are used for this purpose if they can be obtained in sufficient quantities, or a frame can be constructed of lath and covered with burlap or cheesecloth. The danger from frost, however, lies not so much in the possibility of injury to the trees themselves, as in the destruction of the crop through freezing of blossoms of early flowering varieties. To avoid this, late blooming varieties may be planted, such as those of the Guatemalan type, which bloom so late in the spring as practically to eliminate all danger from this source. It is only occasionally

that the Mexican varieties are caught, but as the crop is practically certain to be lost, if a very heavy frost occurs during the blooming season, the only safe way will be to plant late blooming varieties.

The tree requires about the same irrigation as the orange. Insufficient irrigation will result in small fruit.

In selecting varieties for planting on a commercial scale, there are a number of points which should be kept in mind. Fruits which ripen during midwinter will command the highest prices in the markets, and there will probably be the greatest demand for avocados at this season of the year. As

Figure 5. At left a Mexican seedling Avocado, eighteen months from seed; at right a budded tree of the South American type, three years from the bud and grown in California.

to size of fruit, there is no advantage in having the very largest. While a two pound avocado is a regal fruit, for practical purposes one of half that size is better. Quality should be one of the most important factors in choosing a commercial fruit, and other desirable points are prolificness, a smooth, thick and leathery skin which will stand shipment, good keeping qualities, and a small seed, completely filling the cavity, as a loose seed pounds the walls in transit, causing early decay. We must, however, have still smaller varieties for cheaper trade, and summer varieties for local consumption, and we already have a good assortment of varieties to choose from for these purposes.

THE FUTURE OF THE AVOCADO IN SOUTHERN CALIFORNIA

It may seem a strong statement to say that within the next quarter of a century the avocado will rank with the orange as a commercial fruit in Southern California. But there is a strong foundation of fact underlying this statement and the reasons seem sufficient, indeed, to warrant the belief that it may become even more important.

First, the adaptability of the avocado to this climate has been proved beyond the possibility of a doubt. There are one hundred or more trees now in bearing, ranging in age from three to twenty-five years, scattered over the southern end of the state from the cool sea coast to the hot and dry interior. These trees embrace a number of widely different types, sizes and characters of fruits. This test of adaptability ought to be sufficient to satisfy the most skeptical.

Second, the food value of the fruit is the main basis for the above statement. It presents in a most easily digested and assimilated form as high as 12 to 18% of fat, which places the fruit in a class with the staple food products, instead of being a mere luxury as is the case with many fruits. The taste for the avocado is not always acquired upon first trial, but a few repetitions are usually sufficient to make any one extremely fond of it. The price is now prohibitive to most, and only a few have had opportunity to acquire the taste, but as the production becomes greater and the price lower, an almost unlimited demand will be created throughout the whole country. It is, of course, universally known as one of the most important staple fruits throughout the tropics and subtropics of the world.

Culture of the fruit in this country will be restricted to limited areas in Florida and Southern California, and consequently the danger of overproduction will be practically eliminated. As rapidly as price and production permit, the avocado will become an important and indispensable part of the daily food of the majority of the people of the United States.

LIST OF VARIETIES

known in California, arranged according to general characters and possible usage:

For winter fruiting: Lyon.

For late fall fruiting: White, Ganter.

For late summer and early fall fruiting: Harman, Fowler, Chappelow, Blake.

For spring fruiting: Walker, Miller.

Large varieties: Lyon, Miller.

Small to medium varieties: White, Walker, Harman, Ganter, Fowler, Chappelow, Blake.

Best varieties for shipping: Lyon, Walker, Miller.

Best varieties for local use only: Ganter, Chappelow, Fowler, Blake, Harman.

Most prolific varieties: Walker, Ganter, Lyon.

DESCRIPTION OF VARIETIES

The following list contains not only those varieties of local origin which have been named up to the present time but is a complete list of all the named varieties in cultivation of which it has been possible to obtain descriptions.

With the increasing number of varieties being propagated every year, it will be absolutely essential to any exact knowledge of this subject that the introducer of any variety shows sufficient differences between the new variety and all previously known ones to warrant giving it a name.

Better Known Varieties

PROVISIONAL KEY TO THE VARIETIES

This key is not to be considered as anything definite for the determination of varieties. It is merely intended to point out the distinguishing characters of the varieties described and supplement the descriptions.

A. Skin smooth.
 B. Towards base broadly rounded; general shape round to oblong.
  C. Skin thick.
   D. Roundish oblate to oblate pyriform; seed more or less loose in cavity ..... TRAPP
   DD. Round to oval; seed tight in cavity ..... SINALOA
  CC. Skin thin; shape oval to oblong.
   D. Averaging more oblong; flesh very rich and buttery; skin glossy; seed not compressed ..... FOWLER
   DD. Averaging more oval; flesh more watery, and not buttery; skin not glossy; seed compressed ..... GANTER
 BB. Towards base more or less tapering, pear shaped, or bottlenecked.
  C. Black, or dark or reddish purple when ripe.
   D. Slender pear shaped, or even banana-shaped.
    E. Skin thin; seed tight; becoming almost black when ripe ..... CHAPPELOW
    EE. Skin medium thick, seed loose; purple with scarlet streaks ..... FAMILY
   DD. Stout pear-shaped; reddish purple; skin medium thick ..... WESTER
  CC. Red mottled with yellow; skin thick; seed tight in cavity ..... CARDINAL
  CCC. Green principally when ripe, in ground color at least.
   D. Without distinct neck; seed loose in cavity; skin thin ..... HARMAN
   DD. With a more or less distinct neck.
    E. Skin thick and tough.
     F. Weight up to 3.5 pounds ..... POLLOCK
     FF. Weight up to 1.5 pounds ..... LANDON
    EE. Skin thin.
     F. Color clear green.
      G. Size small ..... BLAKE
      GG. Size large ..... QUALITY
     FF. Color green, washed with purple; size small ..... WHITE
AA. Skin rough, usually thick.

B. Towards base broadly rounded; pedicel inserted on one side; color dark green ..... MILLER
BB. Towards base more or less tapering, pear-shaped, or bottlenecked.
C. Color deep, dark green; weight up to 1.3 pounds.
D. Length about 4 ins.; pedicel inserted at center; flesh thin ..... WALKER
DD. Length about 6 ins.; pedicel inserted on one side; flesh thick ..... LYON
CC. Color pale greenish yellow; weight up to 2 pounds ..... RICO

Trapp

(Figure 6 A)

Form roundish oblate to oblate pyriform; size medium to large; cavity regular, small, shallow, with gradual slope, somewhat furrowed; stem stout;

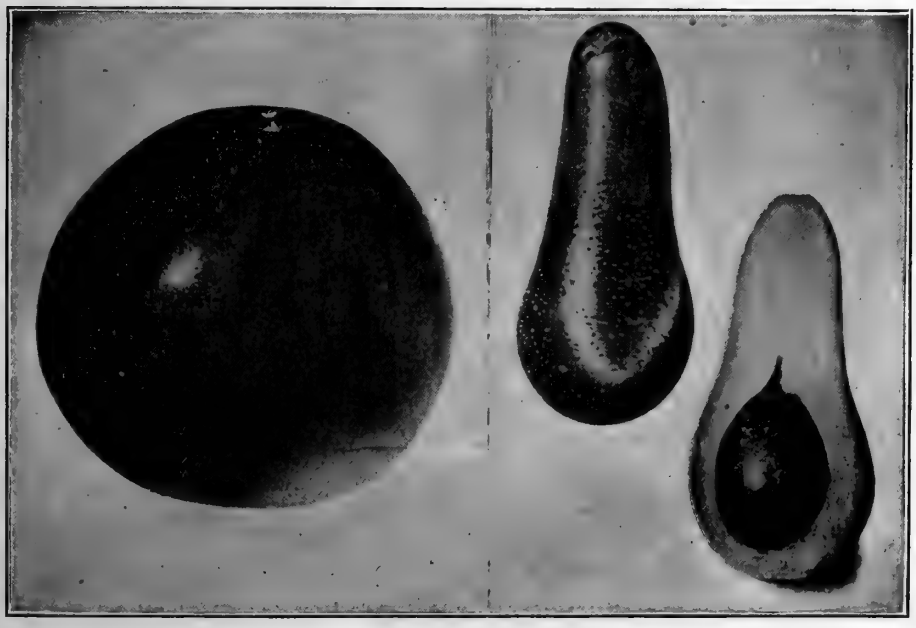

Figure 6. At left the Trapp Avocado and at right the Chappelow, as originally figured in Year Book U. S. Dept. Agriculture.

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.—1906 Yearbook U. S. Dept. of Agriculture.

Sinaloa

(Figures 7 and 8)

Form oval; size medium to large; stem stout; surface smooth, undulating; color light green with numerous large, irregular, brownish dots; skin thick

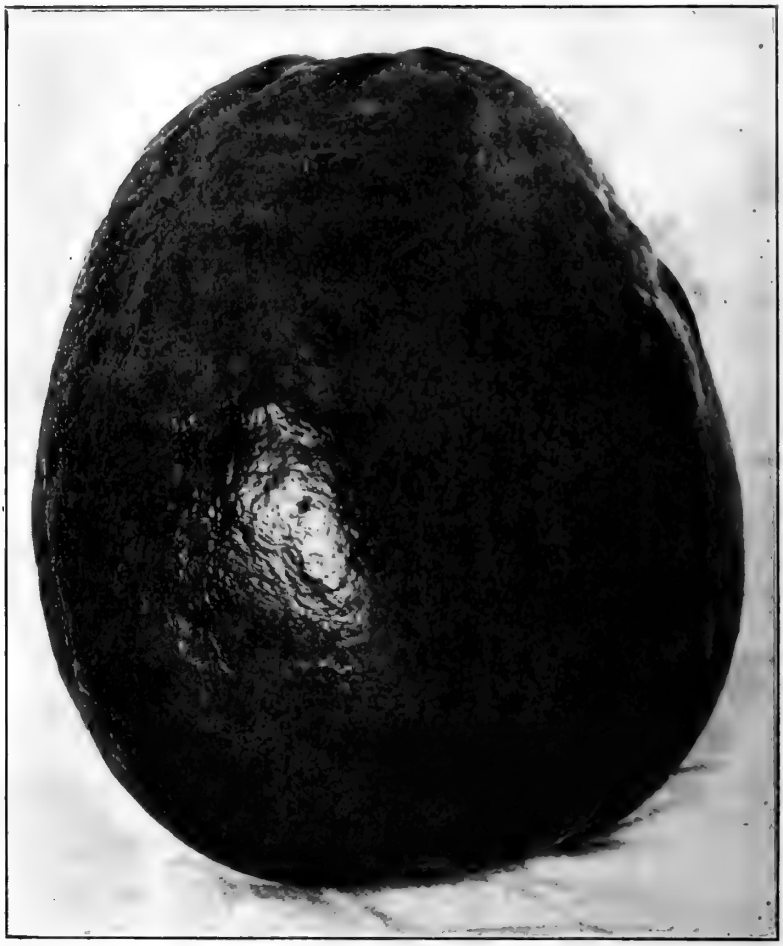

Figure 7. The Sinaloa Avocado, natural size.

and very tough; flesh rich yellow in color, shading to light green near the skin; texture smooth and very buttery; flavor very rich and nutty; quality very good; seed large, oblate, tight in cavity; season September to October. Originating in Mexico and now in our own plantations.

Fowler

Form oblong to oval; dimensions, length four and one-fourth inches, diameter three and one-fourth inches; apex a dot; base flattened slightly; cavity

regular, small and shallow, flaring; pedicel stout; surface smooth; color light green, with numerous small, rounded, yellowish dots; skin very thin, glossy, adhering closely to flesh; flesh yellow, changing to yellowish green near skin; texture smooth and buttery; flavor very rich and nutty; fibre slight; quality very good; seed medium large, oblong-conical, tight in cavity; season July to October at Pasadena, California.

Tree is of vigorous growth, upright, round topped, with abundant healthy foliage. Rather shy bearer. This is originally described here. A seedling of the Blake, and very similar to the Ganter.

Figure 8. The Sinaloa Avocado.

Ganter

(Figure 9 A)

Form oval to oblong; dimensions, length two and one-half to four inches, diameter one and three-fourths to two and three-fourths inches; apex slightly depressed; base flattened; cavity regular, small, rounded or flaring, slightly furrowed; pedicel very stout; surface smooth, undulating; color

light green, with numerous small, irregular yellowish green dots; skin thin and tender, adhering closely to the flesh; flesh yellowish cream color, changing to pale green near the skin; texture smooth but not very buttery; fibre very slight; flavor rich, nutty; quality very good; seed large, oblong-conical, somewhat compressed, about 25% loose in the cavity; seed cavity medium large; season November to December at Whittier, California.

Tree is a vigorous grower and rather spreading in habit, with abundant healthy light green foliage. A very prolific bearer. Here first described. Very similar to the Fowler.

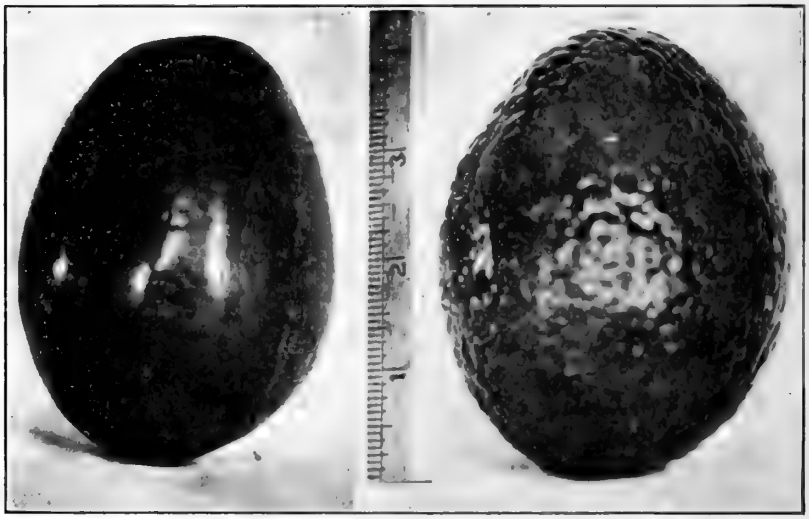

Figure 9. At left the Ganter Avocado, grown at Whittier; at right the Miller, grown at Hollywood.

Chappelow

(Figure 6 B)

Form oblong, slender pyriform or "bottlenecked"; 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, California.

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.—1905 Yearbook, U. S. Dept. of Agriculture.

The fruits produced by the original tree show considerable variation in form, and Mr. Chappelow states that they are becoming larger as the tree grows older.

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 and September, and into October.

Shape of fruit variable, from pear-shaped to long-oblong, nearly banana-shaped; size, variable from 6 by 3½ to 3½ by 1½ inches; color purple, with scarlet streaks, very attractive; skin medium thick, smooth; stem large; meat yellow, free from fibre; flavor good, seed small, loose in cavity.—*Rolfs.*

Figure 10. A common Cuban type of large purple Avocados, apparently the same as the Wester.

Wester

(Figure 10)

Form roundish or obliquely pyriform with short neck; average weight 650 grams; skin medium thick, smooth and glossy, adhering to meat; color reddish purple; meat greenish next to skin, rich yellow toward center of fruit; flavor good, rich and buttery; seed medium large, usually loose in cavity; season October.

This variety is of vigorous growth and very prolific.—Bureau of Plant Industry.

Cardinal

Form bottlenecked; skin thick, red, mottled with yellow; flavor very good, a trifle watery; seed small, filling cavity; season October in South Florida.—*Wester.*

Harman

(Figure 11 A)

Form irregularly oval, slightly compressed, and flattened obliquely at the apex; dimensions, length three to four and one-half inches, diameter two to three and one-half inches; apex a dot; base tapering somewhat and slightly flattened; cavity regular, small, shallow, flaring, and somewhat furrowed, calyx persistent in the form of 6 divisions surrounding the stem base of fruit; pedicel stout, insertion usually one sided; surface smooth, glossy;

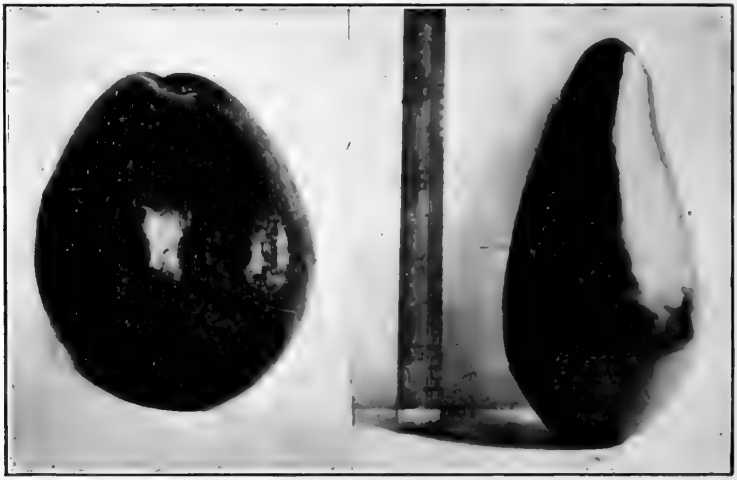

Figure 11. At left the Harman Avocado grown at Sherman, Cal.; at right the White Avocado grown at Santa Barbara.

color light green, washed with reddish purple, with numerous large, irregular greenish yellow dots; skin thin, adhering closely to the flesh; flesh greenish yellow, changing to yellowish green near the skin; texture smooth and very buttery; fibre practically none; flavor very rich and nutty; quality very good; seed very large, roundish conical, often loose in cavity; seed cavity very large; season October to November at Sherman, California.

Tree is upright, round-topped, and of fairly vigorous growth. Foliage rather scant, but healthy. Moderately prolific. This is the first description of this variety.

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 six and one-half by four and one-half inches; weight up to three and one-half pounds; color greenish; rind medium; meat yellowish; flavor good; seed medium.—*Rolfs.*

Landon

Form broad pyriform or bottlenecked; size medium to large, average weight one and one-fourth pounds; surface smooth, undulating; color light green; skin thick and tough, separating readily from the flesh; flesh rich yellow, changing to yellowish green near the skin; texture very smooth and buttery; flavor rich and melting; quality very good; seed medium large, broadly conical, tight in the cavity; season September to October in South Florida.

Quality

Form bottlenecked; size large; color green; skin thin, smooth; quality very good; seed medium large, loose in cavity; prolific bearer; season September in South Florida.—*Wester.*

Blake

Form slender pyriform, bottlenecked; dimensions, length three and one-half to four and one-half inches, diameter one and three-quarters to two and one-fourth inches; apex slightly protruding to form a point; base very slightly flattened; cavity regular, small, very shallow and flaring; pedicel stout; surface smooth, slightly undulating; color light green with numerous small, round, greenish yellow dots; skin very thin, adhering closely to the flesh; flesh creamy yellow, changing to yellowish green near the skin; texture smooth and buttery; fibre very slight; flavor very rich and oily; quality very good; seed medium, conical, often loose in the cavity; seed cavity medium large to large; season September to October at Pasadena, California.

Tree upright, of fairly vigorous growth, with abundant, healthy, light green foliage. Moderately prolific. Here first described.

White

(Figure 11 B)

Form slender pyriform; dimensions, length four and three-quarters, diameter two and one-fourth inches; apex slightly protruding to form a point; base somewhat flattened; cavity regular, small, shallow, rounded, pedicel stout; surface smooth; glossy; color bright green, washed with purple, with numerous small, round, yellowish dots; skin thin and leathery, adhering closely to the flesh; flesh cream color, changing to pale green near skin; texture smooth; fibre objectionable; flavor rather watery; quality fairly good; seed conical, large, tight in cavity; seed cavity long, pointed, and wrinkled; season November to December at Santa Barbara, California.

Tree is upright, moderately vigorous, and a rather shy bearer. First described here.

Miller

(Figure 9 B)

Form oval; dimensions, length four and one-half inches, diameter three and one-half inches; apex a slight point; base rounded; cavity regular, small

and shallow, flaring, furrowed; pedicel very stout, insertion usually one sided; surface very rough; color dark green, with numerous small, round, yellowish dots; skin very thick and tough, separating readily from the flesh; flesh yellowish cream color, changing to yellowish green near the skin; texture, smooth; fibre very slight; flavor fairly rich; quality good; seed large, roundish conical, tight in cavity; seed cavity large; season February to April at Hollywood, Los Angeles, Cal.

Tree is upright, vigorous, with abundant dark green foliage. Moderately prolific. Here described for the first time.

Walker

(Figure 12)

Form broad pyriform; dimensions, length four and one-fourth inches, diameter two and one-half inches; apex a dot; base rounded; cavity none; pedicel rather slender; surface very rough; color dark green, with numerous medium

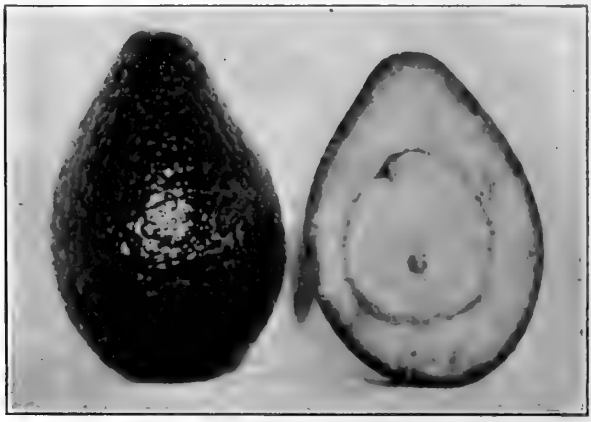

Figure 12. The Walker Avocado, one of the Guatemalan type, one-half natural size.

sized, round, yellowish green dots; skin very thick and tough, separating readily from the flesh; flesh cream color, tinged with green near the skin; texture smooth, but not buttery; flavor fair, rather watery; fibre objectionable; quality fair; seed large, broadly conical, tight in cavity; seed cavity large; season March to May at Hollywood, Los Angeles, Cal.

Tree is a vigorous grower, spreading in habit, with abundant, healthy, dark green foliage. Extremely prolific. A seedling of the Miller. Here first described.

Lyon

(Figure 13)

Form broad pyriform; dimensions, length five and one-half inches; diameter three and one-half inches; apex slightly depressed; cavity almost none; pedicel very stout, insertion usually one sided; surface rough, color dark green, with numerous small, irregular, yellowish or russet dots; skin very thick and tough,

separating readily from the flesh; flesh yellowish cream color, tinged with green near the skin; texture smooth and fairly buttery; flavor rich and nutty; fibre none; quality very good; seed large, broadly conical, tight in cavity; seed cavity medium large; season February to April at Hollywood, Los Angeles, Cal.

Tree is a vigorous grower, upright, with abundant, healthy foliage. Very prolific. This is the first description of this variety.

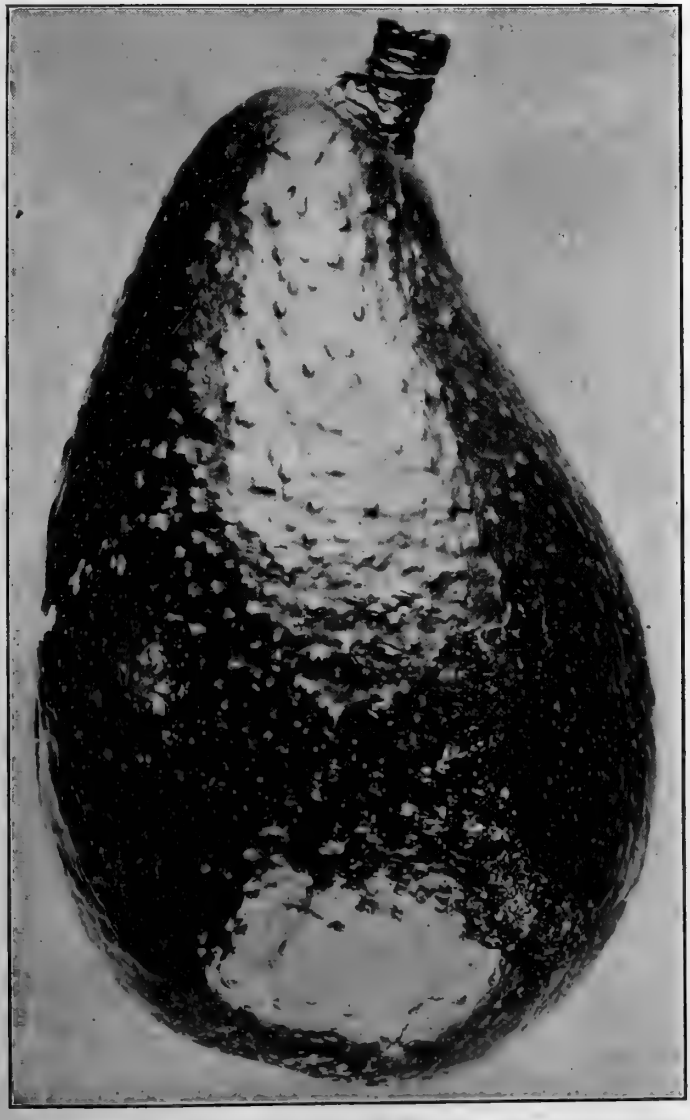

Figure 13. The Lyon Avocado, a fine example of the Guatemalan type. This specimen grown at Hollywood. Natural size.

Rico

Form rather oblong, thick necked, with oblique depressed flattening on opposite sides of both ends; average weight two pounds; skin rough; color pale greenish yellow; flesh pale yellow, with very little green near the skin; texture fine grained, firm; flavor very rich, nutty and buttery; season August to November in South Florida.—*Cellon.*

Insufficiently Known Varieties

Largo

Budwood from Mr. C. H. Matthews, who described the fruit as follows: "Egg shaped, very large, three and one-half to four pounds in weight; skin green, very thin; flavor very good; seed small; ripens in August and September."—*Wester.*

Johnstone

Budwood from 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."—*Wester.*

Blackman

Form oblong; size medium large to large; color greenish red to chocolate; skin thick and leathery; flesh delicate yellow, soft and melting; seed tight in cavity, medium large; quality good; season September in South Florida.—*Wester.*

Cyrus

Form pear-shaped to round; skin smooth, yellowish, thin, quality good; seed loose in cavity; very prolific; season September to October in South Florida. (Analysis gave 17% fat.)—*Wester.*

Sterling

Skin thick; color dark bronze red; quality good; seed filling cavity, medium large; season October in South Florida.—*Wester.*

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, four by five and one-half 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.—*Rolfs.*

Wither-Tip of Citrus Trees

(*Colletotrichum gloeosporioides* Penzig)

Its History, Description, Distribution, Destructiveness, and Control

BY E. O. ESSIG*

HORTICULTURAL COMMISSIONER OF VENTURA COUNTY

Common Names: Wither-tip; Leaf-spot; Tear-stain; Lemon-spot; Anthracnose; Canker.

INTRODUCTION.

The first observations on wither-tip in Ventura County were made by Dr. Albert F. Woods, Pathologist and Physiologist in the U. S. Department of Agriculture, Bureau of Plant Industry, during the month of April, 1909. At that time he made very careful examinations and found that much damage was being done by its attacks. The leaf-spot, lemon-spot, red-spot, dropping and discoloration of leaves, and the dropping of young fruit were all classed as the results of the wither-tip fungus.

Later in August of the same year Dr. P. H. Rolfs, who had done more work on this disease than any one else, visited the orchard and pronounced all of the above forms wither-tip, just as had Dr. Woods. Mr. Powell was of the same opinion, so it was not strange that the management of the Limoneira ranch, where these valuable observations were made, began at once to take steps to not only hold the disease in check, but to prevent the conditions already occasioned by it. The work there has been pushed with much interest and the results to date will be found in this article further on.

During the summer of the year 1910, Mr. C. N. Jensen of the Whittier Pathological Station made several trips into this county investigating this problem, but he did not remain in the State long enough to finish his work. At an inspection of the trouble in the Limoneira orchards he left the impression, to me at least, that this fungus was not in the habit of attacking strong and healthy tissues, but rather those portions of the tree which had become weakened by some external or other internal factor. In a letter from Dr. Coit, of the Whittier Station (following) it is made plain that Mr. Jensen did recognize the fact, that under proper climatic conditions, the disease did attack perfectly healthy trees. However, the impression left was that much of the work on wither-tip control was of little avail and we rather awaited further specific evidences of its work. These came in the form of a very severe outbreak in the Havana Seedling Orange orchard belonging to Mr. N. W. Blanchard of Santa Paula during the months of November and December, 1910. The tops and sides of the large trees were dreadfully injured by the work of the fungus, which killed fruit-bearing-wood back as far as four feet from the tips of the branches. The leaves curled up on the twigs and died before dropping to the ground and much of the fruit dropped within a few weeks.

*Graduate of Pomona College.

Inspection has shown that evidences of the diease could be found in every party of Ventura county. During the month of December, 1910, the navel orange trees of A. Anlauf in Santa Paula canyon showed the same conditions, while most of the lemon trees were affected, as noticed by the experts at the Limoneira ranch.

As soon as the attack was noticed, branches and leaves were taken to the laboratory and the characteristic-fruiting bodies of the wither-tip were obtained in great numbers. Samples were also sent to the Bureau of Plant Industry at Washington and to the Whittier Pathological Station. The replies affirmed the observations taken in the laboratory here and were as follows:

Figure 14. At left showing ground under trees covered with fruit and leaves dropped by the wither-tip; at right, the side of a tree with numerous twigs killed by wither-tip.

"E. O. ESSIG, *Santa Paula, Cal.*

"Dear Sir: I regret the delay in answering your letter of November 5th. I have been away travelling nearly all the time for the last month and in the meantime, Miss Hasse, my assistant, has made a careful examination of these specimens. They turn out to be typical wither-tip, the fungus *Colletotrichum gloeosporioides* being abundant * * * Your experience in having this attack following a series of rains is also the regular thing for that fungus.

"Yours very truly, M. B. WAITE, *Pathologist in Charge.*"

Washington, D. C., Dec. 12, 1910.

"Southern California Laboratory,
"Whittier, Cal., Nov. 7, 1910.

"MR. E. O. ESSIG,
"Horticultural Commissioner, Santa Paula, Cal.

"Dear Mr. Essig: Your interesting letter of November 5th and specimens of diseased orange twigs at hand.

"You are quite right in your decision that the specimens represent injury done by the wither-tip fungus, *Colletotrichum gloeosporioides*. I beg leave to differ with you, however, slightly in your statement that the opinion today is that the wither-tip disease does not attack healthy growth. Mr. Jensen, who worked on this disease last spring, maintained that the wither-tip did not attack healthy growth in any part of California except certain situations along the coast where the damp fogs and cold winds from the ocean seem to bring about a condition which permits the fungus to act as a parasite on lemons and oranges. He stated that in two places which he thought wither-tip might become a parasite in California were in the vicinity of Santa Paula and certain limited areas in the neighborhood of San Diego. In fact, he found one place near San Diego where the fungus was undoubtedly assuming a role of a parasite and advised that the trees be sprayed with Bordeaux Mixture.

"We are very interested to learn of the additional case you describe on Mr. Blanchard's trees and would suggest that the logical procedure would be of course to spray with Bordeaux Mixture.

"Would be glad to hear from you in the future in regard to developments.

Very truly yours,

"J. ELIOT COIT, *Acting Superintendent.*"

With all of the past experience with wither-tip behind us and with the added features already described we felt that immediate measures should be taken by all to hold this disease in check. The present article, aimed for the general public, is to set forth, as clearly as possible, the seriousness of a problem which we may all of us have to face, and which many of us are facing at the present time. Every possible bit of information has been collected and included in the article so as to make it as thorough as our present knowledge will allow. I am quoting very liberally from Mr. H. Harold Hume, Prof. P. H. Rolfs and Mr. H. S. Fawcett, all of whom have written valuable information concerning wither-tip. All correspondence relative to the subject has been included and in this shall be found much of the latest in investigation. Mr. J. D. Culbertson, Assistant Manager of the Limoneira ranch, has taken the time to give us the history and present status of the work which has been, and is being, done there. Combining our own observations, we trust that some value may be had from this first publication.

HISTORY AND DISTRIBUTION

The fact that the wither-tip had existed as a serious citrus pest in other places first led progressive growers to fear it in this country. At the present time it is known in practically every citrus growing section in the world in spite of the fact that many hold that it can do damage only where certain moisture conditions are secured.

Of the general distribution Prof. Rolfs states, "The disease extends through a large portion of Florida, the West Indies, South America, Australia, and Malta. In Florida the diseases seem to be increasing in severity." Prof. L. M. Underwood wrote: "This disease was found at only one point in Lake

county (Florida). Dr. Martin found it in 1886 at Green Cove Spring. It does not seem to be widespread nor at present of much importance, but is recorded here that attention might be called to it, so that its nature might be known and its progress watched."—Jr. of Mycol., VII.; p. 35, 1891.

"Professor Hume has collected specimens of the disease in several places in Florida. He also mentions that some pomelo seedlings lost nearly all of their leaves as a result of the attack of the fungus in question." "Miss Stoneman found that this fungus attacked orange trees in conservatories." "Penzig mentioned this fungus as being destructive to citrus plants, attacking the foliage mainly." "McAlpine found this fungus on the orange near Melbourne, Australia, in 1892, and in 1898 it was found by Tryon to be destructive to the lemon leaves in Queensland." "In Brazil it seems to be quite generally distributed. Noack found it especially severe at Sao Paulo, where it was recognized not only on the leaves, but also on the smaller twigs, latter were killed as far as the fungus penetrated, showing a very decided demarcation between the sound and diseased areas." U. S. Dept. Agrcl. Bull. No. 52, 1904, p. 10.

"This disease on the fruit was first observed by the writer in the autumn of 1901, but attracted little attention at that time, as the damage was slight, only a few specimens of the diseased fruit having been observed in a single grove. Since that time the disease, in the grove where it was first observed, has increased to such an extent that the trees, on which it was first noticed, yielded a very small proportion of sound fruit during the present season. The disease has probably been at work for a considerable length of time, and as is usual in such cases, attracted little attention until it became serious. The loss during the past season in two or three instances has amounted to from five hundred to a thousand dollars in a single grove."

"From our present knowledge of this disease it appears to be on the increase and we are probably justified in predicting that it has not yet reached its worst. The disease is in all likelihood an introduced one and it may be looked to, to attack the sweet orange in addition to the lemon, lime and pomelo. It frequently occurs upon leaves, twigs and branches of the sweet orange, and on one occasion sweet orange fruit on one of the fruit stands in Lake City, Florida, were observed, covered by lesions (diseased spots) caused by this same fungus *Colletotrichum gloeosporioides*." H. H. Hume, Fla. Exp. Sta., Bull. No. 74, pp. 161-162, Aug., 1904.

In view of the fact that the disease is thought to do damage only in a damp or moist climate, it might be interesting to state that the writer recently spent a week in the Salt River Valley, Arizona, looking over the citrus orchards and especially as to the distribution and damage caused by wither-tip. Of course it was at a damp period of the year, but cannot be compared to the favorable places Dr. Coit quoted Mr. Jensen as pointing out to be favorable to the severe attacks of the disease. The fruit growers of that section stated that much of the bloom and young fruit had been dropped by some mysterious manner—frost they believed to have been the cause though it had come some time before the real damage was done. All of their

descriptions pointed to wither-tip as we saw it in Ventura County, and the matter was followed up as carefully and as fully as time would permit. The results were that under the trees were to be found quantities of the discolored leaves so common to the attacks of this disease, while the familiar leaf spot was seen everywhere. Bare twigs and dead branches showing the acervuli (fruiting bodies) were also very common. Perhaps not all of the dropping of the young fruit, referred to, was caused by wither-tip, but, from the indications, it is more than likely that a great loss was due to it. Even the indications in the discolored leaves, leaf-spots and bare twigs are interesting from so dry a country as Arizona and only goes to show that the disease may thrive and do well in any climate where there is a rainy season.

In California. In this state the disease may be found in practically every citrus growing section, but it is not contended that it has been doing damage in all. In Ventura County, the writer has collected specimens of the leaf-spot in all parts, including those sections furtherest away from the coast. As stated before the fungus seems to thrive best in the vicinity of Santa Paula in spite of the fact that lemon groves are situated much nearer the coast and are subject to more cold and dampness at Oxnard than at this place. No serious attacks on the orange trees have been noticed at Ventura which is situated right on the sea border.

DESCRIPTION

On the Leaves. (Figs. 15 and 16): The presence of the fungus is best told by its appearance on the leaves. The most common forms are leaf-spots which show up while the leaves are still clinging to the tree and appear to be healthy in every other way. The spot is usually light brown to nearly colorless and is surrounded by a very characteristic brown ring, which separates the dead from the living tissues of the leaf (Fig. 16). Arising upon the dead discolored spot are numerous minute dark acervuli (fruiting bodies of the fungus). The spots may begin at any point of infection and spread so as to run into each other almost entirely destroying the texture of the leaf. They may start at the tip-end or at an edge and cut out deep margins. It appears that this condition is brought about by the fact that after the infection started the leaf was able to retain enough vigor to resist the attacks, so that the diseased areas only were killed, instead of the entire leaf succumbing and falling off as is usually the case.

This latter form is perhaps the most common indication of wither-tip on the lemon trees. The leaves first turn a sickly yellow color, gradually become brown and fall to the ground. Many may fall while still in the yellow state, while large numbers have been collected and the wither-tip obtained from them, which were still green when they fell. Not a few leaves may be found which begin to turn brown at the tip (Fig. 15) the infection working backwards to cover the entire surface before the stem is reached and severed.

On the sweet and navel orange-trees the infestation is very marked and sudden. The leaves die, curl up and turn a greenish-brown color while

still hanging to the twigs. Entire twigs may thus be affected and the foliage does not fall until it is thoroughly dead and dry. One can always tell this stage by the dark color of the leaves.

In all cases of doubt as to whether wither-tip is in an orchard or not, it can be accurately demonstrated by placing the leaves or twigs, supposed to be infected, into a moist chamber and within three or four days the cinnamon-brown acervuli (Fig. 15) will appear on all surfaces in great numbers.

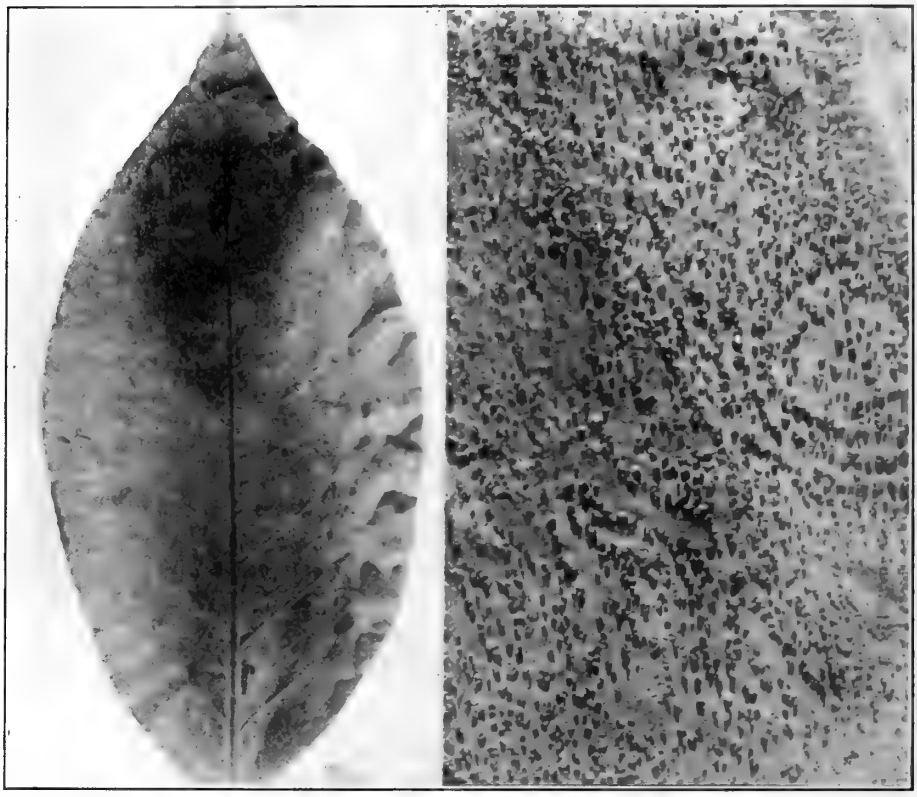

Figure 15. At left a lemon leaf showing darkening area by incipient wither-tip; at right the magnified surface of an orange leaf covered with numerous acervuli of wither-tip, each one of which contains great numbers of spores.

Of the leaf-spot H. H. Hume writes in Bull. No. 74, Fla. Agrcl. Exp. Sta., p. 164, Aug., 1904: "On the leaves, the disease first appears in the form of rather irregular areas from one-eight to three-fourths inches across. Occasionally they become confluent or join each other so as to embrace a large portion of the surface of the leaf. The spots vary in color from bronze-yellow to a dark shade of brown, depending upon the stage of development. Usually the diseased spots are located near and extend to the margin of the leaf. The tip is quite a favorite seat of infection, the lesions (diseased

spots) may, however, be located on the leaf entirely removed from the margin. The characteristic color noted above marks the commencement of the disease, the period during which the mycelium (fungal threads) is growing most actively in the tissues of the leaf."

"As the disease progresses, the affected area becomes more clearly defined. The areas representing a number of separate spots of infection, close to each other, becomes continuous. The color changes from yellowish to the gray hue of dead tissue. The line of division, between the dead and the green, living tissues, is slightly elevated and as already noted, clearly defined. At this stage, a close examination of the discolored spots on the upper side of the leaf reveals the presence of a number of minute dark dots. These dots are arranged more or less completely in concentric circles or ovals.

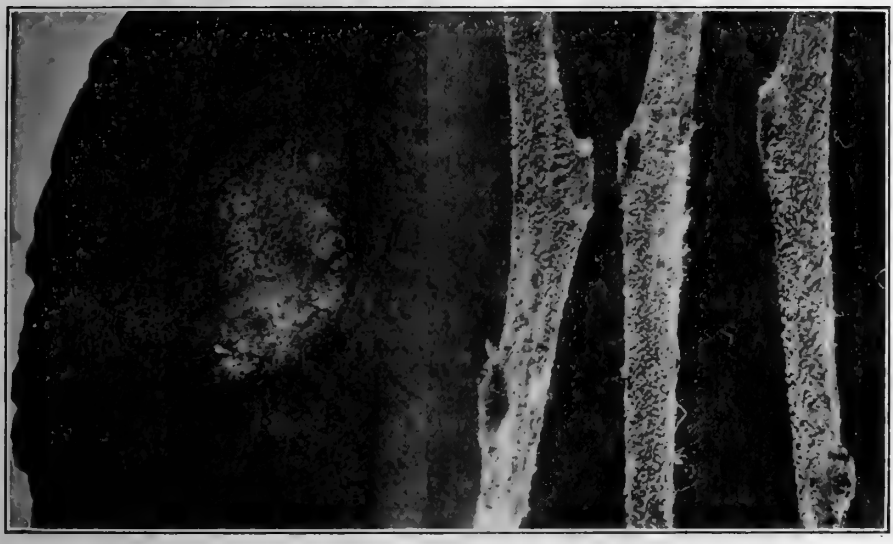

Figure 16. At left a characteristic leaf spot of lemon probably also due to wither-tip; at right fully developed acervuli of wither-tip on orange twigs.

These dark dots are in reality the spore-bearing parts of the fungus (Acervuli) containing large numbers, the spores, by means of which the disease is spread from one portion of the tree, from one tree or from one grove to another. The affected, or diseased areas are usually located near the tip or side of the leaf, though they may be situated near the central portion of the blade."

Of this leaf-spot Prof. Rolfs says, "The first point of attack is in the leaf. The development of the fungus takes various peculiar forms. At times the acervuli are distributed in a more or less irregular way from the center, resembling 'fairy rings.' At other times the infection takes place in the tip of the leaf, which gradually withers back to the stem. Small trees may be defoliated and the fungus continue to develop in the twigs." U. S. Dept. Agrcl. Bull. No. 52, p. 15, 1904.

On the Twigs. (Fig. 16): The twigs on the Havana Sweet orange trees at Santa Paula often died back as far as did the leaves, but in most cases they first remain green but bare for some time after the leaves have been killed and dropped. Fig. 10 shows a branch nearly four feet long which was entirely killed on the tree before the leaves dropped. This condition is especially true of the smaller outside twigs on the orange trees. This dying is accompanied by the same unhealthy discoloration described in the leaves, the tissues dividing the dead from the healthy portions assuming the characteristic brown ring. No spores appear upon the twigs until after they have been dead for some time and are subjected to a moist condition. In the moist chambers of the laboratory the fruiting bodies were

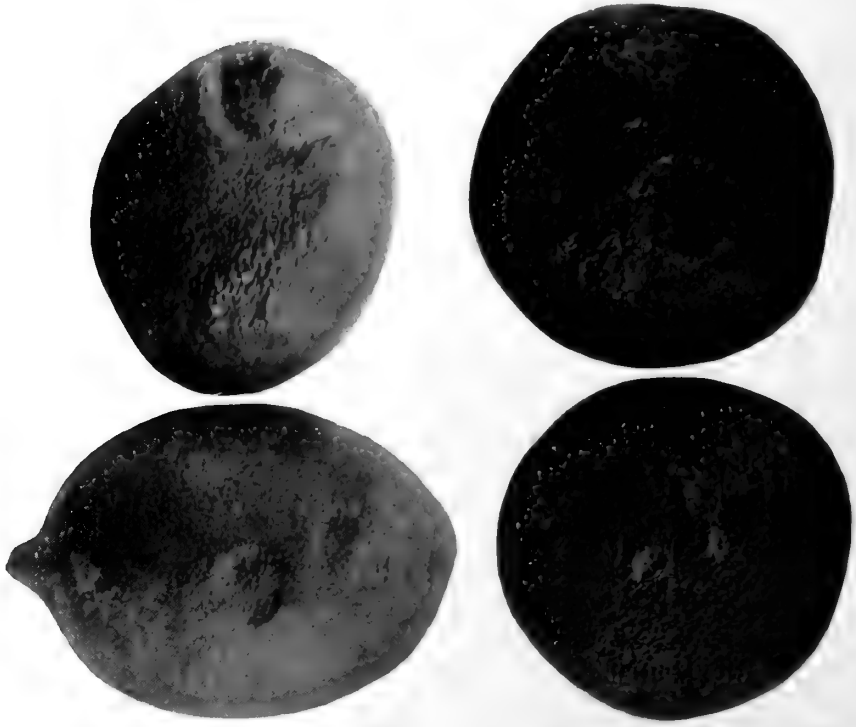

Figure 17. Spots caused by wither-tip on lemon; the same on orange to the right.

produced upon all of the dead tissues (Fig. 16) and upon the apparently healthy green portion of the twigs 12 inches below the ring, showing that the disease was working back all of the time and simply awaiting a condition favorable for another outbreak.

The twigs of the lemon trees do not succumb to the attacks of the disease as rapidly as do those of the orange. They remain bare for a long period, and though green and healthy-looking do not bear leaves or fruit. So far as worth to the tree is concerned they might just as well be dead. In time they do turn brown and slowly die from the tips back, the infection usually

stops at a fork in the branch. The lemon trees, showing the effects of the disease most, are those which have the greatest number of fallen leaves and bare twigs.

On the Fruit. (Fig. 17): The fruit-spot, commonly called lemon spot, orange-spot, and pomelo-spot or anthracnose is the most easily recognized. On the lemon it usually develops in the packing house and is first simply a dull green blotch, remaining so after the lemon has turned yellow in curing. Later the center of the spot, which may enlarge, becomes from a sickly-yellow to a brown color and is softer than the margins, which have retained the same firmness as the rest of the lemon. This stage develops the black or dark brown acervuli, which appear in the center of the spot, giving it a dark color. The tissues begin to sink, forming a depression in the center of the spot. The fruit may keep in good condition when thus infected for a long time without any apparent progress in the work of the fungus and again it may decay very rapidly. The green spot may not develop to form the fruiting stage until after the lemons have been placed upon the market, so may admit of the marketing of the fruit, but it places it in the lowest grade.

It will be interesting to note that many have considered this spot a result of sweating and not a fungus at all, but it is the wither-tip brought out, perhaps, in greater abundance, by sweating, than under normal conditions, which has given rise to this belief.

The so-called "red-spot" (See Fig. 18) on the lemon has never been described outside of California. However, it has received considerable attention from Dr. Woods and Prof. Rolfs—men who are the best authorities known on wither-tip. These men have all pronounced it as a result of this fungus.

The infection takes place at any point on the rind in the form of minute dark brown or cinnamon red spots. At first these may be so small that they cannot be detected without the aid of a hand lens and may be very scarce. The spots grow in size and increase in number until the whole rind is speckled. Later they become confluent and spread over the entire surface giving the fruit a dark-brown or even black appearance. The disease does not seem to affect the pulp of the fruit at all, but simply disfigures the rind so as to make it unfit for market. Each red spot, in the earlier stages, produces a sunken area which is very characteristic of this stage.

The attack is more often on the fruit known as "tree-ripes"—fruit that has ripened on the tree—but it is not an uncommon thing to find it also abundant upon the green fruit. It was first noticed on the trees affected with "Gummosis," and it has not infrequently been attributed to that as a cause. It may be that it was most abundant here because of the weakened condition of the tree, brought about by the gumming, which enabled the fungus to find the most favorable conditions for growth.

Of the spot Dr. Woods writes: "Before leaving California I arranged with Mr. Powell to have a lot of the lemons and grapefruits showing the tear-stain and browning and other effects of the wither-tip fungus forwarded to

me. I had these carefully examined and found the fungus, *Colletotrichum gloeosporioides,* present in practically all cases."

Concerning the same point, Mr. M. B. Waite, Pathologist in Charge of the Bureau of Plant Industry, Washington, D. C., writes: "In the first place there is no question about its (the disease on lemon twigs and fruit sent to Mr. Waite for determination) being affected with the wither-tip fungus, *Colletotrichum.* Spots were found with a little of the fungus on microscopic examination and upon culture tests the material was found to contain considerable of the fungus. Ripe spores were found on old, dry twigs, while the leaves and the fruit developed spores after being sterilized and covered with a dry bell jar."

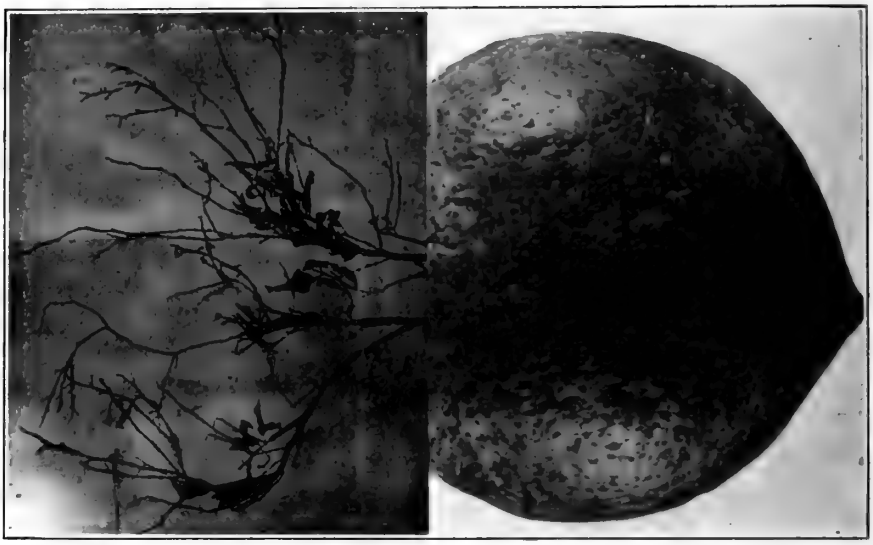

Figure 18. An orange branch killed by the wither-tip, some of the dead leaves still hanging; a lemon showing red-spot caused by wither-tip.

"I think the red spider is responsible for the spread of the fungus to a considerable extent on the lemons this season, the slight injury produced by the spider making an opening for the fungus to get into the skin of the fruit."—*P. H. Rolfs.*

On the orange the first symptoms appear as greenish or brownish irregular blotches, resembling greatly those described on the lemon. These spots grow rapidly while the fruit is still on the tree and may assume nearly half the size of the fruit. (This being due to the fact that many spots become confluent thus forming a single large diseased area. The average size, however, is about that of a 25c-piece.) With age the center of the diseased area may become lighter before turning a dark brown or black with the appearing of the dark fruiting bodies. The area may be raised above the remaining surface of the orange or it may sink to form a depression as is shown in the photo (Fig. 17).

Mr. Hume gives the following about the disease on the fruit of the pomelo: "Upon the fruit the disease is first manifested by the irregular brownish discoloration. This discolored area is irregularly defined around the margin. The diseased spot may be on any portion of the fruit and may vary from an inch or so in diameter to an area nearly equal to that of the outside of the fruit. As it progresses these spots gradually change in color, sometimes becoming grayish, sometimes somewhat lighter. Ultimately, however, the whole affected area becomes dirty black in color. If the point of infection is small at first it gradually enlarges under favorable conditions so as to embrace the whole fruit. Sometimes the affected area remains constant in size for a considerable time, in which case in its older stage it varies from black at the center through various shades of brown, brownish yellow to the normal yellowish color of the healthy rind at the margin." Fla. Agrcl. Exp. Sta. Bull. No. 74, pp. 165-166, Aug., 1904.

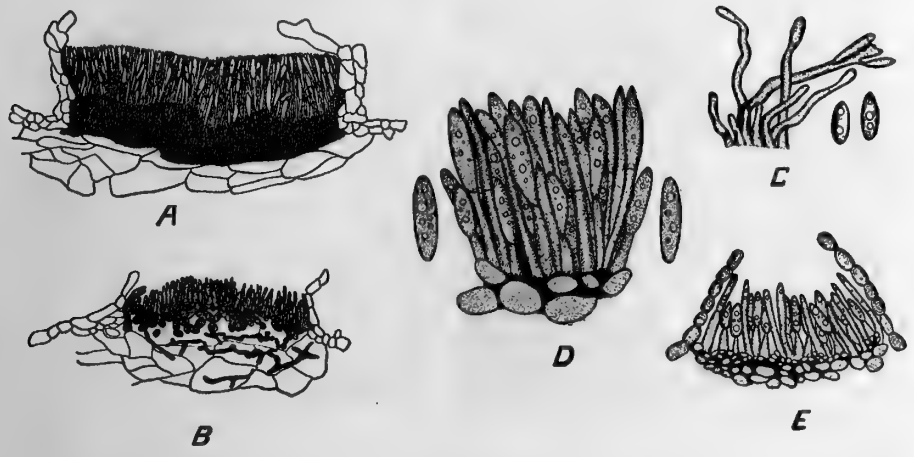

Figure 19.

Details of fruiting bodies of wither-tip fungus: A, acervulus with compact contents of setae, conidiophores and conidia (original); B, acervulus in more advanced stage, the spores escaping (original); C, conidiophores, conidia and setae (after Hume); D, enlarged portion of B; E, cross section of acervulus after McCullough in Bull. 52, U. S. Dept. Agrcl.

SPECIFIC DESCRIPTION

This fungus is strictly parasitic, e. g., feeds directly upon the tissues of the host plant. The conidia (spores) are very minute regularly oval bodies which are admitted into the tissues of the host by means of small punctures or abrasions of any kind. Here they germinate, forming rather stout mycelium, which penetrates the plant cells, and through which the fungus draws all food. Not until the tissues of the plant are killed are the acervuli (fruiting bodies) produced. These acervuli contain the conidia or spores which develop within the little sac. As soon as they are produced from the mycelium they shove themselves through the surface of the host and when the conidia are ripe the top opens up allowing them to escape.

There are millions of these conidia formed within each acervulus. (Fig. 19 A, B.) As stated above the spores (Fig. 19 C, D, E) are oblong or oval, but much longer than the diameter. In mass they appear cinnamon brown or even dark, but under the lens they are apparently colorless, containing minute granules and several oil globules, as shown in the figures. They are formed as small buds (conidia) upon the ends of short conidiophores and break off very easily when mature. There may be seen all stages of these forming conidia and conidiophores in a single acervulus, but all will mature before the fungus has finished its mission in life. It is not over-stepping the mark to say that each acervulus may produce many thousands of spores, all of which will germinate under favorable conditions. The acervuli may be produced upon any surface of a twig, fruit, or leaf in numbers sufficient to prove that the mycelium has penetrated every cell beneath. (Fig. 19 B.)

Prof. Rolfs' technical description is as follows: "Acervuli located on the surface of the leaf, twig, or fruit; 90-270 u in diameter, erumpent, superficial. Shape various, not uniform, occuring on either surface of citrus leaves; disposed irregularly or in more or less concentric lines; pale to dark colored. On tender lime twigs, tender lemon twigs, lemon fruits, and lime fruits, pale colored, dull red in masses, confluent. Epidermis breaks irregularly."

"Setæ fuliginous, ranging in length from 60 to 160 u, frequently once or twice septate, disposed at margin of acervuli. Frequently absent, and on tender lemon twigs, tender lime twigs, lemon fruits, and lime fruits usually absent."

"Conidia broadly oval or oblong, 10-16 u by 5-7 u, hyaline; size variable in same acervulus, usually with one or two oil drops. Developing from a well defined stroma; basidia, 3-8 u. In moist chamber the conidia stream from the break in the epidermis."

"Intra-basidial setæ, variable 8-30 u by 3-6 u, cylindrical or sometimes enlarged at distal end; hyaline."—U. S. Dept. of Agrcl. Bull. 52, p. 16, Mar., 1904.

DESTRUCTIVENESS

As has been stated before, the first appearance of the disease upon the orange, in a seirous way, was upon the foliage and especially on the fruit-bearing wood for the next season, although much of the present bearing wood was completely killed and the fruit fell to the ground. The photograph (Fig. 9) will give some idea of this attack. It will be seen that the leaves have died in patches all over the outside of the tree. The bare twigs at the top shows an earlier attack which dropped all of the leaves. Figure 18 A shows a branch taken from the top of a sweet orange tree a week after the infection was first observed upon the tree. Figure 14 A shows a typical case of fallen leaves and fruit. This photograph was taken under the tree shown in Figure 14 B a week after that photograph was taken. It will give some idea of the severity of the disease and an idea of what it means to an orchardist.

Not all of the fallen fruit show the effects of wither-tip at the time it dropped, but if placed away in moist chambers soon develop the spots described above. The infections are quite general on much of the fruit that has not fallen and the amount of injured fruit may reach to several hundred boxes, not counting what may develop after it has been picked and boxed for shipment.

The fact that the infection takes place before any evidence is displayed upon either tree or fruit makes the pest a serious menace if one has not been prepared to meet it in advance. All fruit which has become infected on the tree cannot be treated in any wash that will prevent the coming out of the fruiting bodies. To demonstrate this, leaves infected in the orchard were soaked a short time in Bordeaux Mixture, such as is used for spraying citrus trees, and placed in the moist chambers. The acervuli appeared in great numbers through the residue of the Bordeaux upon the leaf. All methods of control must be directed as preventive. This makes the results of the first unlooked for attack very destructive to the orange grower. It is well to dip the fruit, however, to prevent infection in the box or in the packing house.

The leaf-spot—"Canker"—is more common upon the lemon than upon any other citrus tree in this county. In Florida it seems to work to even a greater degree upon the pomelo, but such a case has not been observed here yet. Neither have we ever found the withering of the twig and leaves as described by Prof. Rolfs on the lemon tree. The discolored leaves, the spot, and the bare twigs give us the most evident clues in the field.

It is the dropping of the young fruit that is considered the most serious work of the fungus in the lemon orchards. At times it seems as if a third of the young setting lemons were dropped by it. The brown mummies on the ground or still clinging to the trees are full of the wither-tip spores. Much of the work being done at the Limoneira ranch is to prevent this condition. The results and costs, as well as the importance of the work there is to be presented in Mr. Culbertson's paper further on. Concerning the dropping of the bloom due to wither-tip, Prof. Rolfs states:

"The most serious shedding of bloom occurs as the result of an attack of a parasitic fungus, *Colletotrichum gloeosporioides*. This is a serious trouble, for only too frequently its cause is not recognized, the shedding of the bloom being ascribed to one of the before-mentioned causes, or to the presence of thrips or other insects.

The first sign that we notice in connection with the wither-tip dropping of bloom is that a great number of unopened flower-buds have fallen from the tree. As this same effect may be the result of other causes, the mere fact that we find unopened flower-buds on the ground should not be considered as proving that we have a case of wither-tip bloom dropping. Upon closer examination, however, we find that where the bloom has dropped on account of being affected with the wither-tip fungus, there are little red markings upon it; and the buds or blossoms may be partially, or even entirely, covered by these red patches. By examining such flower-buds or

petals in the laboratory it can be easily demonstrated that they are affected by the wither-tip fungus. By using a strong hand-lens one is able to see the minute pustules in which the spores are produced. Such diseased flower-buds and petals, however, differ so strikingly from those that have fallen naturally, that almost every one whose attention has been called to the point is able to distinguish between them, without the aid of a lens. When much bloom has dropped as a result of being affected with the wither-tip fungus, one almost invariably finds the typical signs of wither-tip on the tree. The most prominent of these are the dying back of small sprigs, and the very characteristic want of leaves on the inside of the tree. Whenever one sees a tree in the orchard that has no interior foliage, it should be noted as a suspicious specimen.

The wither-tip fungus which causes the dropping of the flower-buds lives over the winter in the leaves, or in the twigs of the tree, or on fallen fruit. From these sources some of the spores find their way to an open bud, where the fungus grows very rapidly and produces myriads of spores. Bees, flies and other honey-loving insects, visit the affected blossoms, and coming into contact with the fresh spores, not only carry them on their bodies to almost every open blossom on the tree, but in crawling over the unopened buds they convey the spores to these as well. But worse still, the insects which have visited an infected tree carry the spores to other trees in the grove, and from these secondary infections numerous other infections occur in time; so that hundreds of trees that were free from the wither-tip fungus may become infected from one single tree with diseased blossoms.

DROPPING OF NEWLY-SET FRUIT

Sometimes this fungus does not attack the bloom, but attacks the newly-set fruit after the blooming period is over. Not unfrequently one may see the ground under a citrus tree strewn with thousands of small fruits, every one attacked by wither-tip fungus. In this case the same remedy used for the shedding of bloom will be found useful."—Fla. Agrcl. Exp. Sta. Press Bull. No. 84, Mar., 1908.

The large fruit spot described under the heading "Description" (Fig. 5) shows up to a considerable degree in the packing houses. In the past little attention has been given to it except to cull all infected fruit and run it into the lowest grade. While many of these lemons go down before shipment the bulk remain sound enough to reach the eastern markets. The principal injury is due to the fact that fruit, which would be first grade except for the spots, is rendered almost worthless for selling purposes.

The "Red-spot" usually appears in the field and all infected fruit is culled out by the time the fruit is ready for the pack. It has the same valueless feature as has the lemon-spot in rendering the fruit unfit for market. The fruit infected with this spot keeps very well, for only the rind is injured. I have in my office a lemon preserved from last year, the rind of which is entirely browned due to the red-spot, but the inside of which is

perfectly sound and in excellent condition. The occurence of the trouble is sufficiently great to warrant considerable expense in preventing it.

LITERATURE AND SYNONYMY

Colletotrichum gloeosporioides Penzig.

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" " Hume. Fla. Agrcl. Exp.. Sta. Bull. No. 74, Aug. 1904.

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" " Hume Cirt. Fruits and Their Cult. pp. 473-475, Dec. 1907.

" " Duggar. Fung. Dis. of Plants, p. 327-328, 1909.

" " Cal. Cul. 32, p. 708, June 1909.

" " Cook. Cal. Cul. 33, p. 460. Nov. 1909.

" " Fawcett, Fla. Agrcl. Exp. Sta. Press Bull. No. 133, Dec. 1909.

" " Massee. Dis. of Cul. Pls. and Trees. p. 144, Jan. 1910.

" " Fawcett, Cal. Cul. 34, p. 725, June 1910.

" " Cal. Cul. Pruning 35, pp. 660-661, Dec. 1910.

CONDITIONS FAVORABLE TO GROWTH

Any climatic condition unfavorable to the growth of the tree is liable to bring on an attack of wither-tip, especially in a country which has been subject to this attack.

Frosts kill the twigs of the trees and afford excellent places for the fungus to germinate and produce spores.

Wind.—Hard winds whip the trees so as to cause numerous abrasions and wounds, which afford excellent entrances to the spores of the wither-tip.

Insects.—Perhaps no better condition is afforded for the infection of the plant tissues than that due to the attacks of insects. Scale pests constantly draw sap from the trees, and the slightest rain washes the spores down the limbs and into their punctures. It might be expected that this disease would be worse in dirty orchards than in those which are kept perfectly clean.

Diseases.—Gummosis has certainly had something to do with the production of the "red spot" so often referred to. As has been stated, the two conditions have been associated together as arising from a common cause. The

spot is probably caused by the weakening of the tree due to the gummosis rather than any other reason. It might naturally be expected to find the wither-tip upon any diseased trees which are suffering from Gummosis, Die-back, Foot-rot, etc.

Lack of Care.—Poorly fed trees have been observed to succumb to this disease first—the leaves showing the spots, the twigs dying, and the fruit spotted before it appeared elsewhere. The cure is obvious.

Moisture.—This is perhaps the most important factor in contributing to the growth of this disease. As with all of the fungi a moist condition produces ready and rapid germination and excellent conditions for future growth. The early observations of the wither-tip were all connected with the belief that it could thrive only in a very moist climate. This belief caused some surprise to the Florida experts who thought that the climate in California was too dry.

The attack in Ventura County was preceded by an unusually heavy rain which brought on the attack almost immediately.

It will probably be found in any citrus growing community which receives any rainfall at all, from the fact that it has been observed in Arizona, but only during the winter months.

In a wet country much trouble must be expected from this disease.

A systematic application of sprays should be continued throughout the year, in plots at least, so as to be sure of the advantages of the preventative work of fungicides.

TREES ATTACKED IN VENTURA COUNTY

SEVERE ATTACKS:

Variety	*Location*	
Havana Sweet Seedling Orange	Santa Paula.	
Navel Orange	"	
Valencia Oranges	"	and Saticoy.
Eureka Lemons	"	
Lisbon Lemons	"	

Slight Attacks.

All citrus trees in this county.

MODES OF DISTRIBUTION

Wind.—The spores are so minute that when they become dry they may be carried for miles by the wind. These spores are usually blown into the tops of the trees and the heavier attacks may be expected in these places. In Southern California it must be expected that, if the disease is common along the coast, that the coast winds are sure to carry the spores to all inland sections and these need only the moisture conditions to produce the disease.

Water.—If the spores find lodgment in the tops of the trees they are sure to be carried to all parts of the undergrowth by the first rain. This is the most effectual way of infecting all parts of the tree. The "Tear-stain" is produced by the dripping of the water from an infected twig or "Mummy" to an uninfested lemon.

Insects.—Prof. Rolfs attributed much of the red-spot to the work of the red spider, and this indeed is a very important factor in the scattering the spores on the leaves and fruit as well as a means of inoculating those portions of the tree. Other insects as young black scale, plant lice, as well as the silver-mite, prove efficient distributors of this disease.

General Articles on Wither-tip.

Of the disease in California the California Cultivator states: "This disease has been quite severe on citrus trees in some parts of the state. Last November it occurred in a number of groves near DeLand, causing much damage. It killed back twigs and limbs even in otherwise healthy and well-kept groves. It was noticed, in some cases, that the damage done by wither-tip became evident after several weeks of dry weather following a period of moist weather. It was also noticed that in a neighborhood where groves were close together, the disease would frequently be severe in one grove while at the same time a neighboring grove would remain free from it. Within the same grove also there were individual trees and individual limbs of a tree that were attacked, while other trees of the grove and other limbs of the diseased trees remained uninjured. The difference in the action of the fungus toward different limbs of the same tree is probably due to a difference in the vitality of the individual limbs. Any cause rendering a branch somewhat weak, such as previous heavy load of fruit, would most render that branch susceptible to an attack of the fungus. The same would doubtless be true in regard to the susceptibility or immunity to the disease of the different trees in a grove. Cases occur that can be accounted for by considering trees as individuals, each slightly different from the other. One tree apparently just as healthy as another is, for some cause, not yet understood, less resistent to this particular disease, and is therefore attacked, while the tree next it may remain uninjured."—Cal. Cul. XXXII, p. 708, June, 1909.

The condition, as stated above, is no doubt a common example of the attack of the wither-tip, but such was not the case in the orange orchards at Santa Paula. The trees were in excellent condition, with plenty of fertilizer, water, and cultivation. There had been no frosts, and no hot weather to weaken the trees or branches. A rain fell about three weeks before which started the spores germinating and an attack resulted which did not omit even the healthiest-looking and most vigorous trees. It was a case where every tree was touched without regard to its vitality.

Prof. Cook of Pomona College writes: "During the last two or three years a new disease has appeared in our citrus orchards. It is the old well-known wither-tip of Florida. It attacks all kinds of citrus trees. It is probable that it is affecting many orchards without being known or recognized at all.

The disease pits the fruit; causes the leaves to fall, and the terminal twigs to wither. In some orchards it has done serious harm and would have become very much more serious had it not been discovered and the remedy applied."—Cal. Cul. XXXIII, p. 406, Nov., 1909.

The History and Control In the Limoneira Orchard

BY JAMES D. CULBERTSON,* ASSISTANT MANAGER

"During the summer and fall months of 1908 we became suspicious of a new and strange trouble affecting the lemons in the Limoneira orchard. It was evidently a fungus, and although confined mostly to the ripening fruit, nevertheless the incipient stages were plainly noticeable on many of the half-grown lemons that were still green. Of the ripe fruit a great many of the lemons were rendered unsalable and thrown away, while thousands of others were thrown into the lower grades by the disfigurement resulting from this "rust" or "brown-speck" as some called it. On the greener fruit it appeared as tiny black specks, like minute pin-pricks, while on the half-ripe and ripe lemons these specks were usually a reddish brown, and many of them had increased in size varying from the smallest speck visible under a hand-lens to the size of pock-marks, or even larger. Each spot formed a marked depression in the rind, and not infrequently they would merge into one another until in some instances covering the entire lemon, leaving only a brown "mummy" hanging where the healthy yellow fruit had been. Traces of this trouble had been noticed off and on for several years, but the amount of fruit affected by it was so insignificant in relation to the whole that its presence at first occasioned not even a comment, so that it is not known when it made its first appearance.

By the spring of 1909, however, we began to realize that the percentage of infected fruit was a commercial consideration in itself, not to speak of possible future increase in loss. The new crop was being gathered from the trees and everywhere throughout the 300-acre orchard the presence of this trouble was more evident than ever. Specimens of affected fruit were sent to various sources for identification. Trees containing the worst affected lemons were usually below the normal in vigor of leaf and twig, and often chloratic and subject to gum disease. In some cases we wondered if this first trouble could be a part of the cause, as we later learned that it was. But on even the healthiest trees it was nearly always possible to find some of both the green and yellow lemons affected with the characteristic minute spots.

While waiting for reports on the specimens sent out it happened that Dr. A. F. Woods, then Assistant Chief of the Bureau of Plant Industry, and Mr. G. Harold Powell of the same Bureau, were making a trip through Southern California and paid us a visit. It was the 20th of April. When taken to the orchard, without hesitation, they pronounced our trouble "wither-tip", scientifically known as *Colletotrichum gloeosporioides,* a fungus parasite of Citrus known and dreaded in Florida for 15 years. While we had noted only its effects on the fruit our attention was called by these gentlemen to numerous dead twigs, to yellow and brown spotted leaves, and also to countless small blackened and dried lemons that had probably been attacked and killed by the fungus, when otherwise healthy, before they were larger than small beans. These were characteristic of "wither-tip" ravages in Florida, and the presence

*Graduate of Pomona College.

of the acervuli on dead twigs and leaves, together with frequent brown stains, "Tear-stains", on the fruit, further convinced them that our trouble was the same.

They were surprised that in the dry climate of California the fungus could thrive and propagate itself so vigorously. Dr. Woods and Mr. Powell both assured us that it could be checked by fungicides, particularly mentioning Bordeaux Mixture with Bicarbonate of Soda, but they were of the opinion that its present development in the orchard was probably abnormal, due perhaps to extraordinary weather, for we had had a warm winter with more than the average amount of humidity. With the return of dry summer weather they thought it would make little or no further progress and probably would cause no anxiety in the future except possibly during seasons similar to the one just passed. Accordingly we did nothing at the time other than to send samples of twigs, fruit, and leaves to Washington, together with a request for all available literature on wither-tip, particularly Bulletin No. 52, by P. H. Rolfs, treating of the disease in Florida. The edition of this bulletin was completely exhausted, but a later appeal to Dr. Woods, who had returned to Washington in the meantime, brought the following reply:

"Washington, D. C., May 29, 1909.

MR. JAMES D. CULBERTSON, *Santa Paula, California.*

My dear Mr. Culbertson: I have your letter of May 21st. relative to your failure to get the wither-tip bulletin. I was very sorry to find on my return to Washington recently that this publication had been entirely exhausted and that there was no copy to be had either from the department or from the Superintendent of Public Documents. A new edition will have to be printed.

Before leaving California I arranged with Mr. Powell to have a lot of the lemons and grapefruits showing tear-stain and browning and other effects of the wither-tip fungus forwarded to me. I had these very carefully examined and found the fungus, *Colletotrichum gloeosporioides,* present in practically all cases. I explained to you, this fungus, which produces diseases of various names, such as anthracnose, wither-tip, canker, lemon-spots, tear-stain, etc., lives perennially in the twigs of the diseased trees. Infection of the twigs is known to take place through the flowers, through injury to the foliage, the fruit, and stems, by insects or otherwise. I think the red spider is responsible for the spread of the fungus to a considerable extent on the lemons this season, the slight injury produced by the spider making an opening for the fungus to get into the skin of the fruit.

(For control see same under that heading.)

Very truly yours,

A. F. WOODS,

Physiologist and Pathologist and Assistant Chief of Bureau.

Through the courtesy of Mr. G. W. Hosford in investigating the careful handling of lemons under the direction of Mr. Powell we obtained a few days' use of a private copy of Bulletin No. 52 referred to above. A typewritten copy of this Bulletin put us in possession of sufficient data to direct

us in some experimental tests against the fungus. Apparently it was increasing in the orchard, both on twigs and fruit, especially affecting the young lemons just setting from the bloom.

Within two days the most startling evidence of what wither-tip may do to an orchard impressed itself upon us. In one of the healthiest of the grove we suddenly discovered that half of the leaves had fallen from the trees so recently that many of them showed no evidence whatever of wilting. For a few days the petioles still clung to the tree. Some of these fallen leaves were turning brown beginning usually at the tip and extending down the midrib while others contained irregular yellow-green spots of irregular shape. A slight jarring of the boughs by the hand precipitated still more leaves, apparently vigorous and healthy, save for the pale yellowish-green spots described above.

The next day, June 5th, 1909, we had one of our power spray outfits in the field and sprayed three small groups of trees with the following:

FORMULA NO. 1.

Resublimed sulphur	1¾ lbs.
Sodium Hydroxide 98%	1¼ lbs.
Water	50 gals.

This we prepared by first passing the sulphur through a fine sieve and adding just enough water to make a thick soup. To this we added the pulverized caustic soda, stirring vigorously to prevent burning. After a few minutes the sulphur was almost entirely dissolved. The solution was then strained directly into the spraying tank which already contained the extra 50 gallons of water. This amount treated 7 trees.

FORMULA NO. 2. SELF-BOILED SULPHUR

Resublimed sulphur	8 lbs.
Unslacked lime	8 lbs.
Water	50 gals.

This we prepared as per directions given in Circular No. 27. (See under heading of control.)

This quantity sprayed 8 trees.

FORMULA NO. 3. BORDEAUX MIXTURE

Bluestone	5 lbs.
Unslacked lime	6 lbs.
Water	50 gals.

Eight trees required all of the 50 gallons.

Of course we knew that we could not expect to save the leaves and twigs already affected and that any results from the spray might not be clearly noticeable for months. The presence of black scale and more or less red spider in the orchard suggested the possibility of a spray combining both the merits of a fungicide and an insecticide. Accordingly we sprayed another set of rows, adding to each of the above formulæ 28° Beaume spray distillate in sufficient quantity to make the mixture contain 2½% distillate.

Formula No. 1, the sodium sulphide spray with the distillate added, seemed superior to either of the others, practically eliminating the red spider and promising high efficiency against the young scales. Occasional burns on the fruit where a drop would collect and evaporate, and slight injury to the young growth and lemons just setting, were more than offset, as we thought, by its greater efficiency against spider and scale. Four power sprays were soon at work covering the orchard at the rate of about 6 acres per day. They were at work steadily for nearly three months and our expenditure exceeded $3,000 or more than 11c per tree. Our faith in this combination was supported also from the following letter from Mr. R. C. Allen, of the Sweetwater Fruit Company, San Diego Co., California:

Figure 20. Tank for receiving lime after it has been slacked and is ready to mix with copper sulphate. The agitator is the special feature of this tank.

"Bonita, California, June 16, 1909.

"MR. JAS. D. CULBERTSON, *Limoneira Co., Santa Paula, Cal.*

Dear Sir: We have your letter of the 11th in regard to spraying with sulphur. This is no new thing with us, as we have been using it systematically for the last ten or twelve years. We use about 10 pounds of sulphur to the 200 gallon tank. We dissolve the sulphur with at least half as much caustic soda, our method being to moisten the sulphur first and then add the soda and heat over a fire, being careful not to let it boil over. Some people get satisfactory results without the fire, but we do not.

It may be some advantage to use caustic potash instead of soda for the reasons you mention. But so far as it affects the tank, or upon the hands of the sprayers is concerned the caustic principle in the potash or soda is entirely exhausted in fusing the sulphur. We advise the use of a good grade of sublimed sulphur in preference to the ground. The latter contains a good deal of impurities and is much more difficult to dissolve.

We have hitherto used galvanized tanks on our spraying machines but we have recently bought a bean outfit which has a wooden tank. As we have used the same iron tank for 5 or 6 years and it is still in good condition, you need not fear any trouble on that score.

I think it is practical to use the solution for circulation in the water jacket, but it will require to be cleaned out occasionally, and probably will not be as satisfactory as where clear water is used.

We have been in the habit of dissolving about 50 pounds of sulphur at a time, using a galvanized iron wash tub, and making our fire at any point where it is most convenient to mix the material, but I believe it would be better to have a central place for boiling, using a large cauldron.

In regard to the effectiveness of this spray on the "wither-tip" I am not wholly sure, though I have great faith in it. We are preparing to begin at once using the Bordeaux Mixture on part of our orchard. Simply enough to demonstrate whether there is any advantage in its use over the sulphur sprays. I think that we have seen "wither-tip" years ago upon grapefruit without in the least realizing what it was. During the years when we sprayed with sulphur it disappeared. But for the past three years we have been fumigating with the consequence that not only the "wither-tip" but red spider, and even a little silver mite, have begun to reappear. So that in any event a sulphur spray has become a necessity.

I have not yet noticed any such dropping of green leaves in our orchards as you speak of. I should be very glad indeed to have you send me the bulletin on "wither-tip."

Very truly,

R. C. ALLEN."

Instead of sodium sulfide spray we used the potassium sulfide, obtained in the same way except that caustic potash was used as a solvent instead of caustic soda. We believed that its value as a fertilizer over against the negative value of the sodium as a soil constituent more than justified its use even at a considerable increase in cost. This will explain Mr. Allen's reference to the caustic potash.

The sudden dropping of leaves mentioned of one portion of the orchard extended more slowly to the entire orchard. June 17, 1909, I made the following note: "Through lower half of orchard wither-tip generally distributed."

July 12.—Prof. P. H. Rolfs, Director of the Florida Agricultural Experiment Station and author of the Government Bulletin No. 52 on wither-tip, addressed a meeting of the Southern California Lemon Men's Club at the Chamber of Commerce in Los Angeles. He had spent a few days looking through the orchards in the vicinity of Los Angeles and Whittier where he found the fungus generally distributed. He considered it hardly necessary to spray for the twig withering as he found it here, but he did advise the spray for the leaf-spot and lemon-spot, as these manifestations of the fungus result in loss of foliage and fruit. Florida experience in later years had proven that the Bordeaux Mixture as weak as 4-4-50 solution was preferable to any other spray known.

Two days later Prof. Rolfs visited the Limoneira orchard. Like Dr. Woods and Mr. Powell, he was surprised that the fungus has been able

to gain such a foothold in so dry a climate. On his advice we discontinued the sulfids sprays and began with a 3-3-50 Bordeaux and distillate mixture on the remaining third of the orchard.

It may be well to state here that the application of the distillate with the fungicide did not in the end do as efficient work as we at first thought it would. With the Bordeaux its killing power seemed almost entirely lost.

No further spraying of the orchard as a whole was attempted until Nov. 1910, but in Jan. 1910 and again in June, 1910, one ten-acre plot was thoroughly sprayed with the Bordeaux, leaving as a check four rows through the middle unsprayed. Careful watch was kept on the fruit and trees in all parts of the orchard. During a full year subsequent to the general spraying of the orchard as recounted above, there seemed little difference between the sprayed and unsprayed trees. The former always seemed darker green and possibly set their fruit a little better, but we could not be absolutely certain on these points. Perhaps as Rolfs suggested, we were enjoying a non-infectious period such as is often very evident in Florida.

With the removal of the older lemons that were affected at the time of the first spraying there was left little evidence of the fungus either on leaf or twig or fruit. But in September and October, 1910, the minute reddish brown speck on the fruit and the pale green or yellow spot on the leaf began to show soon after an unusually heavy early rain. By the first of November a trace of it could be found on almost every tree. Occasional leaves had already dropped.

On the ten-acre plot that had been given the two extra sprayings with Bordeaux it is difficult even at the present time—Jan., 1911—to find the least trace of the fungus in active development except on the four rows left unsprayed. There it is easy to find it on both leaf and fruit, though not as yet seriously injuring either. The difference conspicuous at a glance is sufficient to convince us that there is great promise in prompt and thorough treatment at the right time of the year. Just what time and just how often is yet to be definitely determined.

We began spraying this time with a 4-4-50 Bordeaux, on Nov. 12. Three-fourths of the orchard has been treated. Under the trees first sprayed only the leaves already badly affected at the time have fallen since, while trees not yet sprayed have in some portions of the orchard carpeted the ground with leaves, and every shake of the boughs adds to their number. We are exercising great care in the matter of check rows, leaving several in every section of the grove that we may know with certainty the merit of our work and its value in regard to the time of application.

The conclusions are more or less tentative—we are not sure that we can prevail much against the fungus when weather and tree conditions favor it, but from results thus far apparent from spraying we are sufficiently convinced to spend another $3000 this season in combating it with Bordeaux.

Whether or not the following facts have any pertinent significance in this discussion may be a matter of question, but it is nevertheless of interest. Our

winter and spring crop of lemons for 1910 was nearly 50% short of the previous year's crop during the same portion of the year, while the 1910 summer crop was the greatest summer crop we have ever produced. The lemons that were picked this last summer came from blosoms that followed immediately the fungicide spraying of the year before. Other factors may have contributed to this result, yet it may be that the spraying was not the smallest factor as is evidenced by Prof. Rolfs in his article on Citrus Bloom Dropping. . (See under lemon below heading of Destructiveness.)"

METHODS FOR CONTROL

The methods used in the control of this fungous parasite must necessarily be preventative. After the disease is once established in the tissues of the host it can never be destroyed without destroying the host also, because it works within the tissues, and until the acervuli appear upon the surface to expose its conidia or spores for distribution, it is protected by the epidermal layers of the host.

Many methods have been recommended. It may be that certain measures taken in some localities may prove impractical in others, while a combination of all may be successful in special cases.

We shall take up the discussion, then, under the following heads: Spraying, Pruning, Orchard Practice (to include Cultivation, Irrigation and Fertilization), and Packing House Methods.

SPRAYING

In all the work that has been done with sprays in combating the withertip, the Bordeaux Mixture stands out as the most efficient, and we are wont to give it the first place in this consideration.

The formula now used at the Lemoneira orchard is known as the 4-4-50 or,

Unslacked lime	4 lbs.
Copper sulphate (bluestone)	4 lbs.
Water	50 gals.

The task of mixing these chemicals, where so much of the spray is used, is no small thing in itself. A great deal of study has been given to the construction of suitable mixing apparatus.

The first consideration is to get the materials high enough on a platform so that they can be easily and rapidly placed in the spraying tanks of the power machines. This is done by constructing, at convenient places in the orchard, platforms large enough to hold a large box for slacking lime, a lime solution agitator, and a vat for dissolving the bluestone. Such a platform is about 12x12 feet square and 4½ feet high. A large standpipe for filling the tanks is a necessity or the water must be pumped into the tank while the solution is being added.

The lime is first slacked in a common vat for that purpose. The great trouble has always been to keep the slacked lime agitated properly when it was being drawn off to mix with the bluestone in the spraying tank. This problem has been met with a special agitator for this purpose (Fig. 20).

The lime from the slacking vat is strained into this tank through the slanting bottomed strainer (Fig. 21 B). The agitator works by means of a hand lever and the contents of the tank may be thoroughly mixed in a few minutes before it is drawn off for use. Here it is again strained through the strainer shown in Fig. C, as well as is the bluestone.

The bluestone vat is simply a box containing slats, across the entire box as shown in Fig. 21 D, or simply across one end. These slats must be low enough so that the bluestone, contained in sacks, which is placed upon them will be completely immersed in the water used as the solvent. This method admits quick dissolving of the bluestone, much more rapid than if simply poured into the tank and stirred.

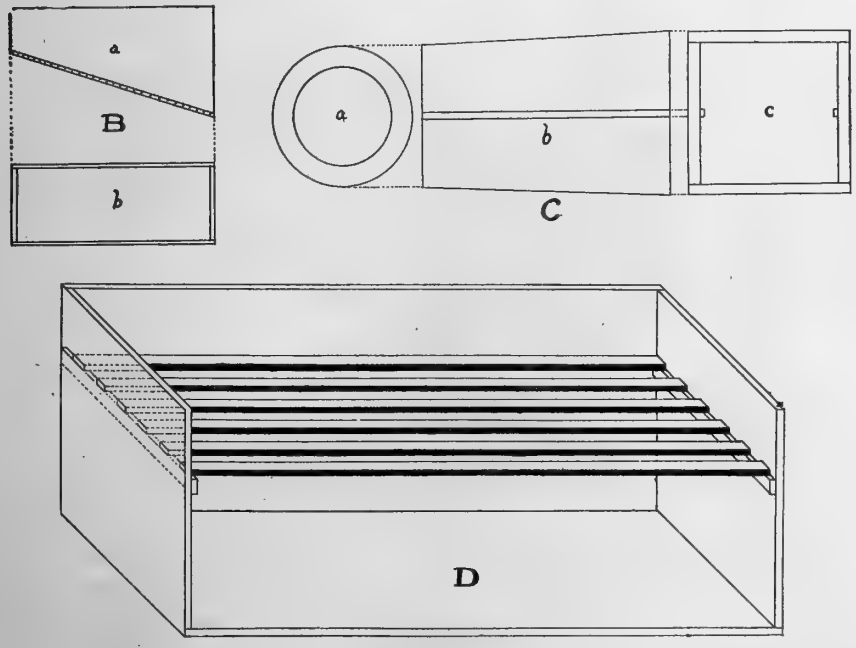

Figure 21.

B, slanting-bottom strainer for straining lime into sprayer tank; a, a side view, the screen nailed on a slant at bottom, and b, top view showing shape of box; C, round wire sieve for straining lime into sprayer tank, a, the wooden bottom with hole covered with wire screen, b, cylindrical sides made of fine wire screen tacked around the round bottom and square top, and c, top of strainer; D, box for dissolving bluestone, this being placed on the slats in sacks and under water.

The lime and bluestone are mixed with a given amount of water so that the proper quantities of the resultant solutions can be measured so as to give the mixture the strength of the above formula.

The sieve used should be made of brass wire and contain 20 meshes to the inch.

Mr. Culbertson stated very clearly that the Bordeaux Mixture has given them very satisfactory results. His experience had been extensive. He has used many other sprays, but has discarded all for the Bordeaux.

Prof. Rolfs makes this statement regarding Bordeaux:

"The loss from spotting of lemons may be greatly reduced, if not entirely prevented, by spraying with fungicides, such as potassium sulphid, ammonical solution of copper carbonate, and Bordeaux Mixture."—Bull. 52, U. S. Dept. Agrcl., p. 17, 1904.

SELF-BOILED LIME-SULPHUR MIXTURE

Among other sprays recommended by Dr. Woods and tried out by Mr. Culbertson was the Self-boiled Lime-Sulphur Mixture of the following formula:

Unslacked lime	8 lbs.
Resublimed sulphur	8 lbs.
Water	50 gals.

The self-boiled lime-sulphur mixture is a combination of lime and sulphur boiled with only the heat of slacking lime and is primarily intended for summer spraying as a substitute for Bordeaux Mixture where the latter is injurious to foliage or fruit. For most purposes Bordeaux Mixture is the better fungicide, and should be used except when likely to injure the plants treated * * * The self-boiled lime-sulphur mixture, however, when prepared as a mechanical mixture with lime and sulphur with only a small percentage of the sulphur in solution, is not injurious to peach foliage, and in our experiments for two years past has proved to be a good fungicide.

The mixture can best be prepared in rather large quantities—say 20 pounds, or even 40 pounds, at a time—so as to get enough heat to produce a violent boiling for a few minutes. Place the lime in a barrel and pour on enough water (about 3 gallons to 20 pounds) to start it slacking and to keep the sulphur off the bottom of the barrel. Then add the sulphur, which should first be worked through a sieve to break up the lumps, and finally enough water to slack the lime into a paste. Considerable stirring is necessary to prevent caking at the bottom. After the violent boiling which accompanies the slacking of the lime is over, the mixture should be diluted ready for spraying, or at least cold water added to stop the cooking. Five to fifteen minutes are required for the process, according to whether the lime is quick acting or sluggish. The intense heat seems to break up the particles of sulphur into about the physical condition of precipitated sulphur, and the violent boiling makes a good mechanical mixture of the lime and sulphur. Only a small percentage of the sulphur—enough to improve the adhesiveness of the mixture—goes into solution, but if the hot mass is allowed to stand as a thick paste the sulphur continues to unite with the lime, and at the end of thirty or forty minutes enough of the reddish liquid is produced to burn peach foliage and even apple foliage in some cases. Hence the necessity for cooling the mixture as soon as the lime is well slacked. The finely divided sulphur in mechanical mixture with the lime is depended upon for the fungicidal action rather than the sulphids in solution, the latter being harmful to foliage except in very dilute form.

The mixture should be strained through a sieve of 20 meshes to the inch in order to remove the coarse particles of the lime, but all of the sulphur should be worked through the strainer.

The amount of water required to make the best mixture depends largely upon the lime. Some grades of lime respond quickly and take a large quantity of water, while others heat up slowly and are easily "drowned" if too much water is added at once. Hot water may be used to good advantage in preparing the mixture with sluggish lime, but with quick acting lime hot water is not necessary and is more likely to bring too much of the sulphur into solution. If desired, the mixture may be kept for a week without deterioration, but should be thoroughly stirred before using.

In applying the self-boiled lime-sulphur mixture the spraying outfit should be equipped with a good agitator. The mixture settles to the bottom of the tank, and unless kept thoroughly agitated cannot be evenly applied. For a power sprayer the propeller type of agitator is most suitable. The agitator of the ordinary barrel sprayer is not unusually adequate and when used should be supplemented with frequent hand agitation."—U. S. Dept. of Agrcl. Circ. No. 27, pp. 5-6, 1909. W. M. Scott.

Regarding this mixture Dr. Woods wrote Mr. Culbertson:

"Of course, we have not tried these mixtures on oranges and lemons, but Mr. Scott suggests that the mixture made of 8 pounds of sulphur, 8 pounds of lime, and 50 gallons of water would be the best for this purpose. This would probably control the wither-tip and to a considerable extent prevent the development of the sooty mould following aphis and scale."

POTASSIUM OR SODIUM SULPHID SPRAY

As recommended by Prof. Rolfs in Bull. 52:

FORMULA

Flowers of sulphur	30 lbs.
Caustic soda (98%)	20 lbs.
Water to mix	20 gals.

Dilute four quarts of above mixture to 50 gallons of water.

Place 30 pounds of flowers of sulphur in a wooden tub large enough to hold 25 gallons. Wet the sulphur with 3 gallons of water; stir it into a paste. Then add 20 pounds of 98% caustic soda (28 pounds should be used if the caustic soda is 70%) and mix it with the sulphur paste. In a few minutes it becomes very hot, turns brown and becomes a liquid. Stir thoroughly and add enough water to make 20 gallons. Pour off from the sediment and keep the liquid as a stock solution in a tight barrel or keg. Of this solution use 4 quarts to 50 gallons of water.

Important.— (In regard to the use of this spray in California see the letter from Mr. R. C. Allen of San Diego County, in Mr. Culbertson's paper. Also see what Mr. Culbertson says about this.)

The potassium sulphid is made as above only when diluted for use add 1 ounce of stock solution to 2 gallons of water.

AMMONICAL SOLUTION OF COPPER CARBONATE

"Put 3 gallons of water in a wooden or an earthen vessel, pour 3 pints of ammonia (26°B.) in this, and stir it to mix the two evenly. Take 8 ounces of copper carbonate and shake it into the ammonia water, stirring the liquid for awhile. If a considerable part of the copper carbonate remains undissolved, the liquid may be left to settle; if, however, nearly all of the copper carbonate is dissolved, more of it should be added in the manner previously described until a considerable amount remains undissolved; then it is set aside, as stated before. After the precipitate has settled, use the clear blue liquid. The undissolved copper carbonate may then be treated with more ammonia and water, fresh copper carbonate being added whenever the residue becomes less than an ounce. The solution should not be kept for more than a day or two, and when used one gallon should be diluted with 15 or 20 gallons of water."—Prof. Rolfs, in Bull. 52, p. 17, U. S. Dept. Agrcl., 1904.

This spray has never been given a test in this county, but during the present spring extensive tests will be made by this office as well as many other fungicides not yet tried.

PRUNING

Because of the fact that the fungus has never killed the limbs of the lemons outright and it was difficult to ascertain just which wood was infected, the matter of pruning has never been taken up. Then, too, the disease was so general that the possibilities of eradication or control seemed hopeless by means of so slow a method.

The pronounced attack upon the orange trees was so great that the cost of pruning would far exceed anything in the form of sprays.

The fact that the disease had never shown up to any degree upon the twigs before makes it seem to us that pruning would do little good on such large trees. However, in consideration of the facts presented so strongly by Prof. Rolfs and Mr. Fawcett in regard to this method, some checks are to be made to test this advice.

If fungicides applied to the diseased twigs are capable of holding the disease in check and prevent its spreading, we can save much by their application over pruning.

It would be useless to attempt to prune it out of a lemon orchard, where, as stated above, the point of infection on the limbs cannot be definitely ascertained, because only the discolored leaves, spotted fruit and dropped bloom are the only indications. If future observations are able to show just where the infection takes place on the lemon trees as it does on the orange, pruning may be resorted to.

Winter Pruning for Wither-tip. is well described by H. S. Fawcett, in Press Bull. 133, Florida Agricultural Experiment Station, December 11, 1909:

"Wither-tip is one of the worst fungus diseases of citrus trees in Florida. In the winter season, diseased trees may be distinguished by the yellowing and falling of their leaves, the dropping of their fruit, and the dying of

their twigs and branches. A citrus tree affected with wither-tip will begin to lose its inside leaves. The outer leaves then turn yellow and fall, leaving many bare and discolored branches. The fruit also drops, with or without spotting.

HOW TO PRUNE

The important thing in pruning is to cut out enough of the wood, in order to get rid, not only of the bare branches, but also of all the branches that show even a slight sign of the disease. In severe cases of wither-tip, there are seen, in addition to bare branches, many limbs on which the yellowish leaves are about to fall. Close examination will show that the disease is slowly making its way back and poisoning these limbs. This poisoning may start from an infection at the tip, or from an infection on a side branch lower down, from which the poisonous effect has spread to the main limb. Sometimes only one side of a tree, or only one branch, is severely affected; while the remaining part of the tree is uninjured. Whatever may be the conditions, it is important to get rid of these poisoned limbs. All limbs that show the beginnings of the disease must be taken out. Drastic measures must be employed, and many bearing limbs may have to be sacrificed. To prune only half-heartedly may make matters worse, rather than better. When pruning, care should be taken to make smooth cuts, usually at the base of a branch or limb, so as not to leave any projecting stubs, in which infection is almost sure to start again. After pruning, paint the larger cut surfaces with carbolineum or pine tar.

The grove should be given unusual care after a severe pruning of this kind. It should be fertilized, so as to bring about a vigorous healthy growth, and to render the trees resistant to further attacks of the fungus.

WHEN TO PRUNE.

Winter pruning for wither-tip should be done between the middle of December and the middle of January. It is important not to delay the work beyond this date. Do not prune while the new growth is putting out, for this is almost sure to result in injury rather than benefit. Begin the work at once, and do not consider the looks of the trees, but take out everything that shows the presence of the disease.

The beneficial results already obtained on hundreds of acres of groves treated in this way, under the direction of Experiment Station workers, have proved the effectiveness of this treatment."

To this we may add the advice given by Prof. Rolfs, in Bull. No. 52, 1904, page 18:

"In a small orchard, or in the case of an isolated tree, especially in a young orchard, much good can be done by cutting out the diseased twigs and picking off the diseased leaves. Where this is practiced with thoroughness the disease can be reduced to a point where it does only a small amount of damage, or it may be eradicated; but pruning and picking must be done at frequent intervals and very thoroughly. This would probably be an effective method of keeping the fungus under control in the case of small orange and pomelo orchards.

Where pruning is practiced the weak limbs are taken out. The spurs that have dropped their leaves are also cut out, and in this way much of the hold-over wither-tip is removed. All wood that has withered is also taken away. This pruning reduces in a large measure the number of spores left in the grove and hence greatly diminishes the extent of infection."

In a letter to Mr. Culbertson, Nov. 18, 1909, he states:

"Under another cover I am forwarding to you my bulletin on Wither-tip, also Hume's bulletins on Citrus Troubles and Anthracnose of the Pomelo, and enclosing you a separate on Wither-tip. This you will notice, was printed several years ago. At the present time we lay more stress on pruning, than on the use of fungicides."

The following article by an unnamed contributor in the California Cultivator, Dec. 29, 1910, pp. 660-661, may be of interest:

"Experience so far has taught us that the only true and sure way to cure wither-tip is by thoroughly pruning. Running over and half pruning usually does as much harm as good. When pruning great care should be taken to saw or cut as close to the base or trunk of the tree as possible, and to make smooth cuts and by all means do not leave any projecting stubs. This precaution should be carried out to the letter, because diseases from these stubs are almost certain to occur when wither-tip fungus is present.

Another thing of great importance is cutting the branches close to the tree as the cut surface soon heals over, leaving a nice smooth body; also if the trees are to be washed, or doctored, it can be executed in one-third of the time, besides it adds beauty to the trees * * *

In pruning for wither-tip great care should be taken to remove every limb or branch that is diseased, as it is important to get rid of all poisoned branches and prevent the disease from spreading. Wither-tip can be distinguished in various ways—namely, as the limbs or branches on the outside turn dark brown and the outside bark will continue to get darker until they are dormant, while the inside bark near the body of the tree will keep continually falling and the leaves will turn yellow, and in a short time the limbs will be bare. Trees that die from this disease soon become very brittle and rot in a short time. When the trees are taken with wither-tip, if the fruit is on the tree, it can be noticed by the fruit dropping to the ground."

The combined testimony of these writers seem to show that pruning is a very important factor in handling this disease in Florida. It might be that we should waive the cost of so great a task and get to work in our California orchards, but it can hardly be brought about until the present methods of using Bordeaux Mixture fails and makes it necessary to resort to the more tedious, laborious and costly means.

ORCHARD PRACTICE

Cultivation.—It has been made very plain by all authorities that a weakened condition in an orchard, under certain conditions is liable to bring on an attack of wither-tip. That this is true cannot be doubted.

Every possible means should be exercised to keep the orchard in excellent physical condition. As cultivation is a very important factor in this work it should receive its full quota of attention. In groves subject to this disease the soil should be stirred deeply enough and often enough to insure all that is demanded from it by the tree.

Irrigation.—The first attack brought on in the Blanchard orchard was believed, by us, to be occasioned by a lack of water. This belief was substantiated by the fact that the ravages of the fungus stopped shortly after the water was applied. That this was not the seat of the whole trouble was demonstrated by the fact that later the best cared-for portions of the same orchard were likewise infected.

A starved condition of the tree cannot be brought about more effectually than to cut off the water supply. Thus such a condition favors the attacks of the disease. It is not necessary to warn watchful growers against this state of affairs for it is a condition not desirable in any grove.

Fertilization.—The lack of fertilizers might cut off the food supply and have a tendency to bring on wither-tip, but it is not in this regard that I wish to call attention to this point. It is what Prof. Rolfs has to say in this regard: "In choosing fertilizers to aid in warding off these diseases (various stages and phases of wither-tip) a large percentage of potash should be used in the compound. The source of potash does not seem to be important, but sulphate of potash has proven a general favorite among growers of citrus fruits.

Sulphate of ammonia is somewhat slower in acting than nitrate of soda, but gives a firmer leaf. Nitrate of soda will produce a very quick growth and a large leaf, but these are especially subject to the attack from the fungus unless well balanced by a generous supply of potash. Organic ammonia in the form of dried blood, cotton-seed meal, and bone meal should not be used in combating this trouble, as it is very likely to produce die-back in addition to the softening of the wood, and so lay the tree doubly open to attack."

A very interesting observation was made in the Blanchard orchard in connection with the use of nitrate of soda. Last year an application of 9 pounds per tree was made in three applications. In previous years only 6 pounds per tree at two applications was the most ever given. It is strange that following the heavier application came the only severe attack of the wither-tip known in this orchard. It is not claimed that this was the cause, for the fertilizer had been used previously without bringing the disease, but might it not have something to do with the seriousness of the attack? Had there not been severe attacks in other orchards, which had received no nitrate of soda at all, this belief would have been well founded. The attacks have been general and the first severe ones noted in the orange groves in this county.

PACKING HOUSE METHODS

It is interesting to know that the "red-spot" does not cause infection of other fruit in the packing house. To demonstrate this Mr. Field, manager of

the Limoneira Packing House, made a great number of tests. He bound clean and healthy lemons to those affected, wrapped them together and placed them in a moist tent where infection would take place readily. The operation was repeated a great many times at various periods, but in no instance was the infection contagious.

The "canker" or fruit-spot shows up among the lemons to no little degree in the packing house, though greatest care is exercised in the washing of the fruit. The common treatment is to add one pound of bluestone to every 1000 gallons of water in the washer tank. This is renewed from time to time to keep the proportions fairly even. If the tank is treated in the morning with a fresh supply of the bluestone about one-half the amount is added to the same solution at mid-day.

Mr. Hume states that "many shippers wash their fruit before shipping it. Ammonical Solution of Copper Carbonate may be added to the water used in washing. Another good substance for this purpose would be Potassium Sulphide."—Bull. No. 74, Fla. Agrcl. Exp. Sta., p. 172, 1904.

A Biological Expedition to Southern Mexico

BY D. L. CRAWFORD*

Being confronted again, in 1910, with a most unusual opportunity for pushing scientific investigations in Mexico for the sake of science and the economic well being of both countries, an effort was made to organize and finance an expedition with a larger scope than that of 1909. Through the interest of Prof. A. J. Cook, head of the department of Biology in the College, a sufficiently large sum of money was secured from friends of this work to send two men from here and to hire the services of a native helper. With the assistance of Mr. C. E. Harwood of Upland, Cal., his son, Mr. Paul Harwood, Dr. W. S. Cockrell and Dr. Pehr Olssen-Seffer, all of Mexico City, passes were secured over the National Railways first and later over the Vera Cruz and Isthmus Road, the Mexican Road and the National Tehauntepec. We here take the opportunity to thank the above mentioned gentlemen, and also the officials of the roads over which passes were granted to us: Mr. C. R. Hudson, Vice President of the National Railways; Mr. Thos. Milan, President of the Vera Cruz and Isthmus; Mr. Newberry, President of the National Tehuantepec; and the Manager of the Mexican Road.

Mr. A. S. Loveland, a student of the college, was chosen as my assistant. A very good native helper was hired at Guadalajara, Jalisco. In addition to these two assistants, guides in several places were used.

The purpose of the expedition, as outlined by Prof. C. F. Baker, was to make as extensive collections as possible of insects, economic seeds, both of fruits and ornamental plants and trees, mosses and lichens, living plants, especially palms, cacti, orchids, agaves and succulents of all sorts, etc. It was first thought best to confine our collecting to about four localities south of Mexico City, well separated topographically as well as geographically. These plans were subsequently altered to include about seventeen localities representing six states of Southern Mexico: Chiapas, Vera Cruz, Puebla, Oaxaca, Morelos and San Luis Potosi. The reason for this change of plans was the desirability of making this year's efforts something in the way of a thorough reconnaissance of the southern half of Mexico, as a preparation for future expeditions as well as for permanent work in the future. It is a great advantage to know the typical localities over a large area of territory and to know the country in a comparative way. For this reason the work was necessarily somewhat hasty in most places, but by continually keeping on the move the desired results were in a measure attained.

On June 16th we entered Mexico through El Paso and proceeded directly to Mexico City, where a few matters of business occupied our time for some days. After the completion of this business we went to Cuernavaca,

*Student assistant in Pomona College.

state of Morelos, for a few days of collecting. In spite of the frequent rains we found this region very productive. I was enabled here to see the work of the Mexican orange-maggot, the larva of *Trypeta ludens*. At this time the oranges had not begun to ripen, but the mangoes, which are also attacked by this same maggot, were at their best. I attempted in all the places visited during the summer to acquaint myself with the exact extent of the injuries and the measures taken toward its control or extermination. A detailed account of these observations with the measures used and other measures proposed has appeared in a report on the *Trypeta ludens* in Mexico, published in the Pomona Journal of Entomology.

The climate and topography of Cuernavaca make it quite subtropical in vegetation as well as in its faunal life, so that this spot has become quite famous to entomologists. To the agriculturist it ought to be much more valuable. With its fine soil, abundant rains, even climate and a tremendous market in Mexico City, only four hours distant by rail, the Cuernavaca Valley should be one of Mexico's garden spots.

From Cuernavaca to the City of Mexico the train passes over a high range of mountains, slightly more than ten thousand feet above sea level at the highest point reached. On our return to the city we stopped for one day at a small Indian village, called Parres, very near to the summit just mentioned. Some very interesting specimens were taken at this elevation, as might be expected.

Leaving Mexico City for the second time we set out for the state of Chiapas, on the Pacific side and at the extreme southern end of the Republic. Although it is not a very great distance from the Capital, yet the journey required over four days, owing to slow transit over rather new road beds. Our headquarters in this state were made at the Soconusco Rubber Plantation, Hacienda Dona Maria, near Escuintla. We were given many favors by the field manager of the plantation, Mr. Rolf Olssen-Seffer, which aided very much the work of the expedition. From this place a trip was made to Tapachula, only a few miles from the Central American border, and from this latter place another trip far up into the mountains where lies the great coffee district of the state. The type of insect fauna in this state is, of course, tropical, and except when hindered by the frequent tropical thunder showers, we were able to do some very good collecting. I had been requested by Dr. Pehr Olssen-Seffer to make what studies I could on a certain boring beetle existing in the rubber trees, *Castilloa elastica,* and try to find some effective remedy. A report of these investigations has been published in the American Review of Tropical Agriculture. The well known coffee mildew was found very abundant in the coffee district in the mountains. Attempts have been made in various ways to control the moisture which favors the mildew, but they do not seem to be entirely successful. Resort may have to be taken, as was suggested to one of the planters, to cutting narrow lanes in the direction which the wind takes. This has been tried in other places with more or less success. Mention need not be made of the numerous minor

pests which occur in this state, such as the aphids, scale insects, thrips and leaf-eating beetles, etc.

Leaving Escuintla about the last of July we started back over the Pan American Railway for the Tehuantepec Isthmus territory where we spent a day collecting. This region is quite barren in comparison to the luxuriantly wooded southern part. From San Geronimo, state of Oaxaca, we went across the Isthmus to the state of Vera Cruz, stopping next at Medias Aguas. Here we found a very interesting country, distinctly tropical in its floral and faunal life and yet more mild in its climate than the state of Chiapas. We had an opportunity at this place to see the Castilloa rubber tree growing in a more northern latitude than in Chiapas, and in fact the difference could be readily seen in its slower growth. The insect fauna was very varied and the collecting good. Orchids and palms were quite numerous and varied. The rubber tree borer of Chiapas was not found here, although there were occasional decaying spots which usually are very attractive to such insects.

Santa Lucrecia, the junction of the Vera Cruz al Istmo and National Tehuantepec lines, was the next point visited, but for only one day. Although this is a proverbially hot locality, still the insects seem to thrive as well as at any other place. The topography here, however, was not enough different from Medias Aguas to warrant a longer stay.

Our next stop was in the city of Vera Cruz, from which we took several short side trips into the country districts within fifteen or twenty miles of the city. An hour's ride over the Vera Cruz and Isthmus line brought us to a very good locality for collecting both insects and palms. Some time was spent in collecting certain marine material near the large breakwater. With the intention of returning to this place again at a later date, we left by way of the Mexican railway for Cordoba. This we found to be a very beautiful and rich locality with a very delightful climate. The soil is equalled in fertility by only a few places in other parts of the Republic, but the production is by no means proportionately rich, the reason for which, no doubt, is the lack of advancement in the native farmer. However, some of the best mangoes in the Republic are to be had here, as well as pineapples and some other varieties of fruit.

From Cordoba we went directly to Orizaba, which is situated in a fair sized valley considerably higher than Cordoba. This also is a very rich locality, a little less rolling than Cordoba and with very deep alluvial soil in most places. Some very good collecting was done on the verdant and well-wooded hill and mountain-sides.

On our way to Puebla from Orizaba we stopped one day at a small village called Maltrata, situated in a high valley above Orizaba. A great difference was noted in the relative fertility of this place and the one last visited. This soil lacked humus and seemed to be very unproductive in most sections, although in a few places there were some flourishing groves of various sorts. Going on to Puebla still by way of the Mexican railway we continued to pass

through large or small valleys, some with water and some without, as was Maltrata.

Puebla has an elevation of about seven thousand feet and is well within the inland table-lands. No matter in which direction one may leave the city nothing is seen for miles and miles except vast cornfields. Since territory of this description contains very little of interest to the collector, we passed on down south, after a single day's stop, to the Oaxaca valley. To anyone except the student and collector of cacti and other desert plants the ride from Puebla to Oaxaca is very tiresome, owing to the many miles of intervening desert. One feels fully repaid, however, for the dreary ride when the Oaxaca valley comes into view. Several days were very profitably spent here in collecting in the neighboring mountains and meadows. A very pleasant trip was made to the state experimental station just outside the city of Oaxaca. Although the station is but one year old, yet the results are already forthcoming through its director, Mr. Felix Foex. On our return north we stopped a short time in the middle of the previously mentioned desert where a large number of cacti and agaves were collected, as well as a fair representation of desert insect life. From this point, Tomellin, we went directly to Vera Cruz, via the National Railways (Interoceanic). Here we spent a few more days profitably since the faunal and floral life had undergone further seasonal development during our absence of three weeks.

A few days at Jalapa completed our round-about itinerary from Mexico City and return.

Jalapa was another of the places classed as beautiful as well as rich, in our estimation. Situated well up in the mountains it has a very agreeable climate and is still tropical in aspect. For palms, orchids, ferns and similar plants we found no place equal to it; and for insect collecting also it proved very rich.

From Mexico City a second trip was taken into the state of Morelos chiefly for the purpose of seeing the orange maggot at work on the ripening orange crop. A short visit was paid to Cuernavaca, although there are very few oranges raised there. A longer stay was made at Yautepec, said to be the center of the Republic's citrus industry, and also the worst infested with the maggot.

Several days were spent in the City of Mexico on our return from Morelos visiting the National Museum at Tacubaya under the charge of Sr. Fernando Perez, and the central agricultural experiment station and National Agricultural College, both under the direction of Dr. Jose Ramirez. A trip was made to the Toluca valley west of the city, where a great deal of fruit is raised for the city markets.

The last place visited by the expedition was the region of San Luis Posoti. This is well within the limits of the great northern desert, where the chief vegetation is cactus and mesquite. Very little insect collecting could be done in the vicinity of the city, but a trip to the Rio Verde district proved a little more successful. Here we visited the state experiment station and were

very cordially shown about through the several departments of work. While very little stress is being laid on experimentation with trees adapted to the surrounding conditions, still some very good work is being started in experimental dry farming of corn and other crops.

Looking back over the whole season's work we may note that although a great deal of difficulty was met in operating during the rainy months and the work thus hindered, yet collections made at just this season often exhibit forms unknown to other seasons. Another expedition in the winter months following in general the same itinerary would undoubtedly give very interesting results in a comparative way.

All the specimens collected were forwarded immediately to Pomona College. There all the insects, amounting to above fifty thousand specimens, will be mounted and preserved. Most of the entire collections have been presented to the college museum, but some groups will be presented to other museums or offered for sale or exchange.

As is suggested by the fact that the entire Republic has but four agricultural experiment stations, agriculture has not yet reached the plane which it is hoped it soon will attain. There are three evident reasons for this. First, the Mexican as a rule is not naturally a farmer. Most of the land is divided into tracts known as haciendas and the owners of these tracts are nearly always Mexicans or Spaniards, who are called hacendados. Unfortunately the majority prefer greatly to allow their farms to be run by subordinates while they themselves spend almost their entire time in the city. As a result of this the hacendado cares very little how his place is run or what is done in the way of planting, and quite naturally will not give attention to any agricultural innovations. Second, the native Indians, who constitute largely the peon class and who do most of the actual farming which is done in the Republic, know absolutely nothing of agricultural methods except what they learned from their grandfathers and great-grandfathers. If one asks an Indian farmer why he does this or that he answers: "My father did it this way and his father taught him, so why should I not do it, also?" But in spite of this trait, if the Indian is *shown* something new and *shown* that it is better and more remunerative than what he has, he will, as a rule, give it a trial. And this brings us to the third reason, the lack of experimental stations and demonstration farms to actually show the native farmers what are the best crops for his soil and what are the best methods of raising those crops and tilling his soil. And this third reason is, after all, the most important because the hacendado will simply lose his property to some one who can farm it if he does not wish to, and the Indian can be educated to decent methods of agriculture if he will or else drop out, but agricultural conditions in Mexico will never improve to any appreciable extent if good, practical, and efficiently managed experimental stations and demonstration farms are not established soon in greater numbers than at present exist. Until this change for the better takes place the land will continue to produce less than it is capable of

producing, in fact suffer constant depletion and the entire country will feel this loss.

What might almost be called the universal crop of the country is corn; it is grown on large tracts of hundreds of acres and it is grown on small arable patches on the mountain sides; and yet not in any year has there been enough to feed the nation. The reason for this is not hard to find. I have seen thousands of cornfields "plowed" with the ancient wooden plow drawn by oxen and I have seen a few cornfields plowed deep with modern steel plows, and the difference is great. When a soil is scraped over the surface year after year and never turned, what sort of a yield of corn can be expected? And yet because of the great original fertility of some soils the yield is surprisingly good; but that condition is rare and will not last. The usual crop is much smaller than it need be.

Again, a great deal of land is annually planted to corn which would be far better suited to some other crop. Some of the higher mountain valleys and mesas are quite well adapted to corn culture, but many such places, while they may be forced to produce some inferior corn, are far better suited to the culture of such crops as the apple, cherry or some other hardy, cold enduring fruit. It may be difficult for many to believe that cold climates exist in Mexico, but nevertheless it is entirely true. On many of the mountain plateaus and mesas the temperature falls low enough for snow and very hard freezing. Portions of the Tehuantepec Isthmus territory, also, because the soil conditions are not adapted to its culture. There is very little doubt in my mind as to the adaptability to this soil of the olive tree or the eucalyptus and many other similar trees. The market price of olives is so high that this crop could be made to pay very well. In this very region as well as in other parts of the Republic there is a great demand for good railroad ties and telegraph poles, and this demand will increase constantly. Eucalyptus wood is beginning to be used in this country for such purposes with good results, and a similar demand in Mexico should stimulate its culture on a very large scale in certain states.

While we must realize that the habits of the masses of the Mexican people demand corn as the chief crop of the country, at the same time one cannot help recognize certain places as being well fitted for other crops equally valuable to the country. For instance the Cuernavaca valley with its wonderfully fertile soil, mild climate and abundant rains in season could produce, after proper acclimatization, grapes, melons, berries and other similar crops which have to be marketed immediately. Mexico City, only four or five hours distant by rail, affords a limitless market for such fruits, and the consequent lowering of the present market price of these products would place them within the reach of many more. The current retail price of table grapes in the city is about twenty-five cents per pound, and other fruits are proportionately high. The sugar beet could be grown very well in several localities of large extent as, for instance, in the Yautepec region of the state of Morelos and in the southern part of the state of Vera Cruz. Whether this could be

made to compete favorably with the sugar-cane would be a matter of some doubt until a trial had been made, but they make splendid food for hogs and cattle. The San Luis Potosi territory is admirably adapted to the culture of the maguey fibre, as are, also, other parts of the country.

One must bear well in mind that most of the crops mentioned here have to be acclimatised before they can produce, and this work rightly belongs to the experimental station. There are many methods of grafting and crossing and selecting known to the expert horticulturist which are wholly unknown to the average farmer. Therefore it is only reasonable that the government should take this into hand and develop it for the good of the country as a whole, just as it is done in many other countries.

Then again there is the improvement of crops and methods of culture now existing in the country in a more or less undeveloped state. Under this would be included the breeding and introduction of better varieties in all parts of the country. The peaches are always small and often of very inferior taste simply because there has been no attempt to better them; then, too, the trees do not receive proper care. The same is true of the orange. Often the trees are scattered indiscriminately among other trees and receive no cultivation or care. In some cases, as at Yautepec, in Morelos, the trees are set out in much the same way as they are here, but no attempt is made to improve the varieties by grafting or budding, and, furthermore, many of the trees are eighty to one hundred years old. The oranges are usually quite sweet, but they could not compete with improved stock for several reasons; they are somewhat inferior in taste and quite inferior in appearance. As a proof of this, the seedling oranges are sold on the street for from one to five cents each (Mexican money), while the navel oranges (some are grown in Jalisco, Sonora and other states) are sold for from four to ten cents each, and are considered much more of a luxury.

This work of improvement also belongs to the experimental farm, and should be developed along with the initiative work mentioned above. But for this work as briefly outlined, four stations, three field stations and one central and purely technical, are far from adequate. It is no doubt the present intention of the Mexican government to establish more stations in the near future, and it is sincerely hoped that they will come soon and be made very efficient for the needs demanded of each. Great things are in store for the agriculture of Mexico, if it is energetically developed. It will be a source of immense national wealth when the mines have all been exhausted.

The Botanic Garden of Para

BY C. F. BAKER

Every botanist and horticulturist is familiar with accounts of the magnificent forests, the wonderful display of palms, and the luxuriance of plant life in general, to be found in the Amazon Valley. Few, however, are acquainted with the Botanic Garden of Pará, near the mouth of the Amazon, long ago founded by Dr. Goeldi and now under the control of the Museu Goeldi, with Dr. Jacques Huber, a most devoted and learned botanist, as Director. Through

Figure 22. A view in the southern extension of the garden.

the liberal support of the government of the State of Pará, this Botanic Garden has been able to draw upon practically the whole Amazon Valley for its material and so possesses collections of unique interest and value. The field operations of the Garden have extended from French Guiana and the mouth of the Amazon, to the eastern slopes of the Andes, where Drs. Goeldi and Huber collected in the rich valleys of the Ucayali and the Huallaga. In intervening territory Dr. Ducke has traversed the Rio Negro, the Rio Trombetas and

Figure 23. Showing the fine development out-of-doors of plants only known in northern greenhouses. Note the large Monstera on the tree and the fine marant in center of bed.

many other streams, and Andre Goeldi brought back quantities of living material from the Rio Purus and elsewhere. The writer had the keen pleasure of serving as Curator of this Garden and its great Herbarium for nearly a year, and will briefly indicate here some of the points of interest connected with it.

On entering the Botanic Garden at Pará, one is impressed by the density of the plantings which lack of space has compelled, but which has, however, produced a most characteristic Amazonian effect. One first recognizes numbers of the standard tropical ornamentals, *Murraya, Hibiscus, Tabernaemontana, Datura,* various *Ixoras,* and some more conspicuous things, such as *Randia Stanleyana* with its long trumpet shaped whitish flowers, *Roupellia grata,* and *Brunfelsia grandiflora.* Scattered among these are great numbers of fine native Amazonian ornamentals, many of which have not yet been introduced to horticulture, but which would add great riches to our warm-house collections. A notable example of this is a fine series of *Marantaceae,* including several *Thalias,* numbers of *Ischnosiphons,* and many new *Calatheas* recently described by Dr. Huber, for example, *C. contaminensis, C. laetevirens, C. aberrans, C. Sophiae, C. Ucayalina,* and *C. microcephala*—every one a gem. Equally noticeable is the great wealth of aroids—*Monsteras, Anthuriums,*

Figure 24. A forest scene in the gardens. Note the huge Calathea at right.

Philodendrons, and *Dieffenbachias,* numbers of them still undescribed and never in horticulture, and most noticeable of all that strange, gigantic, almost tree-like aquatic *Montrichardia arborescens.*

Throughout the Garden, everywhere, there are conspicuous epiphytic orchids, bromeliads, and *Piperaceae,* and also parasitic *Loranthaceae*—some so abundant as to necessitate frequent cutting away. The Garden has now the beginning of a really notable collection of Amazonian orchids. In one part of the Garden several remarkably fine *Carludovicas* are much in evidence, and there are also fine specimens of the Guiana Traveller's Tree (*Ravenala guian-*

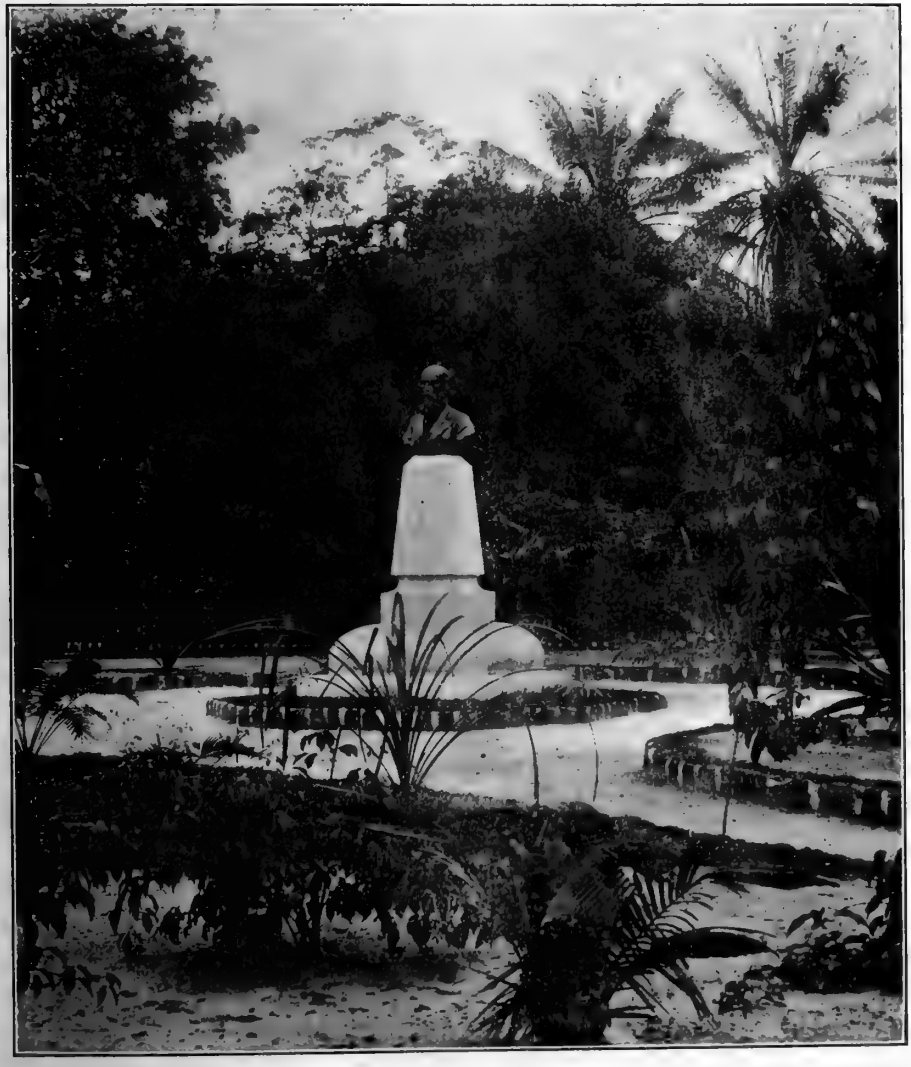

Figure 25. An Aralia hedge with Achras sapota in background. The bust is of Ferreira Penna, a famous Brazilian geographer.

ensis). After having been familiar only with the old *Heliconia Bihai* of the more northern tropics, it was a great pleasure to see here a fine collection of *Heliconias,* some newly described by Dr. Huber and apparently none of them in horticulture; in this collection were *H. pendula* Wawra, *H. stricta* Huber, *H. cannoidea* Rich., *H. episcopalis* Vell. Besides the old-time *Bambusa vulgaris,* the Garden possesses a number of native Amazonian bamboos, most of them unknown to horticulture, and one of the finest only recently described by Dr. Huber under the name of *Guadua superba.* In some borders of the Garden, occurring almost as weeds, are to be found two large, fine *Solanums* which ought to be cultivated if they are not—*S. juripeba,* and *S. grandiflora.*

All of the fruits so characteristic of the more northern tropics, such as papaya, anon, aguacate, mango, mamey, caimito, sapodilla, sapote, and others, are represented in the Garden, and besides these a most interesting series of more strictly Amazonian fruits, some almost unknown outside of that region, such as:

Mangabeira - - - - - - - - *Hancornia speciosa* Gom.
Amapá - - - - - - - - - - - *Hancornia amapa* Huber
Uchi - - - - - - - - - - - - *Saccoglottis Uchi* Huber

Figure 26. One of the finest views in the gardens. The ornamental water tank is draped with Antigonon leptopus.

Umary - - - - - - - - - - - *Poraqueiba sericea* Tul.
Castanheiro (Brazilnut) - *Bertholletia excelsa* HBK.
Piquiá - - - - - - - - - - - *Caryocar villosum* Pers.
Ingá cipó - - - - - - - - - *Inga edulis* Mart.
Pajura - - - - - - - - - - - *Parinarium montanum* Aubl.
Parinary - - - - - - - - - *Couepia chrysocalyx* Bth.
Sorveira - - - - - - - - - *Couma guyanensis* Aubl.
Oity - - - - - - - - - - - - *Moquilea tomentosa* Bth.
Abiu - - - - - - - - - - - - *Lucuma caimito* R. S.
Cutitiribá - - - - - - - - - *Lucuma rivicoa* Gaertn.
Baury - - - - - - - - - - - *Platonia insignis* Mart.
Bacury-pary - - - - - - - - *Rheedia macrophylla* Planch. and Triana.
Biribá - - - - - - - - - - - *Rollinia orthopetala* A.D.C.

The two *Hancornias* also produce a sort of rubber, but their fruits are the most uniquely flavored and deliciously fragrant of perhaps any of the Amazonian fruits. The Abiu and Biribá—at their best—are the peers of any tropical fruits. It should be noted that there are hundreds of seedling varieties of all of these fruits in the Amazon country, and among them in each case, are represented everything from good to bad.

Figure 27. Guadua at left; at right a large bed of Calatheas of many species.

There are also represented in the Garden a series of the cherry-like myrtaceous fruits, all worthy of cultivation, and with great possibilities if modern methods of cultivation and breeding were applied to them. Among these are:

Jaboticába - - - - - - - - - *Myrciaria cauliflora* Berg.
Pitanga - - - - - - - - - - *Stenocalyx michelii* Berg.
Grumixama - - - - - - - *Stenocalyx brasiliensis* Berg.
Aracá do Pará - - - - - - *Britoa acida* Berg.

In fact, horticulture has yet to see some of its greatest marvels when modern methods of cultivation and breeding are applied to the tropical fruits.

There is but limited space in the Garden for specimens of the great timber and forest trees of the Amazon, and yet Dr. Huber has gradually built up a considerable collection of living specimens, some of them already of good size. Conspicuous among these is the fine assortment of leguminous trees belonging to such genera as *Inga, Pithecolobium, Caesalpinia, Macrolobium, Campsiandra, Swartzia, Hymenaea, Sclerolobium, Crudya* and *Lonchocarpus*. Besides the larger trees, there are everywhere scattered through the Garden a great collection of small trees, all of them of great botanical and horticultural inter-

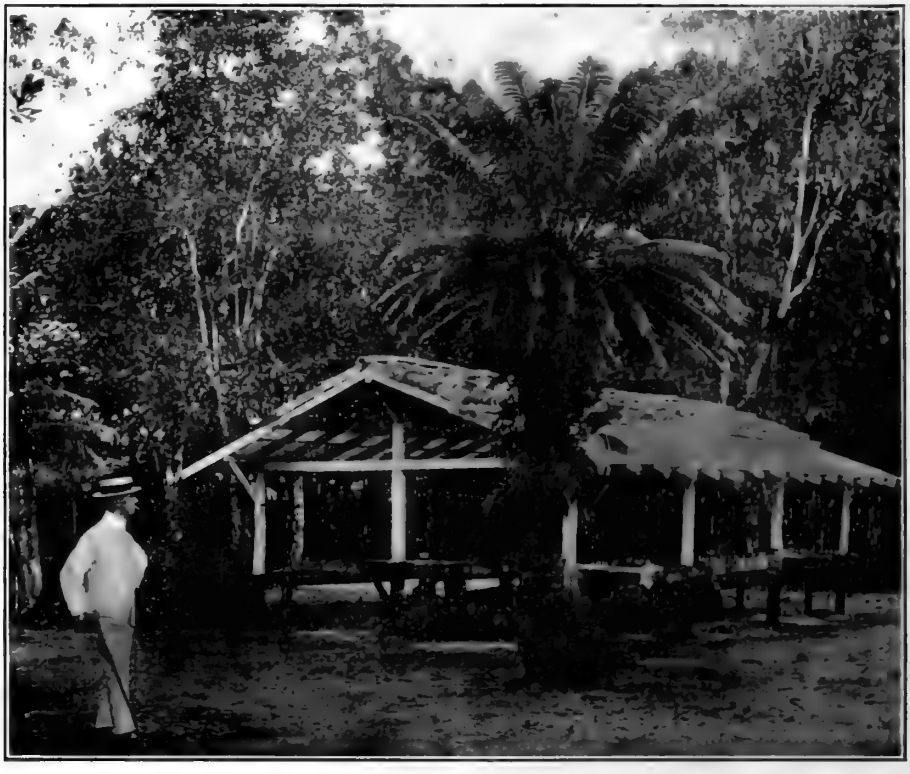

Figure 28. A propagating house built by the author almost entirely from waste materials found on the place. Trees in background are Lucuma Caimito at left and Persea gratissima at right.

est, and among which may be noted in passing several *Cecropias, Qualea speciosa* Huber, *Voucapoua americana* Aubl,. *Vatairea guyanensis* Aubl., *Crataeva benthami* Eichl., *Virola surinamensis* Warb., *Pachira aquatica* Aubl., *Quararibea guyanensis* Aubl., *Matisia paraensis* Huber, and *Dillenia speciosa.* Some of these also eventually attain good size. *Pachira* produces the well-known enormous pompon-like flowers and is a conspicuous feature along the Amazon.

Situated in a country long known for its palms the Garden should be expected to possess a fine collection of these regal plants, and it certainly contains a magnificent display of them, and is constantly making additions to its collection. Conspicuous among the palms is the graceful and beautiful Assahy (*Euterpe oleracea* Mart.), and the huge Pupunhas (*Guilielma speciosa* Mart., and *G. microcarpa* Huber). Other fine palms are the

Mirity - - - - - - - - - - - *Mauritia flexuosa* Mart.
Yauary - - - - - - - - - - - *Astrocaryum jauary* Mart.
Murumurú - - - - - - - - - *Astrocaryum murumuru* Mart
Tucumá - - - - - - - - - - *Astrocaryum tucuma* Mart.
Patauá - - - - - - - - - - *Oenocarpus bataua* Mart.
Bacaba-y - - - - - - - - - *Oenocarpus multicaulis* Spruce.

There are also represented many others in the genera *Maximiliana, Geonoma, Chamaedorea, Iriartea, Phytelephas, Bactris, Cocos, Attalea,* and *Manicaria.*

In two groups of plants in which Dr. Huber is a noted specialist, viz., the genus *Theobroma,* and the Amazonian rubber producing plants, the Garden possesses the finest collections in the World. Among the many very interesting *Theobromas* represented are several varieties of *Theobroma cacao* L. (the Cacao of commerce), *T. bicolor* Humb. & Bonpl. (Cacao do Peru), *T. grandiflorum* Schum. (*Cupuacu*), *T. subincanum* Mart. (*Cupuahy*), and *T. speciosum* Willd. (*Cacao-y*). Dr. Huber calls the Cupuacu the King of Tropical Fruits, and it is certainly altogether aristocratic among fruits. With the *Theobroma* collection may also be seen the very peculiar related *Herrania paraensis* Huber, rarely represented in collections, even by herbarium specimens. The rubber producing plants of the Amazon fall into six genera: *Landolphia,* represented by a new Amazonian species—*paraensis,* just discovered by Dr. Huber; *Hevea,* the genuine Pará Rubber, called Seringueira; *Castilloa,* called Caucho; *Sapium,* called Tapulu, Murupita, Curupita, or Seringarana; *Mimusops,* called Macaranduba and Maparajuba; and *Hancornia,* called Mangabeira. In *Hevea* and *Sapium,* Dr. Huber has discovered many new species, and most of these are growing in the Garden, as is also the new *Landolphia.* Besides many of the older species, one may note in the Garden fine specimens of the following of Dr. Huber's new species: *Hevea collina, H. cuneata, H. viridis, H. Randiana, Sapium Marmieri, Mimusops amazonica, M. maparajuba, M. paraensis.*

The instant thought to an American botanist or horticulturist visiting this great Garden is this: Why, with such a marvelous flora so near us (not

more expensive a trip than to California, from New York) have we not drawn on it more freely and widely? Besides all of the interesting, beautiful, and valuable things in orchids, bromeliads, marants, aroids, palms, and other plants which I have mentioned as growing now in the Pará Garden, there are also in the Amazonian forests wonderful displays of *Melastomaceae, Bignoniaceae, Passifloraceae,* and other beautiful and interesting things, awaiting the collector. Something of the extent of the Amazonian flora may be appreciated from the fact that above 1200 species of forest trees are already known from the banks of the lower Amazon, and Dr. Huber tells me that even there great numbers of the existing species of trees are still unknown to Science.

It is not many years ago that a trip to the Amazon seemed a very great undertaking but now New York steamers not only reach Pará frequently, but pass into the Amazon itself and twelve hundred miles up that river to the city of Manaos, and sometimes the same steamers go on eleven hundred miles farther to Iquitos in Peru, only five hundred miles from the Pacific Coast.

Let us hope that our botanists and horticulturists will awake to the great opportunities existing in that Paradise of Plants, and hasten to send down trained men who can bring to us freely of the riches of that wonderful country.

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Die-Back or Exanthema of Citrus Trees
(A Physiological Disease)

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HORTICULTURAL COMMISSIONER OF VENTURA COUNTY, CALIFORNIA

INTRODUCTION

Citrus Die-back was first described in Florida in the year 1875 by F. H. Fowler*, but when it actually appeared in the orchards has never been ascertained. In California the disease was known in San Diego county in the year 1890 on trees which had been imported from Florida. From its first appearance to the present time there has been much confusion in the minds of citrus orchardists regarding the appearance, work and control of this disease. Since the publication of Bulletin No. 8 by W. T. Swingle and H. J. Webber of the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, in 1896, a better understanding of the die-back disease has become general, and since then many helpful and valuable suggestions have come from B. F. Floyd, H. H. Hume and H. S. Fawcett of the Florida State Agricultural Experiment Station. In California the investigations have not been as extensive as in Florida, because the disease is not as severe here, but several articles have been published regarding it. The first appears in the report of the California State Board of Horticulture in the year 1896, and again in 1902. J. W. Miller, in Bull. No. 132 of the Cal. Exp. Station makes a strong statement regarding its destructiveness in the San Gabriel valley. Ralph E. Smith refers to the disease in a speech before the State Fruit Growers' convention at Marysville in 1907, and since that time reprints of the progress in Florida have appeared in the California Cultivator from time to time. So far there has never been any means of bringing together all of the known knowledge concerning die-back in a connected form for the use of the citrus growers of this state, which accounts in a large way for the present confusion. It is not an uncommon thing to hear growers speaking of wither-tip and die-back as being one and the same thing, and ofttimes I have had this as a query from local growers. In the last number of this Journal the wither-tip was fully discussed and illustrated, so as to make its identity beyond a doubt. In this article I wish to make clear the physiological disease, die-back, by presenting all available knowledge acquired in Florida and in this state, together with illustrations taken in our own orchards. I shall quote freely from all publications listed under the heading "Literature" further on.

*Bull. No. 8, Div. Veg. Phys. & Path., U. S. Dept. Agricl., pp. 14, Note.

Nature of Die-Back

So far as present knowledge goes, die-back is not a fungus disease at all. There have never been found mycelial threads or fruiting bodies which are characteristic of the true parasitic fungi as well as of other members of this group. It is considered, then, a physiological disease similar to Gummosis, Mottled-leaf, Barrenness, etc., the nature of which are not often clearly understood.

History and Distribution

As was already stated the die-back disease was first described in Florida as early as 1875, and is believed to have originated in that state. For some years it was not known to exist in any other locality. Later it was found to have spread very rapidly in that state until in 1907 Hume states that it could be found in practically every citrus orchard in Florida.

It was introduced into California on nursery stock along with other disastrous Florida diseases and first came under observation in San Diego county, being reported by F. Austin, then secretary of the County Board of Horticultural Commissioners, in 1896, although it was stated that the disease had been observed on the same trees for six years, making its introduction approximately 1890. Since that time it has been reported in the San Gabriel valley, along the foothills from Highlands to Pasadena, and is now located in three orchards in Ventura county.

Die-back was reported as existing in the citrus orchards of the Hawaiian Islands in 1905, and in Arizona in 1908, so today it is present in practically every citrus section in the United States, but has never been reported from South America, Australia or from other citrus sections in the Far East.

Appearance and Symptoms

Trees affected with die-back usually present a very dark-green color, although this is not always a sure case of die-back. In severe cases the tree remains dwarfed, with a narrow, oblong shape, and may eventually die. Then, too, the top may be very small, but composed of very compact foliage, due to an excessive production of tender shoots. The dying back of the ends of the twigs and the formation of numerous new shoots often give the trees a very regular and trimmed appearance, but in advanced stages they appear very irregular and ragged.

Twigs

(Figure 29, A and C)

Young—The young twigs on a badly affected tree first begin to turn yellowish before the leaves are matured. The leaves may fall or not. Swellings or gum pockets begin to appear, gum exudes, covering portions of the twigs and leaves with a reddish-brown coat.

Drooping—The ends of the twigs usually droop slightly at first. Later the tip may curve upward, giving the end of the twig an s-shaped appearance. The end dies back from four to six inches (Fig. 29 C).

Gum Pockets—(Fig. 29 A). The swelling appearing upon the young stems between the leaves on the internodes or at the bases of the leaves at the nodes, are caused by the formation of gum pockets within the stem. A cross-section of these

show them to be filled with a clear gum-like substance. The pockets resemble water blisters and are more or less oblong in shape and vary from one-quarter to one-half an inch in length.

Multiple Buds—(Fig. 29 C). Is the name used by Mr. Floyd for the abnormal number of buds which arise from a single axil. There may be from two to four thus formed, where in a normal case only one bud would be found. These buds are sometimes accompanied by an exudation of gum which may in time completely cover them with a reddish-brown stain.

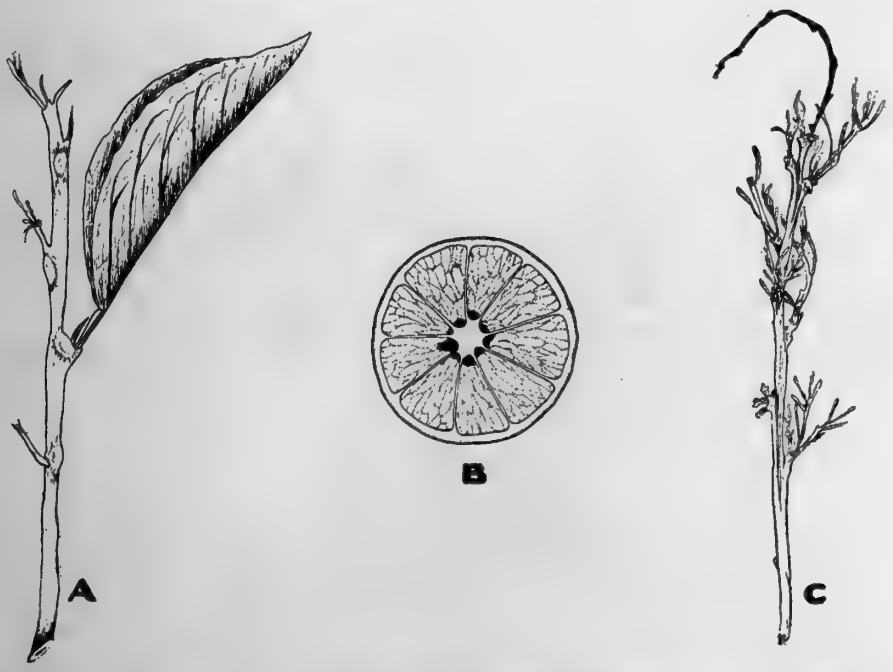

Figure 29. Die-back on Orange: A, showing gum pockets; B, cross-section of a Valencia, showing gum at core; C, twig showing multiple buds and dead tips.

Bark Eruptions—In more advanced stages the gum pockets erupt and allow the gum to flow out in numerous places over the stems. Eruptions also occur from the leaves, showing that the gum does not always come from well defined gum pockets. The gum that oozes out forms small patches, regular or irregular, of resin-like substance, which becomes reddish-brown and which is so characteristic of this disease. This gum soon hardens and presents its natural appearance for a long time. Excellent dry specimens of this stage may be preserved in the laboratory indefinitely.

Die-Back—(Fig. 29 C). The young twigs die back in a very marked manner as described above, and as is well shown in the accompanying illustrations. The dead portion may remain light in color, but is more often covered with a black saprophytic fungus growth. The length of the dead portion varies with the size of the limb, but usually continues from the tip back to the first well defined branch.

Old—The old twigs present much the same symptoms as do the young. The bark erupts and the characteristic reddish-brown stain pads are formed. The affection takes place only in the bark, which is sufficient to kill back old branches almost to the trunk of the tree. In this state I have been unable to find such a case, but it has been reported as occuring in the San Gabriel valley before the year 1902. In Ventura county we find only the young and tender growth killed back.

Leaves

The leaves first turn yellow, as described above, and may or may not fall. Those that do not fall soon begin to show an exudation of gum and the formation of regular or irregular reddish-brown pads over both surfaces, but usually beginning near the mid-ribs and spreading outwardly. Swingle and Webber attribute much of the staining of the leaves as due to the punctures made by scale insects and red spiders, claiming that in many instances the infection takes place only where the tissues were injured.* It is also claimed that the leaves are usually larger and longer than on a normal tree. This has been observed here, but we attributed it to the formation of the so-called water-sprouts caused by the die-back disease which always produce very large leaves.

On a tree that is just beginning to show symptoms of having die-back the leaves appear a deep green color, which is characteristic of an orchard well fed. Of course such a color cannot be taken as an indication of this disease, since all healthy groves show a deep green foliage.

Fruit

(Figures 29 B and 30)

Discoloration—When the fruit is about the size of an average walnut it begins to assume a lighter color and may even turn to a lemon yellow. At this stage it begins to fall and may continue to do so until the last stages of the disease, when there is very little left upon the tree. Soon the brown staining begins and may cover the surface in patches of minute reddish-brown speckles or in an unbroken irregular blotch, which nearly covers the entire surface.

Splitting—(Fig. 30). Accompanying the staining of the fruit is the splitting. The splits or cracks first appear as small "chaps," which gradually lengthen and widen until the core of the fruit may be exposed to view. This splitting may occur even before the staining, but usually as stated above. The crack may begin on the side of the fruit or at the blossom end. It is certainly disastrous to the market value of the fruit, as the appearance is very repellent. The trees affected in this county show great quantities of this insipid and split fruit, much of which is already on the ground. The fruit so cracked is called *"ammoniated"* fruit by Floyd.

Gum-Pockets—Fruits which show splitting or which do not show splitting or even staining, sometimes show the formation of small gum-pockets in the rind or peel, just under the surface. This is found quite abundant on affected sour orange trees.

Again, there may be a formation of gum near the center of the fruit about the seeds and core (Fig. 29 B). The dark area in the figure shows this. The gum so

*Bull. No. 8, Div. Veg. Phys. & Path., U. S. Dept. Agrcl., p. 17.

deposited may be colorless or slightly brown. This condition is quite prevalent in the Valencias on affected trees at Santa Paula, and cannot be told by any outward appearance of the fruit.

Dropping—The fruit first begins to fall before any staining may be noticed, shortly after the first discoloration. It may continue to fall slightly until the first signs of splitting, when most of the fruit drops to the ground. At the time of maturity there is not enough left on the tree worth picking, and what is left is usually thick-skinned and unfit for market. On the Valencia trees referred to above, and which are seven years old, there are not more than two boxes of fruit on twelve trees to date (March 20, 1911,) while neighboring trees are very heavily loaded. Neither is there much upon the ground, for the trees have never borne a good crop since they were planted.

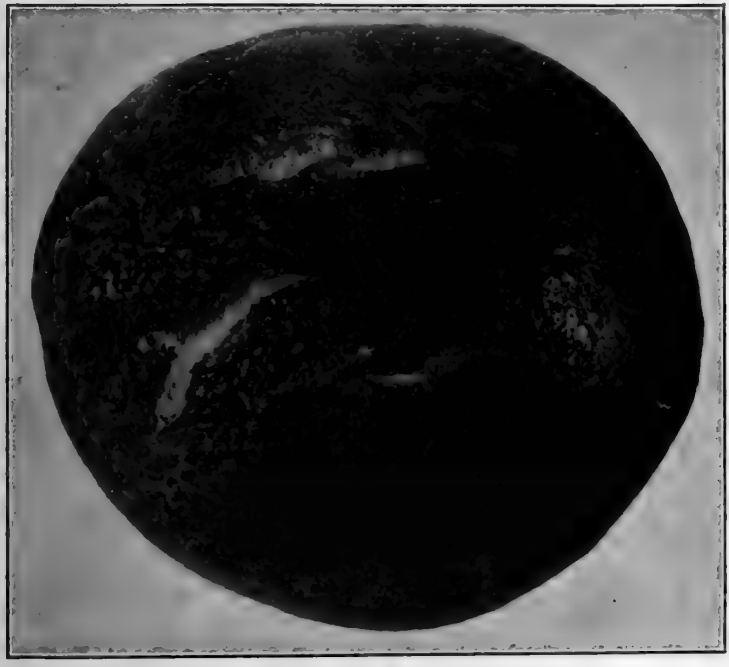

Figure 30. Die-back on Orange: A, Valencia, showing typical reddish-brown stains and cracks in peel.

Causes and Conditions Favorable to Growth

The exact causes of die-back are not all thoroughly understood, but enough is known of the disease to tell almost with exactness the conditions which are favorable to its growth and which will nearly always produce its characteristic symptoms. It is the general belief that the disease is caused by malnutrition, that is, an irregular or improper food supply.

The conditions most favoring its growth are excess of ammonia and improper soil conditions.

Excess of Ammonia—In Florida this seems to be the chief source of trouble, and much more time has been given to the investigation along this line than along any other. Field experiments have been carried on for years with organic nitrogenous fertilizers and enough field observations made to satisfy experts that this excess of ammonia is a most favorable condition for the growth of die-back.

The excess of ammonia is brought about by using large amounts of stable manure, bone and blood, dried blood, cottonseed meal, and any excess of organic matter. In fields that have been highly fertilized for raising truck crops and later transformed into citrus orchards the die-back has been found to do great damage and to occur in almost every instance. This same is true of intensive farming between the rows of citrus trees and the application of organic fertilizers.

Trees growing in or near barnyards, stables, or chicken yards, almost invariably show die-back.

All of these observations, then, indicate that in Florida this really has been a great source of trouble, but in California the trouble is not so much of this nature. In almost every instance die-back here is caused by improper soil conditions.

Improper Soil Conditions—As stated above, are the usual cause of the die-back in this state, and should be the chief problem to be worked out with reference to this disease here.

Poorly Drained Soil—Or low soil is accountable for numerous cases of the disease in question. A large supply of water, bringing with it an over-supply of food, invariably produces the malady. The rise of bottom water during the winter months or during irrigation periods also produces a favorable condition for the spread of the disease. It is this last named condition that is responsible for the worst case near Santa Paula. The affected portion of the orchard is situated near the foot of a hillside where the winter water oozes down during the rainy season, and where the irrigating waters are stored up during the summer months. The soil is a stiff adobe with a few small rocks mixed in for about four feet, where an impervious clay begins. This heavy soil is able to retain a large supply of water and therefore affords a most unfavorable condition for the roots to thrive in. Poor cultivation and very irregular irrigations on the part of the owner add to the already unfavorable natural conditions, and as a result die-back has been able to get a thorough hold in the grove.

Hardpan and Underlaid Impervious Clay—Soil underlaid with hardpan or an impervious clay affords the condition for the wost case of die-back. Such soils should never have been planted to citrus trees is the claim of many experts. In Florida the seat of most of the "soil die-back" is on such soils and large amounts of money are being annually expended to partially remedy this condition.

Granitic Porous Soils—This particular type of soil has been connected with die-back by Prof. Ralph E. Smith of the Whittier Pathological Station. At the Thirty-fourth Annual State Fruit Growers' convention at Marysville, in April, 1908, he makes this report: "This disease (die-back) is described in Florida as being due to an excess of organic nitrogen in the soil. That this is not entirely the case,

but rather that its cause is more complicated than this, is shown by the appearance of the trouble in this state, where it is limited almost entirely to a certain type of soil. This is the coarse granitic, very porous soil, which is found particularly along the base of the mountains in various places between Highlands and Pasadena. On such soils the Florida die-back is of quite frequent occurence. There have been a very few cases of this disease on heavier soils where the Florida experience seems to hold true, all the instances of such soils of which we are aware having been associated with very heavy applications of fertilizers rich in organic nitrogen. In the case of the type of soil mentioned, however, the disease occurs very severely in many instances where only moderate amounts of fertilizers have been applied. The most pronounced quality of this soil is the free passage which it affords to water. It becomes very wet during irrigations, but unless water is applied very thoroughly and carefully and quite frequently, the upper soil becomes absolutely dry between irrigations. This soil also takes up water very poorly in a lateral direction, so that the space between the trees and much of the whole body of the soil becomes extremely dry in many orchards. This disease appears to be brought about in some manner through an irregular food supply, resulting from irregular water supply which trees get in this soil, unless irrigation is particularly well carried out. With trees that are not well fertilized, the effect is simply one of ordinary die-back. True, exanthema seems to result where the soil is of the type described, and a fair amount of fertilizing material had been applied. It is apparently a sort of indigestion in the tree, more food being taken up during irrigation than the tree can take care of after it gets into the condition of dryness which follows. On heavier soils the same thing occurs only where very excessive amounts of nitrogen have been applied."

Improper Cultivation and Irrigation—Anything that tends to bring about malnutrition or indigestion in the tree may be a favorable condition for the growth of die-back. Proper methods of cultivation to aerate the soil and to conserve a regular water supply is important in controlling die-back. Irregular irrigations, with too much or not enough water at a time, may also bring about this disease.

Destructiveness

In Florida the die-back is more generally spread than any other citrus disease. It is claimed to be in every locality and doing damage wherever it exists. All writers make much of the amount of damage which is annually done. Swingle and Webber estimate an annual loss of $100,000 up to the year 1896. Hume and later writers make no estimate in dollars, but all state that the loss is very great. The actual loss is not always as easily determined as in the case of more positive diseases, but must be studied from a great many angles. Thus there must be considered the loss through the unproductiveness and slow development of the affected trees as compared with normal healthy ones; the excessive dropping of fruit; the coarseness and disfigurement of the fruit that does finally mature. Then there is the case where groves have been planted on improper soils which have produced a mild form of die-back, which is just sufficient to stunt the trees and cut down the yield with no real manifestations or symptoms of the real trouble. Much capital has been spent to bring such groves into proper condition without the owner

having the least idea of the cause of the trouble and the result being that little good was accomplished.

In California there have been no recorded facts with relation to the loss because of this malady. As has been stated, it was claimed that whole groves were destroyed before 1902 in the San Gabriel valley, and from time to time since then reports have come in that the disease has done considerable damage. In the reports of the State Pathologist for 1906 and from 1906-1909, the disease is mentioned as being more or less common, but no serious loss is recorded. In Ventura county, where the writer has made his observations, the greatest amount of damage may be accorded to a single orchard, where some twelve or fourteen trees are doing absolutely nothing for the owner. Many other trees also show signs of the disease, but not to any great extent. No doubt the greatest amount of damage in this state is in the production of stunted trees or "drones," which are doing absolutely nothing and which are a source of anxiety to the owner who does not know their ailments. Nothing could persuade the owner in Santa Paula that his trees were affected with die-back, and he could not be induced, by any means, to attempt any remedies. It is to be hoped that enough information can be given the growers in this article to enable them to diagnose the cases and to attempt a cure.

Control Methods

For Excess of Ammonia—Since an over-production of ammonia seems to cause die-back it is necessary to employ some means of preventing the tree getting too much in its food. This may be accomplished by cutting down the water supply and by cultivating only enough to keep the tree in shape through dry spells.

In plowing, all green manure crops or grass should be first removed from the grove to prevent the addition of more nitrogen. If any fertilizing is necessary, use sulphate of ammonia or nitrate of soda to obtain nitrogen. What has been said applies to an orchard which has had an excessive application of organic nitrogen fertilizers. When the condition has been remedied small amounts of organic fertilizers may be again applied, but with such fertilizers as stable manure, blood and bone, dried blood, guano, cottonseed meal, and green manure crops, add also potash and phosphoric acid.

For Improper Soil Conditions—Drain low and poorly-drained soils so as to prevent the over-accumulation of seepage water.

Blast out the hardpan under the trees if it is possible. This method has been very successful on soil of this type in Florida. Subsoilers may be used.

Irrigate regularly so as to prevent over-irrigation at some periods and a scanty supply at others.

Cultivate so as to aerate the soil in case of heavy soils, and try to keep the orchard in good condition. If this will not cure die-back it may be a good investment as a preventative.

Fertilize so as to avoid an excess of ammonia as described above.

Pruning in Relation to Die-back—According to H. H. Hume, die-back in Florida often follows the freezing back of the tops, while the roots remain uninjured. The result is that the amount of food supplied by the roots cannot be utilized by the

smaller top and indigestion or malnutrition begins which in turn produces die-back. In such cases Mr. Hume recommends root-pruning. He says: "The amount of pruning required will depend upon the severity of the attack, the size of the tree and the character of the soil. Pruning may be done by cutting a circle around the tree with a sharp spade, thrusting it well into the soil so as to sever a large number of roots. The balance of the tree is restored by this method, and a complete recovery frequently follows this practice. It should be borne in mind, however, that in addition to this treatment, the cause of the disorder in the tree should be sought for and the conditions favoring the development of the die-back removed as far as possible."

Spraying For Die-Back—So far as I have been able to discover no work of this sort has ever been published as referring to such method of control in this state. Again, we must go to Florida, where it is claimed that very good results have been obtained by the use of Bordeaux Mixture. It must be remembered, however, that an underlying hardpan cannot be remedied by the application of sprays. In such cases, and in all cases, in fact, the cause of the malady must first be sought and remedied as far as possible. It is then that good results may be expected from the application of sprays. The Bordeaux Mixture is attributed by Hume as accelerating the assimilative processes in the leaves and other green parts of the tree due to the "chemo-toxic" effects of the solution, and not as a fungicide in the ordinary sense.

The mixture used for this spray is as follows:

Copper Sulphate (Bluestone)	6 pounds
Unslacked Lime	4 pounds
Water	50 gallons

Since a 4-4-50 Bordeaux Mixture has been found effective in spraying for the wither-tip disease, it might be possible to get good results with this spray on die-back at the same application.

Relation of Die-back to Wither-tip—While these diseases are widely separate in characters and methods of attack, yet they are often associated together on the same trees. The die-back, by weakening the tree, affords an excellent starting place for the wither-tip. Thus a slight attack of die-back may be followed by a severe attack of wither-tip without the presence of the die-back being manifested. This very thing happened in a Valencia orchard near Santa Paula this winter, and it was only after the wither-tip had abated that the die-back showed up.

The stained fruit of the die-back presents the same reddish-brown color of the so-called "red spot" of the wither-tip and where there are no splits, may be confused with it, unless careful observations are made. In the case of the die-back the red spots are never depressed, while in the case of wither-tip they are depressed and in more advanced stages present dark-colored fruiting bodies, while in the advanced stages of the die-back the red spots appear as pads and are accompanied by splitting of the rind.

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The White Sapote

BY F. W. POPENOE, PASADENA, CALIFORNIA

Among the fruits brought to California by the Franciscan fathers when they established their missions along this coast more than one hundred years ago were some, like the olive and the grape, whose cultivation is today an important factor in our horticulture. But there is one at least, which although introduced early in the nineteenth century, is at present cultivated only a little more extensively than it was at that remote day. This is the White Sapote, or Zapote Blanco of the Mexicans, botanically known as *Casimiroa edulis*. In the city of Santa Barbara there is still to be seen (Fig. 31) an aged tree which has survived all vicissitudes from the early mission planting, being without doubt over one hundred years old. This tree is one of the most interesting horticultural landmarks of California, as it has the honor of having been the first tropical fruit tree planted in this state. Several other trees much more recently planted are now in bearing and have helped to demonstrate that this fruit is well adapted to our climate, and with the increasing interest now being taken in the subtropical fruits it seems likely that this one will soon receive the attention which it deserves.

The White Sapote is a member of the order *Rutaceae*, and is found growing both wild and cultivated in the states of Sinaloa and Durango, and other parts of northern and central Mexico. The tree is handsome, having large, palmate leaves, glossy green on the upper surface, and with age forms a dense, dome-shaped head of foliage. As an ornamental alone it is of value, and possesses good possibilities as a street and avenue tree. The fruits greatly resemble in appearance an apple or a quince, and the better varieties are as large as a good-sized apple. When fully ripe the pulp becomes quite soft, and has been described as of a delicious, melting, peach-like flavor. The normal season of ripening is October and November, but as soon as the fruit is fully developed it may be picked and ripened in the house, and is then quite as good as though ripened on the tree.

It should be remembered that the results obtained from this tree in Southern California, both in growth and fruiting, have been produced under the most adverse conditions in practically all cases, and much more can be expected when it is put under proper cultivation.

Of the local trees there are a number which produce small and inferior fruits, worthless or of little value. This is the case with the old tree in Santa Barbara, referred to above, but there are a few which have produced fruits equaling many of the best grown in Mexico, and although it would probably be possible to obtain better varieties by going to Mexico for them, those described are well worth propagating.

Propagation and Culture

Probably the principal reason for this fruit never having been brought into general cultivation in California lies in the fact that its propagation has been but imperfectly understood, and as it does not come true from seed it has been impos-

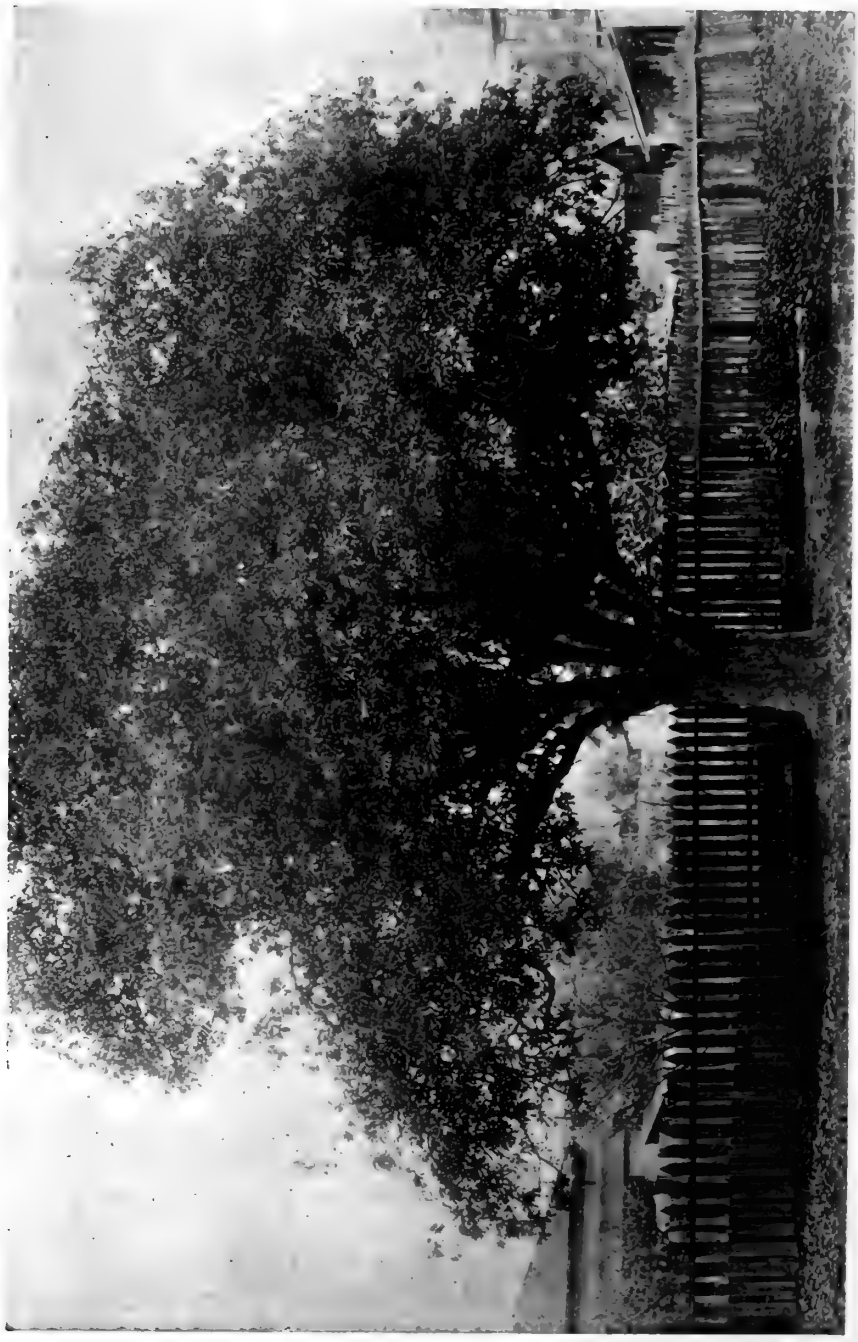

Figure 31. The first White Sapote tree planted in California and probably the oldest tropical fruit tree in the State.

sible to perpetuate the superior varieties. It is doubtful if much experimenting has been done in the propagation of the White Sapote by budding or grafting, but it seems reasonable to believe that it will not be long until our nurserymen will be propagating it in this way, and when this is done and standard varieties established, it promises to appear in general orchard plantings along with such fruits as the avocado and mango.

Quite a number of trees have been grown from seed in recent years and disseminated by nurserymen, and the propagation of the tree in this way is a very simple matter. The seeds do not retain their power of germination for a great length of time after being removed from the fruit, and should be planted as promptly as possible. No special treatment is necessary, and the seedlings make a rapid and vigorous growth under favorable conditions. The seedlings are very much inclined to spindle. I have seen many which have grown to a height of ten or twelve feet before branching, and to avoid this it has been advised to pinch out the terminal bud when the tree has attained a height of two or three feet.

The tree will certainly tolerate a great amount of harsh treatment and still thrive, as is emphasized by the behavior of many of the local trees which have had no cultivation or irrigation for years, and still bear regularly and profusely and are in a flourishing conditon. This drought resistant quality makes the tree very valuable for locations where there is an insufficient supply of water.

The question of hardiness has probably never been definitely settled. In his Dictionary of Gardening Nicholson predicts that it will prove hardy in Ireland and the south of England, and no amount of frost that has occurred in Southern California has been sufficient to injure even the youngest seedlings. Doubtless it will prove hardy practically all over the state. According to Von Mueller it is found in Mexico up to heights of 7000 feet, which certainly goes to show that it is adapted to a cool climate.

A second drawback to its being more extensively planted has been the fact that the seedling trees do not come into bearing until eight or nine years old, but this is a difficulty which will doubtless be eliminated through the propagation of the tree by some vegetative means.

Variations and Varieties

Like most other fruits grown from seeds, the White Sapote is subject to considerable variation. With the local trees no two have produced fruits exactly alike, and there are even marked differences between fruits on the same tree in many instances.

Especially is this variation noticeable in regard to size. None of the trees which I have observed produce fruits of anywhere near uniform size, but this is probably due in a large measure to lack of cultivation and irrigation. For many years the old tree in Santa Barbara was the only fruiting White Sapote in California, and it produced fruits no larger than a cherry. This is doubtless the reason that in early accounts of this species the statement is made that the fruits are from one-half to one inch in diameter. The trees which have come into bearing more recently have produced much larger fruits, in many cases up to the average of the fruits grown in Mexico.

One of the greatest differences between the several varieties here described is in regard to the seeds, their number, form and development. While the number is given as five in all botanical works, in one of the local varieties I have been unable to find even a trace of more than three; in another variety six is not uncommon. In many fruits the seeds do not all attain full size, there sometimes being only one fully developed, while the others are all more or less undeveloped. I have observed this same peculiarity in some of the fruits grown in Mexico. Dr. Franceschi informs me that he has never been able to find any perfect seeds at all in the fruits of the old tree at Santa Barbara. Only one variety which I have seen, the Gillespie, is normal in this respect. In this variety the seeds are invariably well developed, uniform in size, and of good germinating power. In the Parroquia two normal seeds are common, and only one is of not uncommon occurrence, there being but a small, thin husk to show the presence of the other seeds.

There are several other points in which variation is usually shown; in form there is considerable difference, and while the majority of the fruits are round, there are also oval varieties and many trees which produce malformed or abortive fruits, of practically no value. In color there is also considerable variation, and as the highly colored fruits are naturally the most attractive, these would be the most desirable for market purposes. The finer varieties grown in Mexico all possess fairly good color, and in this respect the Harvey is all that could be desired.

There is much difference in the quality of the fruits produced by different trees, and this is, of course, one of the most important points, if not the most important of all.

Much could be done to improve this fruit by selection and crossing; the number of seeds could be reduced, or the seeds eliminated entirely; the flavor could be improved, and a fruit could be produced combining the good points of several varieties and eliminating the bad ones. It is to be hoped that the White Sapote will be given more attention in the future; it certainly merits a more general cultivation, and to the plant breeder it presents very attractive possibilities.

Description of Varieties

Of the numerous trees now fruiting in Southern California, the following are some of the best, and show sufficient differences to warrant being considered distinct varieties.

As has been previously noted, there is considerable variation among fruits on the same tree, and this fact has made it impossible to give a description of a variety which will fit every fruit produced by that tree. Especially is this true in regard to size, there being a great range in this respect on almost every tree. In the following descriptions the dimensions of an average, well developed fruit are given.

Synopsis of the Varieties

A. Form round; diameter three to three and a half inches; cavity shallow to medium; apex more or less extended, five furrowed.

B. Skin smooth, very thin.

C. Color yellowish green, with bright orange cheek.

D. Flesh cream color to pale yellow.

E. Seeds normally five, slightly pointed on one end, two to four, more or less undeveloped. *Harvey*

BB. Skin rather tough, thicker.

C. Color light green, with russet cheek.

D. Flesh white.

E. Seeds five or six, blunt, all perfectly developed. *Gillespie*

AA. Form oval; diameter two and a half inches; cavity none, base slightly extended; apex broadly furrowed with one deep furrow, sometimes two or three others less distinctly defined.

B. Skin smooth, thin.

C. Color yellowish green, self colored.

D. Flesh creamy white.

E. Seeds normally three, long and pointed, one or two more or less undeveloped. *Parroquia*

Figure 32. The Harvey White Sapote, grown at Sierra Madre.

Harvey

(Figures 32 and 33)

This is growing on a vacant lot at Sierra Madre, and so far as I have seen is our largest and most highly colored variety. Possibly it has not as fine a flavor as the Gillespie, but the proportion of seed to fruit is considerably less than in the latter variety, and the fruit is larger and presents a more attractive appearance. Dr. Franceschi states that this tree was raised and planted in its present location by J. C. Harvey, formerly of Los Angeles. In and around Los Angeles are a number of other trees raised by Mr. Harvey, probably from the same batch of seed, and these all produce fruits very similar in general characteristics, so much so in fact that they could not be considered as distinct varieties. But as most of them are inferior, in size at least, the Harvey is the only one of the lot I have considered it worth while to describe.

Description—Form round; diameter three and one-half inches; base somewhat flattened; cavity medium deep, rounded, regular; stem very stout; apex extended to form a nipple, quite prominent, distinctly marked with five shallow grooves; color yellowish green, when fully ripe coloring on one cheek to orange yellow; surface smooth, undulating; dots few, large, rounded, dark brown; skin very thin and delicate; flesh cream color, deepening to creamy yellow near the skin, and becoming very soft; carpels normally five, sometimes four or six; seeds normally five, somewhat the shape of an orange "quarter" but shorter and thicker; broad, slightly pointed on one end, compressed, surface vermiculate or reticulate, one or more of the seeds usually small, thin and undeveloped; flavor good, season October, at Sierra Madre, California.

Tree is upright, open headed, and a very prolific bearer. Here first described.

Figure 33. The Harvey White Sapote tree grown at Sierra Madre, California.

Gillespie

(Figure 34)

This variety is growing on the Gillespie place at Montecito, near Santa Barbara. Dr. Franceschi states that the tree was planted by the late Kinton Stevens in 1892. While not so large or attractive in appearance as the Harvey, it is probably the finest flavored of the local varieties. It is quite distinct from the others in having a rather rough, russet exterior, and perfectly developed seeds.

Description—Form round; diameter three inches; base only slightly flattened; cavity shallow, rounded or flaring, regular; stem stout; apex very slightly ex-

tended; basin deep, narrow, abrupt, deeply five folded; color pale green, one cheek overspread with russet; surface rather rough; dots very numerous, small, irregular, raised russet; skin thin, rather tough; flesh white, becoming tinged with pale green near the skin; flavor very good; carpels normally five, sometimes six; seeds five or six, short and broad, blunt, surface vermiculate or reticulate; season October to November at Montecito, California.

Tree is upright, open headed, very prolific bearer. First described here.

Figure 34. The Gillespie White Sapote, grown at Montecito, near Santa Barbara.

Parroquia

(Figure 35)

This is growing behind the Catholic church on State street in Santa Barbara, and was raised by Dr. Franceschi from Mexican seed and planted in its present location in 1896. So far as I have seen, it contains but three seeds, one or more of which are usually undeveloped, and it also differs materially in form from the other varieties here described.

Description—Form oval; dimensions, diameter two and one-half inches; length three inches; base slightly extended; stem rather slender; apex normally broadly furrowed with one deep furrow, and usually two or three others less distinctly defined; color yellowish green, self colored; surface smooth; skin thin, tender; flesh creamy white; flavor very good; carpels normally three; seeds normally three, one or two usually small, thin and undeveloped, long, pointed on both ends, surface vermiculate or reticulate; season October to April at Santa Barbara, California.

Tree is upright, open headed, fairly prolific. This is the first description of this variety.

The following are some of the principal bibliographical references on the White Sapote:

1884—Von Mueller, Select Extra-Tropical Plants, p. 74.

1895—Franceschi, Santa Barbara Exotic Flora, p. 26.

1899—Rose, Notes on Useful Plants of Mexico (Contributions from the U. S. National Herbarium, Vol. V), p. 217.

1905—Conzatti, Generos Vegetales Mexicanos, p. 163.

1907—Wickson, California Fruits, p. 339.

Figure 35.—The Parroquia White Sapote, grown at Santa Barbara.

Acacias for the Southwest*

BY E. H. SPOOR, REDLANDS, CALIFORNIA

Among all the trees and shrubs that are grown in the temperate and subtropical zones, there are probably none so highly decorative and ornamental as the Acacias. This genus came originally from Australia. It is one of the largest known, comprising about four hundred species. The conditions being similar to their native country, they thrive, and are able to reach their very best development here. They are easily raised from seed, and are quite hardy and vigorous growers.

The Acacias are adapted to many uses. The plants vary widely in form from dwarf shrubs to gigantic trees; also ranging from wide spreading shrubs, such as *cultriformis,* to the most symmetrical tree, as the *melanoxylon.* Some usually have the phyllodes or blade leaves, while others have the bipinnated or feather leaves. A great many are useful as street trees; some beautify the lawns; others make fine hedges. The blossoms differ in form from minute globules to long cylindrical spikes, and in color from a creamy-white to a deep orange. All are abundant bloomers. Some of these do well along the coast in the poorest land nearly in touch of the salt spray, while others meet the demands of the hot interior valleys. Being hardy these grow after a start with practically no care at all; but if given a small amount of care and plenty of water, it is astonishing the way they grow. The Acacias possess an enormous range of foliage forms, and may be so arranged as to give constant succession of bloom the year around. Thriving with the greatest of success they are indispensable in the gardens or on the street.

Propagate by seeds sown between March and August; the earlier started the better. The seeds should be soaked twenty-four hours in hot water before planting. Plant in large pots or flats, with light soil and drainage. Cover with one-eighth of an inch of soil, mixed half in half with sand, with a limited admixture of wood ashes. They will be from a few days to two or three weeks in sprouting. As soon as they are up, prick out into flats or small pots. They should be shaded, but given all the sunlight they will bear. The greatest care should be exercised in watering. Keep moist, but not wet, or they will be likely to "damp off." If grown in pots until they are from two to four feet high, they will do much better when set out. Some varieties which grow much faster than others will be ready to set out the following spring, but generally they are too small until the second spring. If given plenty of water when set out they will make remarkable growth.

The following are lists of all species used and where they may be obtained; also detailed lists for the different purposes:

Seeds Offered by Southern California Seedsmen:

Acacia acinacea.
A. albicans.
A. armata.
A. baileyana.
A. cavenia.
A. cultriformis.
A. macradenia.
A. melanoxylon spectabilis.
A. mollissima.
A. myrtifolia.
A. neriifolia var. floribunda.
A. notabilis.

A. cyanophylla magnifica.
A. cyclops.
A. dealbata.
A. decurrens.
A. elata.
A. extensa.
A. falcata.
A. glaucescens.
A. juncifolia.
A. longfolia.
A. longfolia var. floribunda.
A. longfolia var. latifolia.
A. longfolia var. linifolia.
A. lophantha.
A. obliqua.
A. penninervis.
A. pinifolia.
A. podalyriaefolia.
A. pravissima.
A. primrosa.
A. pulchella var. grandis.
A. pycnantha.
A. retinodes var. floribunda.
A. salicina.
A. saligna.
A. spectabilis excelsa.
A. suaveolens.
A. verticillata.

Further additions offered by Haage and Schmidt are:

A. drummondii.
A. giraffe.
A. leucophylla.
A. paradoxa.

In addition to these Vilmorin offers the following:

A. arabica.
A. calamifolia.
A. catechu.
A. diffusa.
A. eburnea.
A. elongata.
A. farnesiana.
A. grandis.
A. horrida.
A. julibrissin.
A. lebbek.
A. lophantha.
var. neumanni.
var. speciosa.
A. microbotrya.
A. moluccana.
A. nemu.
A. nilotica.
A. obtusata.
A. odoratissima.
A. procera.
A. stenophylla.
A. trinervis.
A. vestita.

Santa Barbara nurserymen also offer living plants of the following:

A. accola.
A. aneura.
A. corymbosa.
A. dietrichiana.
A. flexicaulis.
A. leptoclada.
A. stricta.
A. subulata.

LISTS SHOWING THE DIFFERENT PERIODS OF FLOWERING

Spring:

A. armata.
A. baileyana.
A. dealbata.
A. longifolia.
A. melanoxylon.
A. mollissima.
A. podalyriaefolia.

Early Summer:

A. cultriformis.
A. cyclops.
A. pycnantha.
A. verticillata.

Fall:

A. calamifolia.

These are varieties that have flowered in this vicinity. More extensive lists will be published later, as young, new specimens come into bloom.

LISTS ACCORDING TO ACCEPTED USAGE

Those among the best for street trees are as follows:

A. baileyana.
A. decurrens.
A. dealbata.
A. melanoxylon.
A. mollissima.
A. longifolia.
A. floribunda (A. neriifolia).
A. latifolia.
A. lophantha.
A. pycnantha.

The best lawn specimens are:

A. armata.
A. cultriformis.
A. baileyana.
A. floribunda.
A. lineata.
A. riceana.
A. cyclops.
A. podalyriaefolia.
A. verticillata.
A. latifolia.
A. linifolia.
A. longifolia.
A. albicans.
A. cyanophylla.

Excellent species for hedges consist of:

A. albicans.
A. armata.
A. cavenia.
A. diffusa.
A. pulchella grandis.
A. suaveolens.
A. vestita.
A. verticillata.

Figure 36. Acacia melanoxylon on Grand avenue, Pasadena.

Acacia melanoxylon

(Figure 36)

This Acacia, commonly called the "Blackwood," is a favorite tree for street planting, although not one of the most beautiful. It is an erect pyramidal grower, reaching the height of eighty to a hundred feet. Its popularity for street planting is due to the fact that it is such a symmetrical grower. A peculiar feature of this tree is that when young it has both "blade" and "feather" leaves, and the new shoots have the same feature, although the "blades" are not true leaves. It is a very good hardwood, and is used by cabinet makers. This tree also forms a magnificent dark background for dwarf and brighter blooming varieties. It flowers in March.

Acacia longifolia

(Figure 37)

This is the golden wattle tree; beautiful for street planting or for the lawn. A quick growing variety reaching the height of thirty or forty feet. It has a spread-

Figure 37. Acacia longifolia.

ing habit which makes it very desirable for lawn planting. The golden spikes bloom from February to May. The bark of this tree contains some tannin and the wood is used for various purposes, having light, hard, and tough timber. This is one of the most extensively planted species, and is one of the best, containing several varieties.

Var. *Sophorae*—the pods of this are curled more, the leaves smaller, and it blooms later than the true *longifolia*. It attains a height of twenty or thirty feet in a few years.

Figure 38. Acacia dealbata.

Acacia dealbata

(Figure 38)

The silver wattle; very ornamental, and one of the best for street planting. It has fern-like, glaucous foliage with golden yellow flowers which bloom profusely in early spring. It is a rapid grower, and becomes fifty or sixty feet high. This is largely planted in California, growing very fast when young.

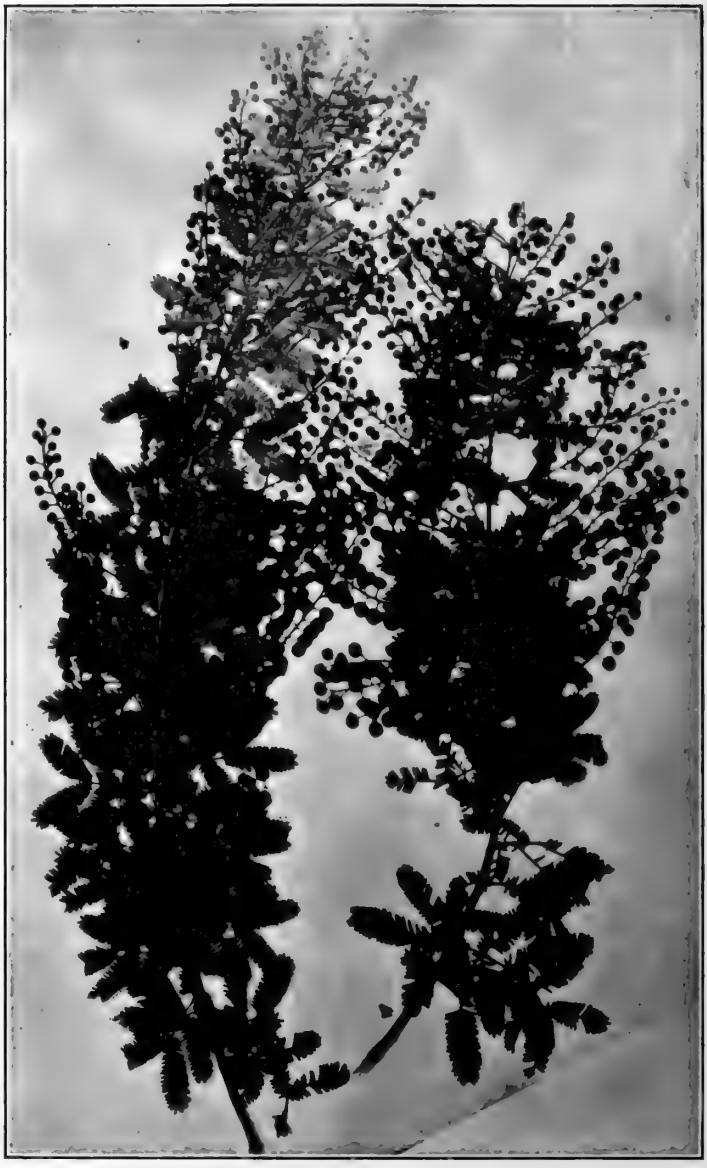

Figure 39. Acacia Baileyana.

Acacia Baileyana

(Figure 39)

This is one of the best and most beautiful of all the Acacias. It unfolds its great bundles of canary yellow flowers early in January, with a contrast of crowded silver green foliage. These flowers completely envelop the tree. It grows rapidly when planted out. After attaining the height of twelve or fifteen feet, it perhaps grows more slowly until it reaches its full height at thirty feet. This is an excellent species for lawn planting, and a beautiful street tree. The bark of this tree is said to contain some tannin.

*In the East our people used to know the different common kinds of oaks, ashes, maples, and other trees, with great familiarity from their earliest childhood. Coming to California they find their familiar oaks and maples replaced by the acacias and eucalypts—strangers from Australia and the Far East, and it takes a very long time to become familiar with the many sorts which are commonly planted here. Mr. Spoor is giving us a simple account of some of these things with illustrations and descriptions by which they may be easily recognized. In working up these articles he acknowledges his indebtedness to all previous writers on the subject, and especially to Messrs. Popenoe, Cornell, and Pierce, for the photographs.—Ed.

Plans and Plants for Small Places

R. D. CORNELL,* LONG BEACH, CALIFORNIA

The greater number of the common trees and shrubs, found in our Southern California home grounds and parks, are not natives of this country, but have been brought in from tropical and subtropical countries and acclimatized here in a new environment. They come largely from Australia, New Zealand, Mexico, Central and South America and West Indies.

The public in general knows nothing of them as to general characteristics, such as genus and species, habits, size of growth, etc.; the park men in general know little of their plants but the proper care of their physical needs; and all too frequently, the nurserymen, entrusted with the propagation and care of the young seedlings, are inaccurately and inadequately informed as to the true names and true characteristics of the goods which they deliver to the public as correctly named. There are no parks or gardens in all our southland where the plantings are named and labeled, so that a stranger might inform himself as to the identity of that tree or shrub which pleased or displeased him.

That which is necessary to develop the greatest charm and beauty of our future California, is a more careful consideration, on the part of the small as well as the large home-builder, in the selection and arrangement of his plantings. It will take but little time and thought and often will save expense in construction as well as add to the selling value of the property.

In the first place, know what you are planting! Be sure of its identity by obtaining it from a reliable nurseryman or other authentic source. Then learn its habits and mature size by noticing some old specimens in your community, or referring to a written authority on the subject, such as "Bailey," found in all good libraries. Now plant the young tree with a view to what it will finally become in size and form, not merely considering how it now looks. Have, if possible, the vision of your home ten years hence, and in laying out the grounds and arranging the plantings you will avoid that crowded, overgrown appearance that is so commonly seen in places, ranging from the small lot to the park measured by acres.

A good creed for the prospective planter is this:

Think, investigate, look beyond today, mix with your selection and arrangement of plantings, your natural common sense, and your investment of a little time and pains will pay an interest of enjoyment, satisfaction and increased value of the property through all the years.

The accompanying half-tones are from photographs taken of Southern California homes. The pictures were best seen from the sidewalk, where the street

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*Mr. Cornell has been making a business of visiting plantings of every description throughout Southern California, identifying the plants used, and observing everywhere the varying degrees of wise and unwise usage of them. This seems to me an unexcelled opportunity for all owners of plantings who are not certain of the identity and possibility of their plants, to call upon Mr. Cornell's services. The expense would be slight and it would give an effective answer to the thousands of questions that are constantly being asked, especially by newcomers to Southern California.—Ed.

trees did not interfere with the view, but it was necessary in order to get the entire yard in focus, to take the photos from across the street, even though the trees partially obstruct the view.

The first two views represent two extremes in the methods of treating the small, city lot, in which the house is necessarily close to the sidewalk. The one might be regarded as a chaste example of planting, the other as very florid.

The first home (Figure 40) gives a pleasing effect to the eye. In the window box are ivy-geraniums, while an Asparagus Sprengerii is hanging above them; suspended under the porch are Asparagus Sprengerii in hanging pots and two potted yuccas are seen on the buttresses; a well kept geranium hedge reaches to the porch floor and hides the foundation; to the left, in the background, are lemon

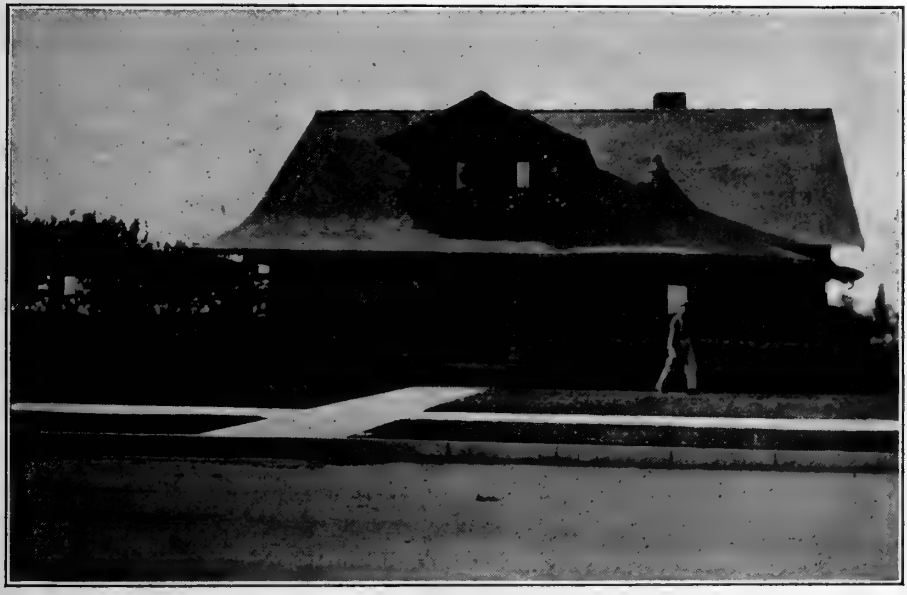

Figure 40. Showing a narrow front yard well planted by being little planted. Some shrubbery might be well used at the sides.

trees. Aside from these, there are absolutely no plantings; nothing to obstruct the view, either from within or without, and give that overcrowded, cramped appearance which is so commonly seen.

The second home (Figure 41) though comfortable and attractive, is the opposite extreme. At the right, is an immense Yucca gloriosa, cutting off the view of that corner of the house and flaunting its bare, unsightly trunk before all passers-by, while beside it, several trees are crowded into altogether too small a space.

On the left, the same fault is to be found. There, are seen an immense pepper tree, a banana, a Sterculia and a bamboo, all in a space inadequate for the pepper alone. Then, too, the Sterculia and bamboo are placed where, within a few years their growth will entirely shut out both the sun and the view.

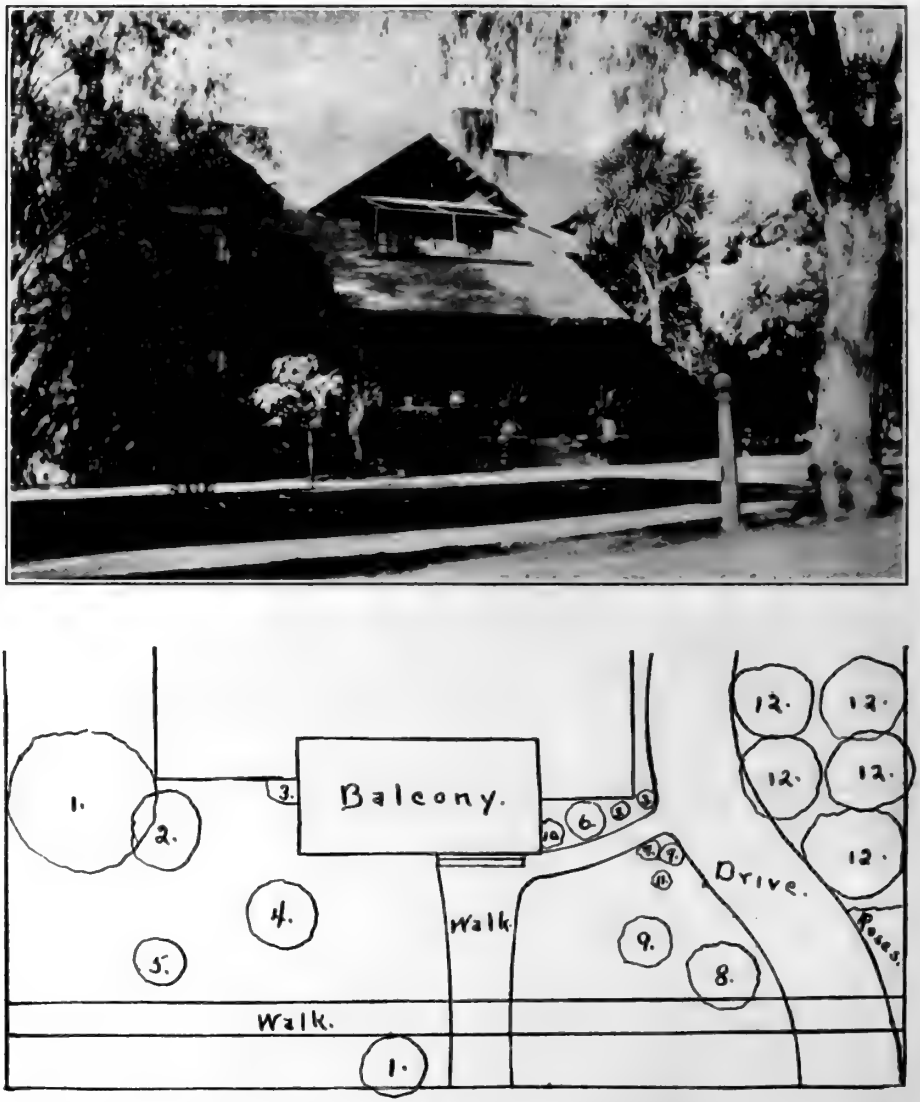

Figure 41. Showing a place somewhat floridly planted, with note-book sketch showing plants used, as follows: 1, Schinus molle; 2, Banana; 3, Tree fern; 4, Sterculia acerifolia; 5, dwarf Bamboo; 6, Yucca gloriosa; 7, Aralia papyrifera; 8, Acacia Baileyana; 9, Pittosporum eugenioides; 10, Hydrangea; 11, Elephant-ear; 12, Oranges. Nos. 4 and 9 are due to become good sized trees.

The effect of the vine covered porch is, however, very pleasing. The climbing fig *(Ficus repens)* is kept well trimmed and in bounds and the porch is seen to contain hanging ferns and potted begonias. There are also potted ferns on the buttresses and a giant tree fern at the left end of the porch.

The last two cuts (Figures 42 and 43) are different views of one and the same home. Might the street trees be cut from the scene, it would be a beauty. Here, there are no large plantings in front of the house, but the trees and shrubs are banked at the sides and in such a way as to hide the rear of the lot and still add to the attractiveness of the place.

The rose-covered pergola at the left, with the pepper at its end, balances and neutralizes the effect produced by the group of trees at the right. In this case, as in the others, the porch is hung with ferns, and potted ferns are on the buttresses.

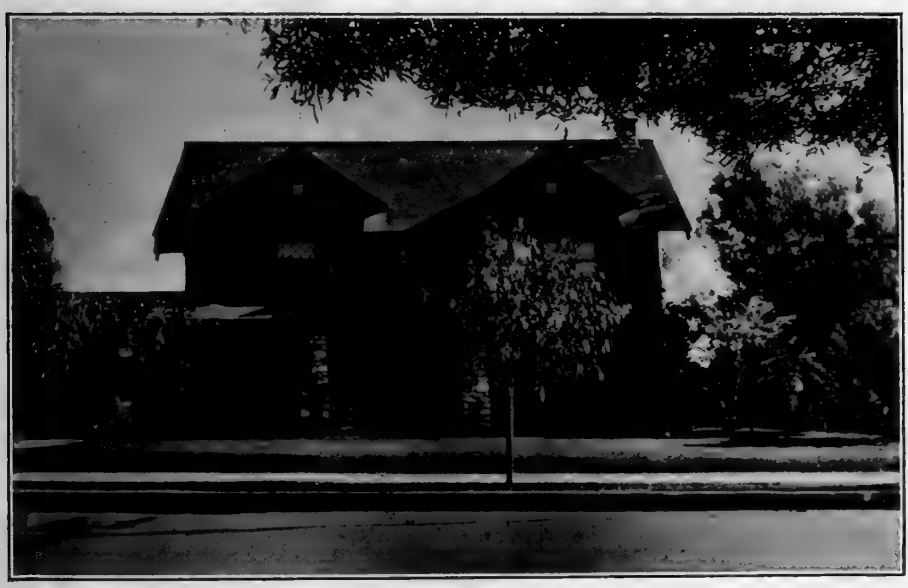

Figure 42. Front view of same place shown in Figure 43.

A bank of heliotrope planted against the foundation of the porch helps greatly in softening the lines.

None of these views can be appreciated, either as examples of good or bad, unless actually seen in the freshness of life and color. But we have here attempted to give our readers some idea of what can or cannot be done with a small home by means of these actual examples.

The accompanying diagram (Figure 44) is representative in part of the manifold possibilities which present themselves for the beautification of the ordinary city residence lot. The plate represents a corner lot and is constructed on the supposition that an alley runs along the rear; and the lot is planted and arranged for a west frontage with an open exposure on the south.

This plan is such as could easily be carried out by the home builder of moderate means, with no additional expense than is ordinarily put on the construction

of and the too often futile attempts at beautifying the grounds. If the owners of city homes would give the matter of plantings and arrangements of walks and drives a little consideration, and not merely put what they want wherever it seems to fit in most conveniently at the time of planting, there would be a marked improvement in the appearance of our California homes.

The essential steps are: First, to consider the conditions, such as direction of frontage, surroundings, contour, shape and size of lot, and the shape, size and

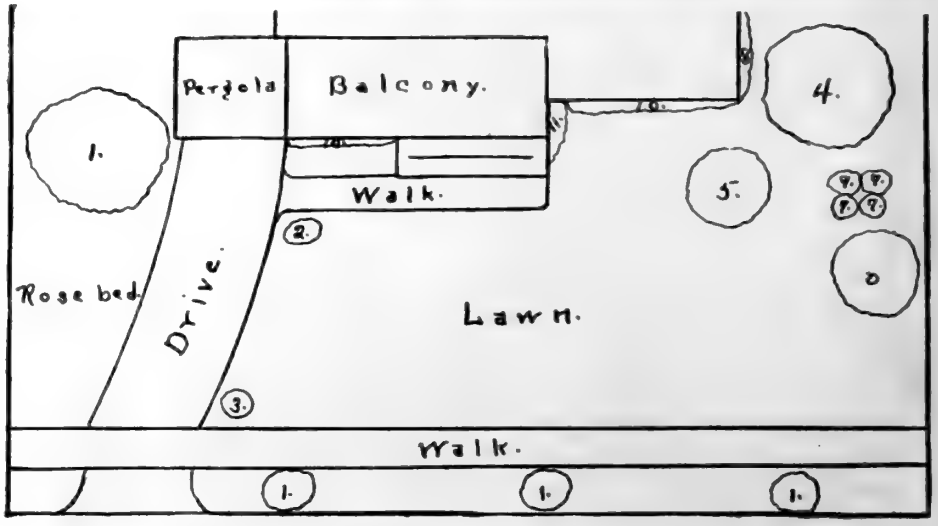

Figure 43. Quartering view of a well planted place, with note-book sketch of plants used, as follows: 1, Schinus molle; 2, Grevillea Thelmanniana; 3, Yucca gloriosa; 4, Acacia floribunda; 5, Acacia Baileyana; 6, Araucaria Bidwilli; 7, Aralia papyrifera; 8, Wigandia; 9 Wigandia; 10, Heliotrope; 11, Elephant-ear.

number of buildings to be placed in the given space; second, construct any drives or walks; third, decide on the plantings which are desired and which are adapted to the environment, and fourth, arrange these in an artistic manner, not in a conglomerate mess. Pre-consideration is the foundation principle of all pleasing landscape effects.

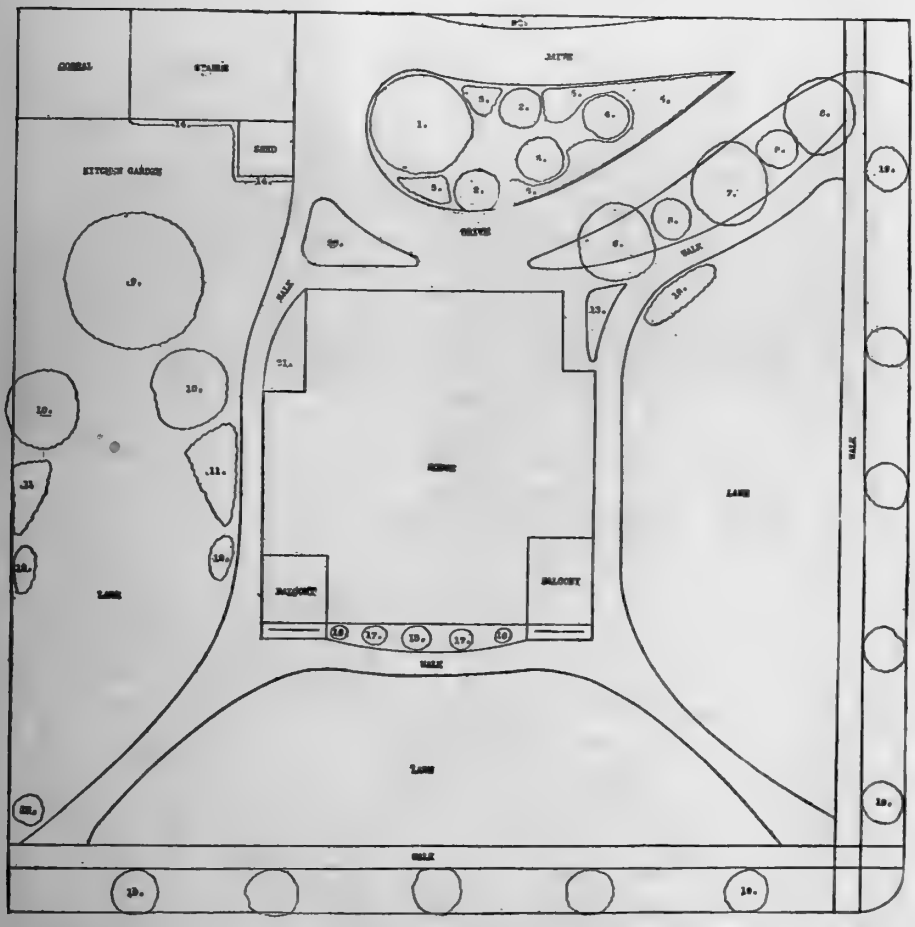

Figure 44. An original plan showing some of the fine possibilities in a corner place. The plants used are as follows: 1, Magnolia grandiflora; 2, Lagerstroemia indica; 3, Eugenia latifolia; 4, Spiraea thunbergii; 5, Lantana; 6, Phœnix canariensis; 7, Cocos plumosa; 8, Cycas revoluta; 9, Eucalyptus viminalis; 10, Acacia decurrens; 11, Chilopsis saligna; 12, Mimulus glutinosus; 13, Calochortus; 14, Ficus repens; 15, Grevillea Thelmanniana; 16, Heliotrope; 17, Fuchsia; 18, Poinsettia; 19, Jacaranda mimosaefolia; 20, Guavas.

A Botanic Garden for Southern California

C. F. BAKER, POMONA COLLEGE, CLAREMONT, CALIFORNIA

Southern California has very justly been called the Garden Spot of Earth! No other similar region is so rich horticulturally, and none other possesses more striking undeveloped possibilities. With such a debt to Horticulture one would expect to find here marked evidences of more than ordinary interest in plants, in botany, and work pointing to wider development and better knowledge of all of the possibilities involved. Comparing the extent and character of our horticultural interests with those of other countries, even some of those far beneath us in civilization, we find here a remarkable paucity of live interest and real activity along these lines. Southern California has taken only a first step as yet in the building of great public parks, and many of our good sized towns have none at all.

In numerous other regions scarcely larger, or even smaller, than this, and with smaller horticultural resources, like Java, Trinidad, Ceylon, Jamaica, or England, and in many of the still smaller countries and colonies, we find great, scientifically managed, and beautifully arranged Botanic Gardens, with extensive botanical and horticultural libraries attached thereto. In such places are gathered all of the thousands of plants of interest and importance to the region, where they may be definitely known by name, where people generally and all growers, fanciers, nurserymen, and others specially interested may visit them at any time, learn to exactly know them, and to examine all of the literature relating to them. In addition to its other possibilities, in such a garden thousands of new things can be introduced and acclimatized, and then thousands of cuttings and packets of seed of desirable things distributed among our people.

The mind leaps at once, in looking over the work of these great projects in other countries, to the tremendous possibilities such an enterprise might have here, in these most favorable surroundings, in both material and educational ways. We have but very few such institutions in the whole United States, like the Arnold Arboretum in Massachusetts, the New York Botanic Garden supported by men of wealth in New York City, and the Shaw Gardens in St. Louis.

Prof. Cook and I have persistently agitated this highly important project and have even tried to interest people at Pomona College in the matter. Pomona College possesses one of the finest parks in the South, of sixty acres and all undeveloped as yet. It might easily be made a most powerful educational tool, and still be a thing of beauty, though it seems more likely to develop into merely a pretty picture for passing pleasure, like so many others of our public parks. We have got to make something more than that out of our parks if we wish them to mean the most to our people, and yield to them the greatest possibiilties.

Even here at the College, without any support, and by personal enterprise alone, we have begun the development of a Garden and have already a collection from all parts of the world of some 25,000 plants in pots, all carefully named, but with no space to plant them out where they will be cared for, and we have in the meantime given away above 10,000 plants and many hundreds of packets of seed,

all gratis. Even all this is, under present conditions, no promise at all that it will be possible to accomplish anything permanent whatever at Claremont. But it is a most important and illuminating practical demonstration of how easily and rapidly such an enterprise might be developed with even moderate support.

Above all things, the enterprise should be *organized and permanently established,* and it will then, surely and rapidly, become one of the most valued possessions of our commonwealth. It could be accomplished anywhere with energy and enterprise, even at Claremont. The people of Southern California want it. Many people throughout the South with whom I have talked concerning it, have spoken of the need of it most earnestly, but their voices have not yet been raised in unison. *Standing together,* our people could have the best and most efficient thing of the sort in the world.

Our experiment in botanic garden building here at Claremont, has amply proven the point we wished to make in connection with it, and that is, that with even a small amount of intelligent direction, great results can readily be accomplished with very limited support, or, as in this particular instance, with none at all, since we have made the work practically support itself. One should now look over these thousands of lusty young plants of interesting and valuable species from all over the world, produced here without hired help and under very unfavorable circumstances, to gather some idea of the really great developments along this line that might be obtained through friendly interest, and even limited support.

We have here shown, conclusively, the ready possibility of producing an unlimited variety of the world's most interesting and valuable trees, shrubs, and herbaceous plants, with wholly trivial effort and expense. If this could be matched with a provision of space for plantings, and a competent Curator, a great Botanic Garden would become an immediate reality.

Fungi Nova, Vivenda Citrus*

DR. H. REHM, MUNICH, GERMANY

Ad folia *Citrus Aurantii* cultivatas, Corona et Claremont, Californiæ, 1, 1911; leg. C. W. Metz et J. A. Prizer.

I. In plagis foliorum vivorum late expansis, longitudinaliter nervorem medialem amplectentibus ambientibusque, plane exsiccatis, papyraceis, flavide albescentibus, curvado-flavorubidule marginaceis arcte gregaria innati, plagulas cinerascentes reddentia, inprimis paginæ inferiore folii, perithecia globulosa, glabra, nigra, pro minutissime perspicue pertusa, papillula perexigua demum prominentia, parenchymatice fusce contexta, 0. 1 to 0. 15 mm. diam. Asci lageniformes, basi lata sessiles, versus apicem cylindraceo-elongati, 50 to 60 micromm. longi, in parte inferiore 20 micromm., ad apicem 10 ulati, 8 spori. Sporæ subclavatæ, utrinque rotundatæ, medio septatæ(paullulum constrictæ, utraque cellula i guttata, hyalinæ, 20 to 7 micromm., in parte inferiore asci plerumque sitæ. Paraphyses nullæ.

Mycosphaerella lageniformis Rehm.

II. In iisdem plagis, a *M. lageniformis* late absessis, nec distincte separatis, sed plus minus ne albidulis hic illic subgregaria innata perithecia globulosa, paginam inferiore folii elevantia ab eaque tecta, demum dirrumpentia, minutissime papillulata, glabra, excipulo sclerotioideo, duro, extus fusco, intus hyalino praedita, 0. 2 to 0. 3 mm. diam. Asci clavato-cylindracei, crasse tunicati, vix stipitati, apice rotundati, 110 to 130, 20 to 22 micromm., 8 spori. Sporæ ovoidæ, utrinque obtusæ, medio constrictæ, transverse 5-, longitudinaliter exclusis cellulis apicalibus 2-septatæ, subfuscæ, 22 to 24, 10 to 12 micromm., distichæ. Paraphyses haud con-

Scleroplea Aurantiorum Rehm.

Von Hohnel—Pragm. Myc. IV, in Ber. kais. Ak. Wiss, Wien, Bd. CXVI, Abt. I. p. 136—claris verbis descripsit definitionem *Scleropleae* (Sacc. Syll. II, p. 277). Oudem. (cfr. Sacc. Syll. XVI, p. 548), generis *Pseudosphaeriacearum,* inprimis Pleosphæriaceis alienum contextu sclerotiadeo, stromatiseo, sine paraphysibus contexto. Peritheciæ hujus generis sclerotiacea certe per longum tempus viva, itaque valde noxia evadere possunt, non minus perithecia *Mycosphaerellae lageniformis* luxurie imprimis sporarum.

Observatione accurata foliorum vivorum mox in lucem prodibis, cujus harum specierum parasiticarum invasione primordia destructionis foliorum prodibis, mihi videtur *Mycosphaerellae.* Utraque species valde noxiæ fere mihi videtur.

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*Dr. Rehm has very kindly drawn up the formal diagnoses of these two interesting new fungi, living on Citrus. One of them, at least, is purely saprophytic. Mr. Metz is preparing drawings of them, and also further notes, which will be published later. These two fungi are of especial interest on account of their occurrence on spots ordinarily attributed to wither-tip.

Comments on the Pomona College Journal of Economic Botany

From Dr. Th. Holm, Brookland, D. C.

"Only a few days ago I asked a friend of mine at the Department of Agriculture why there was no Journal of Economic Botany in the United States, and you may imagine my surprise when I received your Journal the day after. I congratulate you on this fine idea, and I shall certainly subscribe for it. Perhaps I may be able to give you some contributions."

From the Manager of the Southern California Acclimatizing Association, Santa Barbara, Cal.

"Allow us to congratulate you upon the appearance of the first number of your Journal of Economic Botany. A high-class publication on these subjects fills a long-felt want, and if the public appreciates it as we do, it should be a tremendous success."

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"The Journal of Economic Botany is a most worthy example of what some of us did not need to be told of your patient, faithful labors. But I trust that it will make known clearly the debt incurred by our people through your accomplishments."

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"Am pleased to know that you have undertaken this work, for the need of such a publication in Southern California is quite apparent."

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From Prof. A. W. Morrill, State Entomologist of Arizona.

"I am greatly pleased with its contents and general make-up."

From Prof. A. B. Ulrey, University of Southern California.

"I am very much pleased to know that you are publishing in our midst a journal of the quality I find in this one."

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From Mr. P. D. Barnhart, Editor of "Pacific Garden," Pasadena, Cal.

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From Mr. Charles R. Paine, Redlands, Cal.

"Its publication is a venture worthy of success, and if that success is not financial, it surely will be educational."

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As Applied to Subtropical Horticulture

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A. J. COOK, D. Sc., HEAD PROFESSOR
CLAREMONT, CAL., U. S. A.

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of ECONOMIC BOTANY

Volume I SEPTEMBER 1911 Number 3

The Withertip Disease in Florida

P. H. ROLFS
DIRECTOR OF THE FLORIDA AGRICULTURAL EXPERIMENT STATION

In the article on Withertip in the first number of the Pomona College Journal of Economic Botany there has been brought together a very complete and forceful resume of this subject as we now know it. Our laboratory experiments with pure cultures show conclusively that withertip fungus is able to infect healthy, uninjured tissue not only of oranges but of a number of other sub-tropical fruit trees. Naturally the disease is more serious on trees whose constitution has been weakened by other untoward conditions. Consequently, the average grower, whose opportunities for observation and close study are more limited than those of the plant pathologist, is entirely justified in coming to the conclusion that the withertip fungus is a secondary parasite.

In regard to the red spots of an anthracnose-like character which frequently occur on citrus fruits, I may say that mistakes are frequently made. We know that the resultant lesions from certain chemical poisons on fruit are so like those produced by the withertip fungus that they are not easily distinguished even by use of a compound microscope. In pronouncing a case anthracnose, therefore, the experienced plant pathologist does so with a great deal of hesitation unless he is very familiar with the surrounding conditions. For instance, I should hesitate very much in pronouncing a lesion due to withertip by examining a specimen of fruit only, due to the fact, which I have described above, that chemicals are known to produce lesions that are very similar to the withertip lesions on mature and nearly mature fruit. In the groves, however, and where all the surrounding conditions are known to the plant pathologist, he should be able to make a diagnosis without much hesitation.

I was very much surprised during my visit in California by the frequency with which I met this fungus. In most of the cases it was simply hanging around in the groves and doing very little damage, and no one but a person who was familiar with the fungus at first-hand would have suspected its presence.

In our early studies of the withertip fungus we laid a great deal of stress on the use of Bordeaux mixture. Our later and more exact work has enabled us to treat the disease very successfully without the use of this spray. Everybody who has had experience with Bordeaux mixture on a large scale knows that it is a very disagreeable material to handle. In Florida, also, our friendly fungi hold the scale insects so much in check that we hardly need to spray for them. By using

Bordeaux mixture we kill this friendly fungus and thus allow the scale insects to increase with unusual rapidity.

Our best method in Florida consists in thorough orchard sanitation followed by vigorous pruning out of the withertip affected branches. This pruning out is done most profitably during July and during January. It is during these months that our trees are pretty certain to be in full dormancy. Pruning out for withertip when there is much new growth present is a very bad practice since every scratch on the leaves or abrasion on the young growth makes it very liable to withertip infection and the spores must be present in the infected groves by the myriads.

Notes on *Scleroplea aurantiorum* and *Mycosphaerella lageniformis*

CHAS. W. METZ
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The two new ascomycetes described in the last number of this Journal by Mr. H. Rehm are species found in Southern California on orange and lemon trees. The first record of these is from orange leaves taken at Corona, California, by Mr. Prizer of Pomona College. Later the writer found them in orchards near Claremont.

The descriptions of the habit of these fungi, given by Mr. Rehm, are based upon two or three specimens, and are not strictly characteristic. The leaves upon which the fungi are found look almost exactly like leaves affected with withertip, (*Colletotrichum gloeosporioides* Penz.) (See "Withertip of Citrus Trees," by E. O. Essig, P. C. Journ. Ec. Bot. 1-25). The yellow, shrivelled areas may be at the tip, edges, or in the body of the leaf, but are invariably bordered by a brown or dark yellow margin. The perithecia of the two, especially those of *Scleroplea aurantiorum,* so resemble the acervuli of the withertip that to the naked eye they are indistinguishable. They never accompany the withertip, however, at least in this vicinity.

Both the *Scleroplea* and the *Mycosphaerella* are often found on the same leaf, but the larger and less congregated perithecia of the former, usually serve to distinguish them. Whether or not they are parasitic is not known. Certainly they are not found on any but living leaves, so far as I am aware. Fallen leaves, and hanging dead leaves, show no signs of their presence; nor do leaves mechanically injured. Likewise weakened leaves on trees attacked by squirrels, or otherwise impoverished, show no signs of attack. On the other hand, the fungi apparently are of no appreciable harm to infected trees, as they occur on very few trees, and do not spread rapidly. The writer has only found them on one or two lemon, and perhaps a dozen orange trees in this vicinity; and only on two of the latter were they abundant. On these two the affected leaves were all on the south side, facing the road, the other parts of the tree being entirely free from infection. From one tree about three hundred leaves were taken in an area of a few square feet. None of the trees surrounding these two showed any signs of the fungi. At Corona Mr. Prizer found one tree on which a large part of the foliage was affected, while at Riverside investigation shows only a few scattering leaves with any signs of it. The tree at Corona is the only one known to me, on which the disease, if such it is, is conspicuous. At any rate the survey has been entirely too inadequate to justify any conclusions as to the economic importance of the fungi, even if they are both parasitic, as Mr. Rehm believes.

The characters of the fungi themselves can best be seen from the accompanying figures (Figure 45) prepared by the writer. These have been drawn to scale, so that an accurate comparison of size and form can be made. The perithecia

of both species are dark, heavy, and thick-walled, but differ greatly in size and position. Those of *Scleroplea aurantiorum* (Figure 45B) are almost entirely below the surface level of the leaf, while those of the *Mycosphaerella* (Figure 45A) are merely beneath the epidermis, rupturing the latter as they grow. The perithecia, asci, and spores of *Scleroplea aurantiorum* are quite uniform in size and

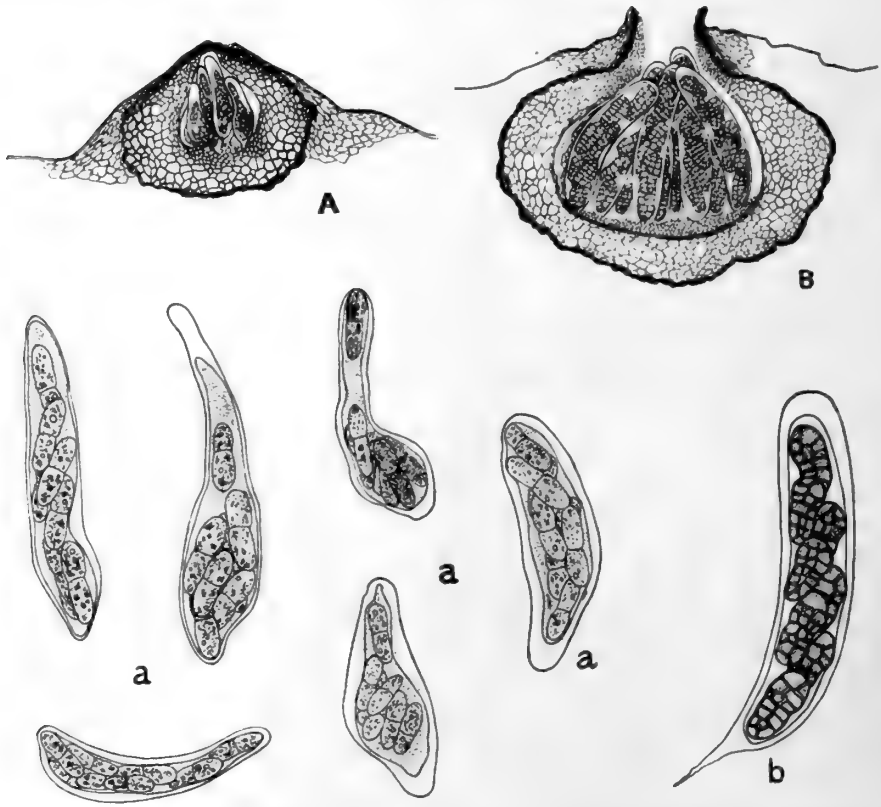

Figure 45. Details of Scleroplea aurantiorum and Mycosphaerella lageniformis. A, a, a, a, M. lageniformis; B, b, S. aurantiorum.

form, as shown in the figures (B and b). The black perithecia, together with the yellowish, opaque spores in the transparent asci, are very striking in appearance. The asci and spores of *Mycosphaerella lageniformis,** however, are neither conspicuous, nor uniform, although the perithecia do not seem to vary much. The asci may be of almost any shape from the typical flask-shape described by Mr. Rehm, to long, cylindrical. The spores, like the asci, are hyaline and not uniform in size, although they are easily distinguished by their shape and two-celled structure. Something of the variation found is shown by the figures of the six asci given, (Figure 45, a a a).

*A *Mycosphaerella* with similarly lageniform and very variable asci has recently been described by Shirai and Hara under the name of *M. macleyae* from *Macleya cordata* in Japan (The Botan. Magaz. XXV, March, 1911).

Modern Agriculture in Mexico

D. L. CRAWFORD
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Mexico, with its many thousands of square miles of good, arable land, is preeminently adapted to agriculture. There are few countries in the world which have the enormous possibilities of wealth which now lie in the most productive soil of our sister Republic. Our states are producing now immense quantities of cereals and temperate fruits, but Mexico has the natural opportunity to produce not only immense amounts of cereals and temperate fruits but in addition nearly all the standard tropical and subtropical products known to commerce.

The topography of the country is very varied. In the vast northern desert, which will some day be transformed by irrigation, are large sections which by the presence of water are enabled to yield richly in citrus and other fruits, cereals and cotton. The southern and more tropical section has a wide range in climate and soil conditions. There are three recognized divisions: the *tierra fria,* or the inland plateaus and mountain valleys, always quite cold; the *tierra templada,* or the lower table lands, moderate in climate; and the *tierra caliente,* or the hot coast country. Each of these three belts is naturally adapted to totally different forms of agriculture. Each of the three belts is, moreover, adapted within itself to different things. One section of the temperate lands may be best adapted to the culture of fruit; another may be better able to produce good corn. One section of the hot country is best suited to the culture of the *Castilla* rubber tree; another is not fitted for this, but favors the production of coffee, or bananas, or the fibre plants. It is a pitiable thing, indeed, to see in Mexico one prospective planter after another go to ruin just because of ignorance or carelessness in not heeding these laws of natural adaptation of soils.

The time was, not far back, when the products of agriculture were with great difficulty shipped beyond the immediate locality where they happened to be grown. This is no longer true. Railroads are tapping scores of rich areas and making it possible for growers in almost any portion of the country to send their goods not only to the large cities of the Republic but also to the outside world. Three long lines of railway enter the United States and a fourth is rapidly being pushed to completion from Southern California to Guadalajara and Mexico City. Three large shipping centers on each coast, Tampico, Vera Cruz, and Puerto Mexico on the Gulf coast, and Acapulco, Salina Cruz, and Manzanillo on the Pacific, together with many smaller ports, make communication with the outside world comparatively easy. And if a better communication is necessary it only required an active demand for it to bring it about.

As a rule a country tries to produce as much as possible of the articles of food used by its own people. The universal crops of the country are corn and beans, as would be expected since these are the two chief articles of food. These are grown, or at last planted, in nearly all regions and under nearly all conditions of soil and climate. Vast corn fields are planted every year on the extensive plateau-

like mesas around Mexico City, Guadalajara and Puebla, in the high mountain valleys and even on the mountain sides around Orizaba, and Zacatecas, and on the lower lands about Vera Cruz and Tampico and the southern hot lands. In fact one can scarecely travel in Mexico without frequently seeing some sort of a corn field—it may be a thousand acres or it may be a quarter of an acre; it may be in a most flourishing and thriving condition or it may be poor and miserably developed and with almost no yield at all. Every man tries to maintain independence and thinks that he can best do this by actually producing his own corn and whatever other food he may need. Accordingly he plants regardless of surrounding conditions.

There are numerous other products, some agricultural and others growing more or less wild and without cultivation. The chili, or red pepper, is grown quite extensively, since this forms a necessary part of the daily diet. One or more of the many varieties of avocado, or aguacate as it is called, by the Mexican, flourish in all parts of the country and always find a ready market. There are many fruits produced by more or less labor such as the mango, guava, many varieties of the sapote—the sapote blanco, negra, colorado, domingo and others,—the arrayan, papaya, bananas of many kinds, and many other native fruits. A very extensively grown plant is the maguey, one of the *Agaves*, which is grown for the production of the native drink, *pulque*. The sugar cane is produced in large quantity both for sugar and similar products, and also for aguardiente, or alcohol. Pineapples are being planted more and more in the lower and warmer belts, and are found to be very profitable. Citrus fruits have been produced in varying amounts for many years. Oranges flourish in many parts of the Republic and when not infested by the terrible Orange Maggot are a great source of profit. The lemon most commonly produced is the small seedling variety but it is very juicy and acid. The sweet lime finds a ready market always and the large citron is not an uncommon product. Cotton is being tried in many sections of the country, and in some instances the results are most encouraging. Rice is produced in the lower belts and even in the state of Morelos around Ixtla. Alfalfa and other fodders are grown to a considerable extent. Vegetables of many kinds are produced for the local markets. Temperate fruits such as peaches, apples, grapes, pears, quinces, and others, are produced in small amounts, but very poor in quality; these are planted more in the higher and more northern sections where the climate is more or less temperate. Finally we come to the tropical products of southern Mexico—coffee, tea, cacao or the cocoa bean, vanilla, rubber, etc.

As will be seen from this hasty and brief enumeration of products the possibilities in agriculture are not only great but most remarkably varied. Mexico presents by far the most varied and at the same time accessible topography of any country in the world. Almost every climatic, atmospheric and soil condition prevails in some part of the land.

In spite of these remarkable possibilities peculiar to Mexico, very little has been done thus far to realize any of them. Nature has played by far the largest part in agriculture in the past years instead of the agriculturist taking the upper hand, as he has done in other countries, and directing the forces of nature in the

way most advantageous to him, and even avoiding or preventing the evil results of natural occurrences. The very methods employed in the tillage and care of the soil not only fail to secure the best possible results, but are causing actual depletion and exhaustion of the soil. If present methods continue and are not replaced by modern scientific methods of tillage and culture, there will come a time, and it will be very soon, when the virgin strength of the soil is exhausted and then agriculturally the nation will surely suffer.

The many books treating of soil and its care have not been written without careful and scientific investigation and experimentation, and there is not a single authority that would advise the use of a forked stick as a plow. Of course, whether or not oxen are used in place of horses or mules is a matter to be decided by the people concerned. If a man is willing to take ten days to plow with oxen the same area which he could in one day with mules or horses, or even in much less time with steam power, then he is at perfect liberty to do so. All that can be said for that man, however, is that he is practicing poor economy and will sooner or later be distanced by the rapid advance of civilization in other regions. But as to the plow itself, there is a far different question at stake. In order to conserve and increase the plant foods stored up in the soil and to furnish the right amount of moisture to the plant roots a good mulch is essential. This mulch should be made by turning over and pulverizing the surface soil from time to time, the depth to which it is turned varying with attendant circumstances. All that the wooden "plow" performs is to merely push the dirt to one side, or sometimes not even that, and thus only scratch the surface, whereas the steel plow completely turns the surface layers and thus makes available for use the nitrogenous and phosphorous foods formed farther under the surface. This, of course, applies more to the annual preparation of a yearly cereal crop rather than to the regular care of an orchard, although in the latter case it is not out of place. As an illustration of this principle one need only to look at the corn fields near Mount Popocatapetl, north of Popo Park. There the steel plow is in extensive use and the results show it plainly. Acre after acre produces some of the richest corn imaginable, while other fields in the same belt not plowed with the steel plow are greatly inferior in their yield. Fortunately the steel plow is gradually replacing the old worthless wooden plow, but this displacement must surely be hastened and not allowed to take its present too gradual course. It was a great surprise to hear a man, who is actually in charge of one of the government experimental stations, say that he had tried mules and horses and steel plows but that he had found that they did not pay and so had returned to the use of the forked stick dragged along at a snail pace by two oxen. His explanation was that the mules and horses could not endure the intense heat. There is absolutely no reason why these animals may not be perfectly acclimatized in a comparatively short time to endure as much as any native animal, as they already have been in other countries. If an experimental farm persists in using the wooden plow, as is done at Oaxaca and at Rio Verde, what can be expected of the common farmer? If it is high tariff duties on farm implements or lack of possible manufactories for them that is preventing or hindering the use of modern tools, then steps should be taken by the govern-

ment to remove the import duties or else promote the manufacture of them at home; at any rate they surely ought to be offered for sale at the most reasonable price possible.

While it is true that in general these methods are necessary to the best success of agriculture, yet local conditions must always be dealt with individually. Field tillage that would bring about the best results in semi-arid soil might be quite disastrous if applied blindly to a very humid soil. The duty of modern science is to study the conditions affecting the growth of crops in as many localities and under as may conditions as possible, not only in Mexico but in Southern California and everywhere else.

Now let us turn to the methods of culture in orchard and other crops, having seen those employed in cereal field preparation. The first thing one notices on entering so-called orchards in Mexico is that nearly everything is left to the processes of nature. Very little order is observed in the arrangement of the trees and little effort is expended to keep the ground free from weeds. The soil is seldom and poorly stirred, thus hindering seriously the bacteriological processes of plant-food manufacture beneath the soil. Again, fertilization of the soil is almost never thought of. Because of the tremendous virgin richness of the soil the idea is quite prevalent that culture is entirely unnecessary and uncalled for. It has been only a comparatively short time since the California farmer and orchardist has begun to realize that there is a limit to the virgin richness of our soils and that this must be conserved most carefully and most scientifically, since personal welfare as well as that of the state depends very largely upon it. The man who ignorantly causes constant depletion of land or who greedily exploits it to its limit is a menace to the nation, no matter where or who he may be.

Very little or no effort has been made to improve orchard stock by budding, grafting or selecting. What might be done in the way of improving the avocado, for instance, or the mango, by breeding and selection is simply beyond estimate. There is scarcely an avocado tree in the Republic, I venture, that is not a seedling, and hardly a mango or orange tree that was not grown from a seed and left unimproved. It is very good philosophy to be satisfied with what one has, but only when that is the best that one can get. To be satisfied with the products of seedling trees is not in the least necessary since they can be improved and the financial returns greatly increased simply by applying some of the scientific methods worked out in other countries.

The avocado, or aguacate, grows in nearly all parts of the country and occurs in many different varieties all the way from the size and the appearance of a small plum or prune to a large full fruit some six inches in diameter. The meat varies in quantity and quality from poor and insipid to rich and delicious. Yet in spite of the immense range of varieties very little attempt has ever been made to improve them or even select the best. It has been taken for granted apparently that no other variety would flourish in any locality except those that have been there for years. In recent articles on the "Avocado in Southern California" by Mr. F. W. Popenoe the possibilities of improvement from budding and selection are strongly brought out. It is a fact well known to horticulturists the world over

that a large proportion of the seedling trees either never bear any fruit at all or else bear a worthless product, and almost none possess the fertility and fruiting capacity which budded stock does if rightly handled. With proper experimentation under thoroughly scientific control the avocado could be made a source of tremendous profit and benefit. The fruit is so universally a part of the people's diet and at the same time so delicious and nutritious that no expense should be spared to produce the best trees possible by selecting and budding the best varieties. Wealth and great benefit to the nation can be derived from its production not only for home consumption, which would necessarily be great, but also for export. With present methods of railroad shipment it would scarcely be possible to export the large, soft, thin-skinned varieties grown in Chiapas and Vera Cruz states, but beyond all question there is a ready possibility of shipping some of the harder and thicker-skinned varieties such as, for instance, those produced in San Luis Potosi, Coahuila, and in the vicinity of Torreon. These varieties even in their present state are very delicious and with improvement in stock and with best methods employed in handling, packing and shipping surely will find a ready market anywhere in the United States, even after Florida and Southern California become heavy producers, as they will. Rightly managed, the avocado industry can and surely will become a source of great wealth to the country, and the time when this shall come merely depends on the readiness of the people to adopt the best that science has to offer. What better investment could be made than a large and scientifically managed avocado plantation, with only the best and most approved stock planted therein, to produce fruit that would easily take preference over the inferior seedling fruit now offered in the market, and some of which could be shipped with great profit into the United States?

In addition to improving the quality of the fruit and increasing the average yield by budding, another great field lies open to scientific effort, namely, that of reducing the avocado seed to the minimum and increasing the quality of the meat. This can be done by selection and budding. There is no possible reason for doubting that this improvement can and will be brought about not only in the avocado and not only in Mexico, but in all fruits and in all countries. For this experimentation Mexico possesses unequaled opportunities and should easily be the teacher of other countries in tropical and subtropical horticulture.

The mango, likewise, is surely subject to very great improvement by the same methods as outlined for the avocado. The seed, or bone as it is called by the native, is needlessly large and fibrous, and might easily be reduced by selection. Just how much improvement can be effected in this fruit is largely conjectural since almost nothing has been attempted in that line. We are safely within the bounds of truth, however, when we declare that a very great improvement in quality and quantity of fruit can be made, with a greater or less reduction of fibre. The "manila" mango grown at its best in the state of Vera Cruz in the vicinities of Cordoba and Medias Aguas, is certainly a most profitable fruit, and yet it can undoubtedly be made more valuable by applying modern science to its culture. This variety of mango, too, seems to be entirely free from the ravages of the orange maggot, so devastating to the native variety. While the "manila" is larger

and in some respects finer than the native variety, still the latter, known by various names, one of which is *mexicano,* is often preferred by the native and foreigner alike. The large market for both varieties demands that both be improved to their highest point of quality.

As in the case of the avocado, so the mango, also, may be made an article of export to the United States—*but only after the orange maggot has been completely exterminated!* Mangoes have been shipped from the Philippine islands to Pomona College in Southern California, being a month in transit, and yet they arrived in edible condition. If that is possible, exportation from Mexico is readily feasible. Although both the avocado and mango have been produced in Southern California and will be later to a much larger extent, yet there will always be an increasing demand for the Mexican fruit to supplement our own productions.

In a previous paper the possibilities in the improvement of the Mexican seedling orange were brought out. While the seedling orange may be considered by many of superior quality in taste to the navel varieties, yet the latter command a price in the markets from two to five times as large as do the seedlings. The general statements made in regard to seedling trees above apply equally to the citrus group. There is a large market for all the numerous varieties, both seedling and hybrid. One variety may be better adapted to certain soil and climatic conditions than the others, in which case that variety ought surely to be planted.

It was stated at the Oaxaca Experiment Station that trials of budded citrus stock had been made without success, due, it was said, to the inability of the stock to resist frosts and other unfavorable conditions. It is hardly possible that acclimatization might not be effected, thus rendering the improved hybrid varieties just as resistant as the original seedling. This must be proven, however, by careful and extensive experimentation. A good start in this direction is being made in Vera Cruz state at Plantation Roma. This is a citrus orchard of about three hundred acres operated entirely by modern scientific methods. Mr. R. D. Huber, in charge, insists on cultivation by means of steel plows and cultivators drawn by mules. Some budded stock has been planted and a thorough trial of it is being made. Experimentation such as this—on a large and practical scale, experimental and at the same time yielding large returns financially—will surely help to advance agriculture, horticulture and pomology to its proper state.

The same may be applied equally well to the culture of lemons, and all other citrus fruits. The producers should be satisfied with nothing less than the best, and should bend every energy toward bringing about these improvements. And so we might go through the long list of native fruits, pointing out where improvement and resulting financial gain could be effected. Some varieties of the sapote might profitably be grown for shipment. The white sapote, *sapote blanco,* is too soft and thin-skinned to allow of exportation, but the sapote *negro* and sapote *domingo* might easily be shipped. The cherimoya and other fruits, also, can be greatly improved and increased in value.

More or less experimentation is now being carried on in the way of selecting and determining the best variety of *Castilla* rubber tree, the best variety of coffee, the best varieties and adaptability of cotton, the most productive sugar cane, etc.

These efforts are in the right direction and cannot possibly be made too intense. It may even be added that efforts toward crossing and hybridizing in the producing of the best varieties are not only advisable but most urgently necessary. The *Castilla* rubber industry is a new one and still in the experimental stage of development. On the Dona Maria and La Zacualpa plantations in Chiapas every effort is being made to determine which of the several varieties of *Castilla* produces the greatest flow of latex through the greatest proportion of the year. As these experiments are being carried on it will be very easy to try hybrid varieties by every possible combination in cross pollination, until one variety is evolved which without question is the most productive. But it is most important to remember that in two distinct belts the most productive variety may not be one and the same.

Similarly, a variety of coffee may easily be produced which will be resistant to the destructive mildew which is so common on these plantations. The annual loss from this one source alone, the coffee mildew, would more than pay for very extensive and comprehensive experimentation by trained horticulturists. Although one is accustomed to think of the banana as beyond improvement, yet in this field, too, there is vast room for improvement in the way of size, flavor, number of "fingers" to the "hand" and "hands" to the bunch, etc. It is subject to a very destructive bacterial disease in Central America, not far from Mexico, and resistant varieties must be discovered or developed. The immense extent of this industry demands that the yield each year be up to the highest standard possible.

The culture of the maguey, or agave, for pulque manufacture, needs but one thing to make it of great benefit to the nation—*extermination!* Just as the manufacture of intoxicating liquors in the United States or any other country is simply sapping the virile strength of the nation and adding absolutely nothing in the way of productive labor, just so does the very extensive culture of the maguey add nothing of productivity and, moreover, it is sapping the life blood of the under class of the nation. One of the great sources of income in the state of Yucatan is the henequen fibre plant, belonging to the same genus, *Agave*. At the National Museum of the commission of biological survey in Tacubaya, Federal District, there are samples of the fibre produced from the various species of *Agave* found in the Republic. A substitution of *maguey verde,* or some other good fibre producing agave for the *maguey blanco,* the pulque plant, would mean a tremendous increase to the national resources and at the same time do away with one of the greatest evils of the country. There is the same reason for destroying this plant wherever it exists in the country as there was for putting the ban on the opium poppy in China.

The vast areas in the state of San Luis Potosi and neighboring states now covered densely with cactus, both *Opuntia* and *Cereus* varieties, could be profitably cleared and planted to some fibre bearing agave. It is barely possible that the cactus thus cleared off might be put to some practical use. In the mean time there are hundreds of square miles already cleared and admirably suited to the growth of the maguey for fibre.

There are some sections poorly adapted to the cultivation of the more valuable crops where *Eucalyptus* timber will undoubtedly be a very rich investment. There are many Australian or Californian species which would do well under conditions of moderately large amounts of rain, such as *Eucalyptus globulus* and *Eu. corynocalyx*. On the other hand, the two species *Eu. rostrata* and *Eu. tereticornis* thrive very well with little moisture and would, therefore, be admirably adapted to growth in the Tehuantepec Isthmus territory where the rains are more infrequent than further north or further south. All of these varieties are succeeding well in Cuba and Porto Rico.

The value of eucalyptus is very great both for use as hardwood timber to replace mahogany and other similar woods, and also for use in railroad construction as ties and telegraph poles. As a hard wood, many species, notably *Eu. globulus*, take a very high and permanent polish and show a most beautiful grain. For use as railroad sleepers and ties the wood is quite unparalleled because of its resistance to rot. Although these species are known to possess these qualities in places where they have been tried, yet it must be a matter of experimentation in any new region. Possibly other species under other conditions may surpass these in value.

In many parts of Mexico there are grown very inferior grades of several of our temperate fruits. The production is not very great, but just enough to show that great results could be obtained by modern methods, since the trees can easily be acclimatized and all that is necessary now is proper management both of tree and soil. *Durasnos* (peaches) may be purchased at almost any market in season, but they are almost invariably hard, small, and more or less tasteless. This condition, it is true, is due partially to ignorance in picking, since they are seldom allowed to even approach maturity on the tree, but even beyond this the quality may be greatly improved by introducing and acclimatizing bud-wood from better varieties, and growing nursery stock for distribution in the various belts. Imported nursery stock of these, as of any other fruit trees, could hardly be expected to compete with home grown stock. In the southern portion of the state of Oaxaca, in the Oaxaca valley and also near Tomellin further north, conditions are most admirably suited to extensive deciduous farming; in may other localities, also, as in the Toluca Valley near Mexico City, may parts of the State of Jalisco, and other places.

The great value in peach culture, or in deciduous fruit culture in general, is attested by the tremendous retail price commanded by imported deciduous fruit in any of the large cities. In Mexico City or Vera Cruz a very common price to pay for improved peaches, imported, is from thirty-five to fifty cents (gold) per pound. Pears, apricots, plums and all the other temperate deciduous fruits, when imported, command a ridiculously high price. There is absolutely no reason why these improved varieties may not be grown in many parts of Mexico and thereby place on the local markets fruit fully equal in all respects to the California fruit and at the same time at a very reasonable price.

The adaptation of many parts of Mexico to temperate fruit culture is beyond dispute. As has been pointed out the topographical and climatic conditions vary more widely than in any other country in the world. The mild and even climate

of some parts without the excessive heat, with unexcelled soil richness and plenty but not too much water makes conditions in these regions fully as conducive to the production of first class deciduous fruit as does any part of California.

The apple is considered purely a northern latitude fruit. There are sections in Mexico, however, which by their altitude, and cold climate at certain seasons of the year, should produce very nice apples, not equal, perhaps, to the fruit of the northern United States but a very good substitute. The ground for this belief is the fact that apples are now produced in considerable quantity in many of the higher localities. The great inferiority in quality is due largely to the lack of proper culture. Here, again, the trees are all seedlings and unimproved in any way. The introduction of seeds of the best known varieties, and their growth, acclimatization and selection in scientifically conducted nurseries would soon place at the disposal of the people varieties not greatly inferior to those now bearing in Oregon. We are safely within reason, too, when we declare that other northern fruits, as the cherry for instance, may be grown in these same belts of the upper *tierra templada* or the lower *tierra fria.*

Another great field which soon must be opened to the agriculturist of Mexico is viticulture. There are just enough grapes produced now in some sections to show that it is possible. Here, again, the process of finding the best paying varieties, or even creating new ones, must precede the wide introduction of the industry. It has been found in other countries that certain native wild grapes can be used as grafting stocks. Whether this may be possible or not in Mexico, still there is plenty of acclimatized stock now growing in various parts which could be used as the basis for experimentation. In addition to finding the best varieties the horticulturist must also adapt the fruiting season to the climatic conditions. Since grapes are very easily ruined by excess of atmospheric moisture at the ripening period, it will be necessary to shift the fruiting season to come after or before the summer rainy period. As was pointed out in a previous paper, the Cuernavaca and Toluca valleys are very well adapted to the culture of the vine and in addition possess the unparalleled opportunity of a tremendous market for all their produce within a few hours by railroad.

Before leaving these special considerations of individual crops, let us take up one other. There are many sections too dry and barren at certain seasons of the year to be productive in other crops, but trials with the olive tree would surely be worth while. Certain portions of Oaxaca are well suited to the growth of the olive tree, and, in fact, the director of that state station is already planning to make a thorough trial under various conditions. The high price commanded by this product in most markets of the world, the great food value, and the ease with which the fruit is preserved and shipped makes olive culture extremely profitable in sections which are not well suited to many other crops.

This hasty survey is only presented as a stimulus to the thought as to what may and surely must be accomplished in the near future in Mexico. Only the bare outline of methods have been suggested and only a few of the typical localities mentioned, but enough to show the wonderful possibilities which are only waiting to be developed.

It is alluring to think of these possibilities, but the realization of them must come through hard and persistent effort and even financial losses by the way. There are three methods by which this advancement must be brought about in Mexico, as in all other countries. A basic knowledge of all scientific facts relating to the subject in hand is, of course, presupposed and absolutely necessary in all cases. A few trained men must be the teachers of the public. The first of the three methods is by means of the government experimental station, the second by demonstration farms operated either by the government or by private capital, and the third is by private farms operated for financial gain but at the same time by the most approved methods and working toward the selection of the best crops.

A beginning has already been made by the government on the first method. A central station at Mexico City with four state stations embraces the entire work in this direction. Three of the five stations were visited by the writer during the summer of 1910 and all the work reviewed with the greatest of interest. The work is new as yet and there has not been time to accomplish a great deal. Without criticizing any individuals connected with the stations, it might be said that more extensive and intensive work is necessary. The most up-to-date and improved methods must be tried out on the experimental farms before the people can be expected to adopt them. The station is supposed to be maintained at the highest standard of efficiency possible, but always doing practical and applicable work, and not necessarily paying its running expenses, but entirely maintained by the government. The efficiency of the station will depend solely on the amount of money allowed for its necessary expenditure and just as much, or *more,* on the man at its head. If, after a thorough investigation, a Mexican scientist proves to be the best, then he is the man for the place; but if a German, or a Frenchman, or an American shows himself to be the best man, then no national or race feeling of any sort should stand in the way of his appointment to the work in question. The government work in the United States has been carried on by men of many nationalities and the only thing that has ever been questioned is their technical and practical fitness for the work in hand—neither their nationality nor their religion enters into consideration. Brazil employs Germans, Swiss and Americans; Peru has engaged Belgians, and so on through nearly all the countries, expert fitness is becoming the only necessary qualification.

The work of the experimental station should be directed first toward the testing of varieties and methods of culture. New crops which might well prove of value should be given a thorough and extended trial. Improvement of nursery stock, methods of breeding, and determinations as to which of many varieties of a certain group of trees or plants are the most profitable; this must all be the work of the station staff, since none others in the country are in a position to carry on such work. Pest investigations and control must be directed by the station chief or one of his associates. For this work a thorough knowledge of entomology in all its branches is necessary, as well as a knowledge of fungous diseases and their treatment. This work should be carried on by the best of experts regardless of cost. The sugar planters of Hawaii and also in Porto Rico employ chemists, agriculturists, entomologists, and plant pathologists at a very great expense, whose

sole and only work is the study of insect and fungous pest control, and other pertinent problems, and they all say most emphatically that it pays.

One man on the staff must have a thorough knowledge of horticulture in all its bearings—plant-breeding, selection, culture and soil tillage, and fertilization. Another man should have a thorough and complete knowledge of soil and plant chemistry. *These men must be had!* If the youth of Mexico can be educated to a practical knowledge of these subjects so much the better, for local conditions are more thoroughly understood by them. In the mean time the world's best experts must be employed.

The demonstration farms may or may not be operated in connection with the experimental stations, but in either case they can easily be made to pay their running expenses, if not become more or less remunerative. The superintendent of each of these farms should have a thorough working knowledge of all the general phases of scientific agriculture and should put this knowledge into daily practice. The field of work must be supplementary to and following up the work of the station, and under the direction of the nearest station director. Results, methods and anything else worked out at the stations must be taken up at the demonstration farms on a large and paying scale in order that the public may be shown beyond question the value of the new methods, or crops.

The third method named is a direct appeal to the private farmer, whatever his nationality. One of the secrets in the rapid advance of American agriculture as it is carried on by the average farmer, is the fact that the farming population in nearly all localities is most cosmopolitan. Thus, ideas from all countries and from all sorts of minds are brought together and the best, or a combination of the best, takes precedence over the rest. Such a farm as that at Roma, Vera Cruz, which was mentioned above, will do as much for the advancement of the nation's welfare through its agriculture as almost anything else which could be attempted. The appeal now is for adoption of approved scientific farming by those now engaged privately in Mexico and, also, for others, of any country whatever, to take up practical, sensible scientific farming in some part of the Republic, and demonstrate to all the doubters the real value of such a course and the great folly of following any but the most up-to-date methods.

For the private farmer who wishes to make his living in agriculture, for the capitalist who wishes to invest in a safe and paying proposition, for the expert scientist—entomologist, mycologist, horticulturist, pomologist, agronomist—what more inviting field for labor will be found than in Mexico, with all its wonderful possibilities now beginning to unfold?

By opening its doors to applied science and improving the almost unimaginable possibilities thereby, Mexico could become one of the leading agricultural centers of the world. To bring this about will require the closest co-operation between people and government in all respects. The time when this condition will arrive will be determined by the readiness with which the government takes the initiative in founding many more, and better equipped, experimental stations and introducing horticulturists and other technically and practically trained men into the staff of these stations. With adequate demonstration of work in progress, we may rest assured that the private farmer will not hesitate to follow up the opportunities thus opened to him.

An Account of the Botany of the Brazil Nut*

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The genus *Bertholletia,* to which is assigned the Brazil nut of commerce, was established in 1808 by Humboldt and Bonpland who placed it in a single species, *B. excelsa.* A translation of Bonpland's description of the fruit of this species follows.

"Fruit a spherical, compound nut the size of a child's head and often larger, divided internally into four cells each of which encloses several nuts; covered on its exterior with a husk of a green color, smooth and shining.

"Main nut very solid, rough and marked by branching furrows on its outer surface, 6 lines (1 cm.) thick, divided internally into four cells by as many membraneous dissepiments which become obliterated in part or entirely after the maturity of the fruit, but of which there always remain traces."

The tree is described as 33 m. high with a trunk 9 dm. in diameter. Leaves alternate, oblong, subcoriaceous, 1 dm. broad and 6 dm. long, borne on short petioles. Type locality, Rio Orinoco.

On account of the great height of the trees these botanists were unable to obtain the blossoms although it is said that they offered in vain an ounce of gold for specimens. On this account they were uncertain as to the position which the genus *Bertholletia* should occupy in the vegetable kingdom. More recent investigations have established its position next to *Lecythis* in the order Lecythidaceae, an arrangement now universally accepted. It is worthy of note also that Bonpland failed to describe either the operculum or the opercular opening of the fruit although the latter is shown in his drawing as becoming decidedly narrower at the inner edge.

The two species of *Bertholletia:*—For more than half a century after the publication of Bonpland's description of *Bertholletia,* the genus was accepted as monotypic. Evidence was being gradually accumulated, however, which was destined to lead to the recognition of a second species. Among the later botanists to contribute to this end may be mentioned Berg who, in monographing the Brazilian Lecythidaceae described under the name *B. excelsa* a species distinct from the one so named by Humboldt and Bonpland. Although Berg's description is marred by several errors, it is sufficiently accurate to demonstrate that the species described is not the *B. excelsa* of Bonpland. Berg's drawing of the fruit or pyxidium is, moreover, quite different from that of Bonpland.

It remained, however, for Mr. J. Miers to point out clearly the distinction between the two plants and to describe Berg's species under the name *B. nobilis.*

The more noticeable points of distinction between *B. excelsa* and *B. nobilis* are collected from Miers' description in the following summary:

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B. excelsa Humb. and Bonp.	*B. nobilis* Miers.
Tree 100 ft. or more high with trunk 2½ to 3 ft. in diameter.	Tree somewhat taller than *B. excelsa* with trunk 14 ft. in diameter.
Leaves green; petioles 9 to 18 lines long.	Leaves rufescent; petioles 3 to 6 lines long.
Floral panicle 8 in. long with single branch nearly equal in length and nodes 1-6 in. apart.	Floral panicle 10 in. long with about 5 short branches and nodes ¼ to ½ in. apart.
Fruit slightly elongated, 6 in. in length.	Fruit approximately spherical, usually under 5 in. in length.
Cortex of fruit smooth, polished, entire, persistent.	Cortex of fruit comparatively thick and rough, darker, contracting and cracking as the fruit dries and tending to loosen and drop off as the fruit is handled.
Opercular opening with straight or concave walls, narrowing slightly at its inner edge.	Opercular opening has sharp edge and concave walls, and widens considerably inwards.
Operculum cylindrical with roundish, indented apex.	Operculum oval or radially compressed, conical and pointed at the apex.
Operculum breaks away and falls from the fruit as the columella shrivels.	Operculum remains attached to remnant of columella and as the latter shrivels, falls into the cavity of the fruit.

The differences noted above, as far as they relate to the fruit, are well shown in the copy of Miers' drawing, reproduced half size in the accompanying Figure 46.

The source of commercial Brazil nuts:—The idea that *B. excelsa* Humb. and Bonp. is the source of commercial Brazil nuts has become so thoroughly grounded in popular and even in botanical literature that it seems to be accepted on faith and passes unchallenged. The extent of this belief will be apparent when we consider that of the following quotations only the last two, or possibly three, make any mention of a second species to which, moreover, they assign a wholly subordinate position.

"Brazil nut. One of the triangular edible seeds of a tall South American tree (*Bertholletia excelsa*) . . ."—Standard Twentieth Century Dictionary.

"Brazil nut. The seed of the fruit of *Bertholletia excelsa* . . ."—Century Dictionary.

"Brazil nut, an oily 3-angled nut, the seed of the lecythidaceous Brazilian tree, *Bertholletia excelsa*."—Webster's New International Dictionary.

"Cream nut (*Bertholletia excelsa* Humb. and Bonp.) This is a common nut in our markets brought from Brazil; hence it is often called Brazil nut."—Nut Culture in U. S., p. 106, Div. of Pomology, U. S. D. A.

"Brazil nuts, Cream nuts, Para nuts—These are edible nuts imported from Brazil—The nuts are the product of *Bertholletia excelsa* (Humboldt and Bonpland) . . ."—U. S. Disp. 19th Ed. p. 1420.

"*Bertholletia excelsa.* Brazil nut.

"A large tree belonging to the family Lecythidaceae, and yielding the Brazil or Para nuts of commerce. A tree 100 to 150 ft. high, distributed throughout

north-eastern South America to the Island of Trinidad."—Cook and Collins, Economic Plants of Porto Rico, Contrib. U. S. Nat. Herb. 8, 2 p. 91, 1903.

"*Bertholletia* Humb. and Bonp.—Tall trees. One or two species South America.

"*a. B. excelsa* Humb. and Bonp.—*Seeds,* Brazil nuts, Para nuts, Cream nuts, Nigger toes, Castana nuts . . ."—Lyons, A. B., Plant Names, Scientific and Popular, 2d Ed. p. 71.

"*Bertholletia*—Brazil nut, Para nut, Cream nut, Nigger toe—Species 2, both of which furnish Brazil nuts . . ."—Hastings, G. T., in Bailey's Cyc. of Hort.

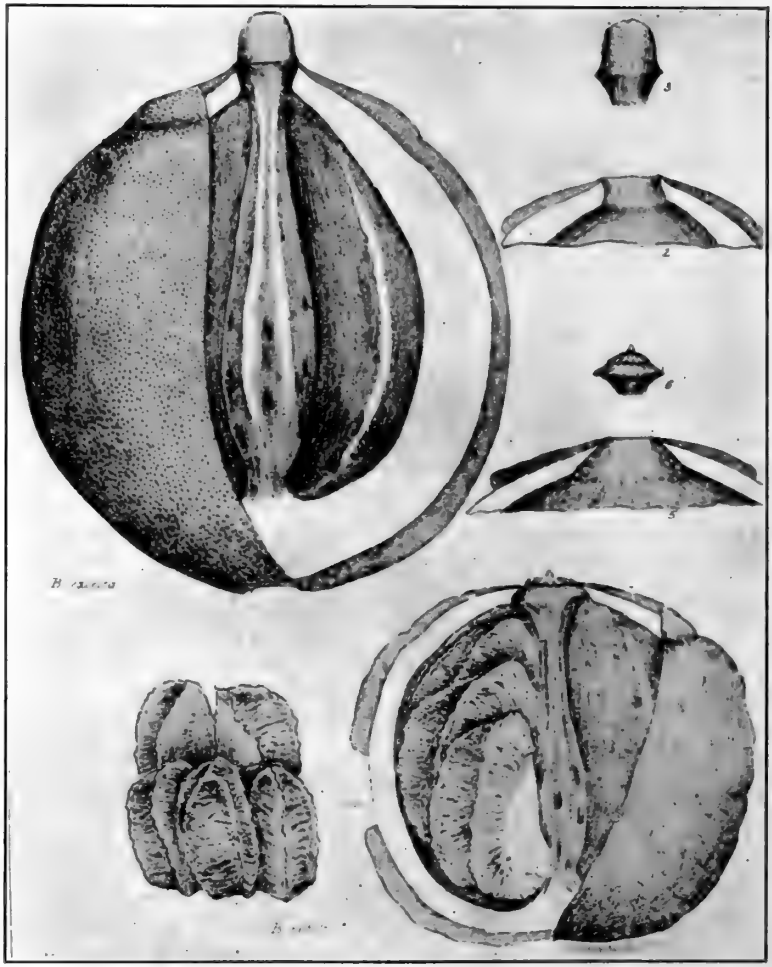


Figure 46. Reproduction of Mr. J. Miers drawings of Bertholletia, copied half size from Trans. Linn. Soc. XXX Pl. 37. Figs. 1-3, B. excelsa. Fig. 1, Pyxidium cut open to show structure. Fig. 2, Section of opercular opening. Fig. 3, Operculum. Figs. 4-7, B. nobilis. Fig. 4, Pyxidium cut open to show structure. Fig. 5, Section of opercular opening. Fig. 6, Operculum. Fig. 7, Nuts. Published with the consent of the Lumaean Society of London.

"The Brazil nut, also called Para nut from the port of shipment—is the seed of a large tree (*Bertholletia excelsa* Humb. and Bpl.)—Another species, *B. nobilis* Miers, also yields a similar nut." Winton, A. L. Micro. of Veg. Foods, p. 312.

This state of affairs seems to be due primarily to Bonpland's assumption stated in connection with his description of *B. excelsa,* that it is this species which furnishes the Brazil nut. The long time which elapsed previous to the identification of a second species allowed this view to become so thoroughly established that Miers' work appears to have been overlooked by persons interested in botany from the economic standpoint. The work of various botanists during this interval, and especially Berg's description of *B. nobilis* under the name *B. excelsa,* no doubt contributed to the same end. Moreover the seeds of the two species, so far as can be judged from the descriptions and drawings available, are so similar as to be distinguished with difficulty if at all.

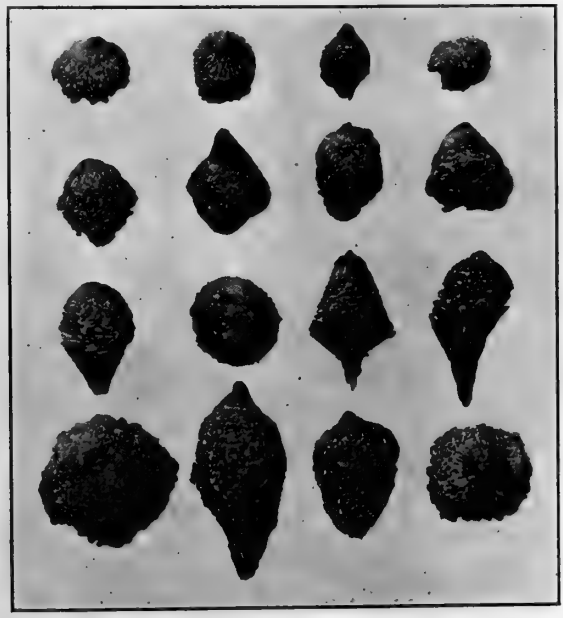


Figure 47. Opercula from commercial Brazil nuts. The pointed apex is broken from the operculum in the lower left-hand corner of the figure and is worn down to a certain extent by friction in some of the others (x2-3).

After making a careful study of the situation, the writer has become convinced that the commonly accepted view is erroneous and that the Brazil nuts of commerce are derived from *B. nobilis* Miers (*B. excelsa* Berg) and not from *B. excelsa* Humb. and Bonp. The reasons for this view are given below:

(a) Commercial samples of Brazil nuts contain, in larger or smaller numbers, opercula (Fig. 47) derived from the fruit and the presence of these in itself is evidence that the nuts were derived from *B. nobilis,* since, as has been noted in the comparison, the opercula fall from the mature pyxidia of *B. excelsa* and hence

would not find their way into samples of nuts from that source. On the other hand their presence among nuts from *B. nobilis* is perfectly normal and what would be expected since in this species the opercula fall into the interior of the pyxidia and become mixed with the nuts. Moreover, the opercula, so far as the writer has been able to observe, are always of the *B. nobilis* type, as shown in the figure. They vary in form from ovoidal bodies to cones of varying slope, being modified apparently by the size and degree of persistence of the columella as well as by the extent of the grinding against surrounding nuts to which they have been subjected during shipment. All, however, are provided with a distinct apical point except where it has been broken off, in which case the fact is usually quite evident. It cannot be denied that the absence of opercula of the *B. excelsa* type

Figure 48. Pyxidium of Brazil nut cut open to show structure, with nuts in place. Note the pointed operculum, and the opercular opening becoming very broad toward the interior of the pyxidium. Small specimen, natural size.

does not preclude the possibility that nuts of this species may be occasionally mixed with those of *B. nobilis,* since the writer is not aware that it is possible to distinguish the species from the character of the nuts alone.

(b) Every pyxidium of the Brazil nut which the writer has had an opportunity to examine has indicated that the fruit is that of *B. nobilis.* Their main points of structure are well shown in the Figures 48 and 49 which illustrate pyxidia obtained from different sources. A comparison of the photographs with Miers' description of *B. nobilis* will leave no doubt of their identity. Most if not all of

the pyxidia which the writer has examined were brought to this country by the importers of Brazil nuts and represent the source of the nuts in which they deal.

(c) The testimony of others, although comparatively scanty, should not be overlooked, since it is improbable that the authorities quoted as stating that the Brazil nut is the seed of *B. excelsa* have given the matter any exhaustive study. After his description of *B. nobilis,* Miers states: "These seeds are known in commerce as Brazil nuts;" and proceeds to give statistics regarding their exportation and use. Moreover, Berg's error regarding *B. excelsa,* although perhaps adding to the confusion, is in reality indirect evidence of the same fact, since it is doubtful if he would have confused the two species had he not been sure that the specimens from which he made his description were those of the Brazil nut which he, in common with others of his time, regarded as *B. excelsa.*

Figure 49. Pyxidia of Brazil nuts from various commercial sources showing characters which identify them with Bertholletia nobilis Miers (x⅜).

Figure 50. Showing the disastrous effect of mixed planting on what was formerly a magnificent avenue. The three trees to the left are Poinciana regia, the two recently planted on the right are Albizzia lebbek, while back of these is one large evergreen, Ficus nitida. Beyond stretches a fine solid avenue of leguminous trees.

Some Aspects of Avenue Planting

C. F. BAKER
POMONA COLLEGE, CLAREMONT, CALIFORNIA

In the growth of civilized communities, especially those most attractive for residence purposes, the matter of highways early becomes one of fundamental importance. As the community develops, the idea of an *avenue* is evolved—a roadway that shall be a thing of beauty, a joy and comfort to the traveler, and an ever-present satisfaction to the dwellers along its path. The high value of a perfect avenue as a real asset to any district, is now everywhere recognized. Property along a well kept avenue is invariably augmented in value thereby. Towns are always more desirable as places of residence, where the streets are developed on a well-thought-out and unified avenue plan.

Where avenue development is extended to country roads, a rural district may easily be peculiarly distinguished thereby, and become especially attractive for rural residence. In most parts of the United States, this important work is either entirely neglected or only just beginning. In Cuba, under Spanish dominion, a system of grand country avenues radiating from Havana was splendidly developed by the Spanish engineers. These engineers evidently possessed a very

clear idea of the two fundamental principles of permanent avenue building: 1, the establishment of a solid roadbed, and 2, suitable uniform and permanent border plantings of trees. These roadbeds are built on well made foundations of crushed stone, and once in their finished form, are kept constantly in perfect order by section crews, just as our railways are worked. In sharp contrast to such a method is ours of neglecting a well-built avenue until it is in such bad condition that

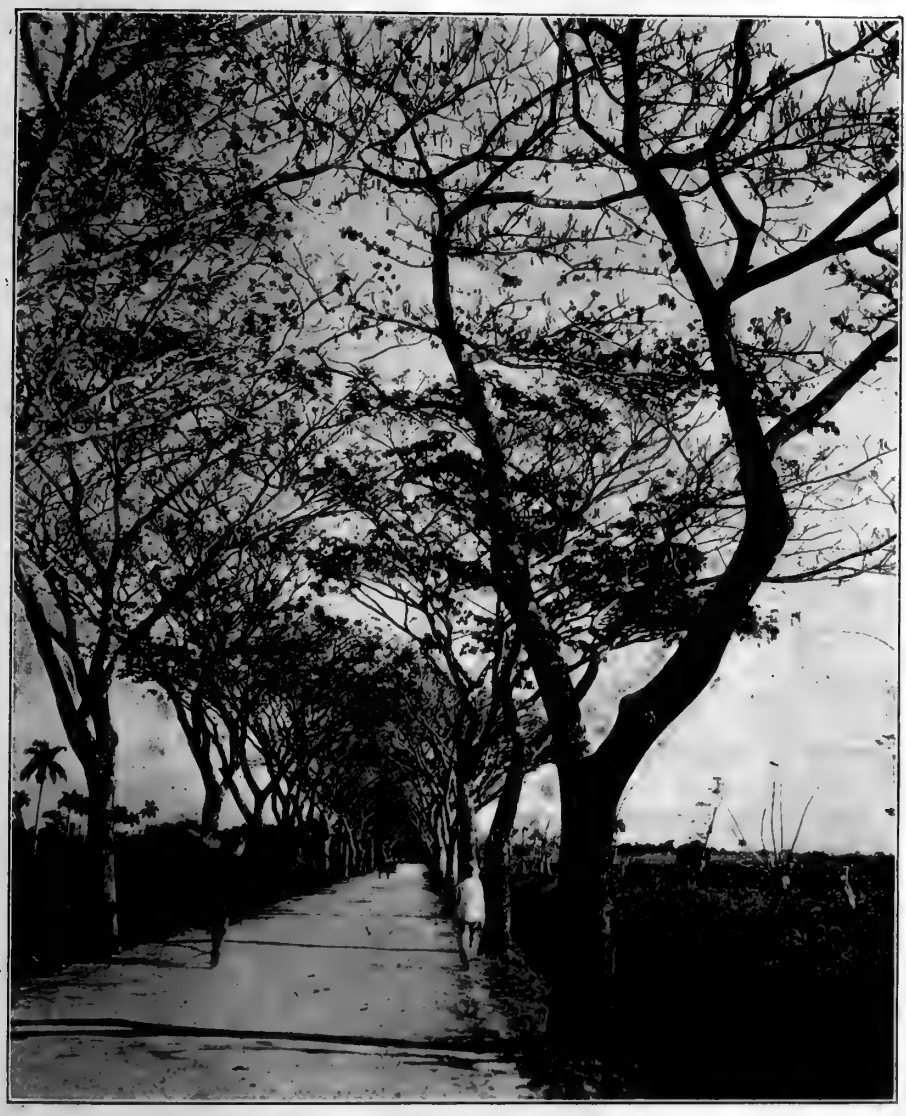


Figure. 51. A Cuban country avenue in winter. Note the large dark pods of Enterolobium and the long slender pods of Pithecolobium saman. In this case a fine uniformity of result is obtained even with a mixture, on account of the striking resemblance in form and habit of the two trees employed.

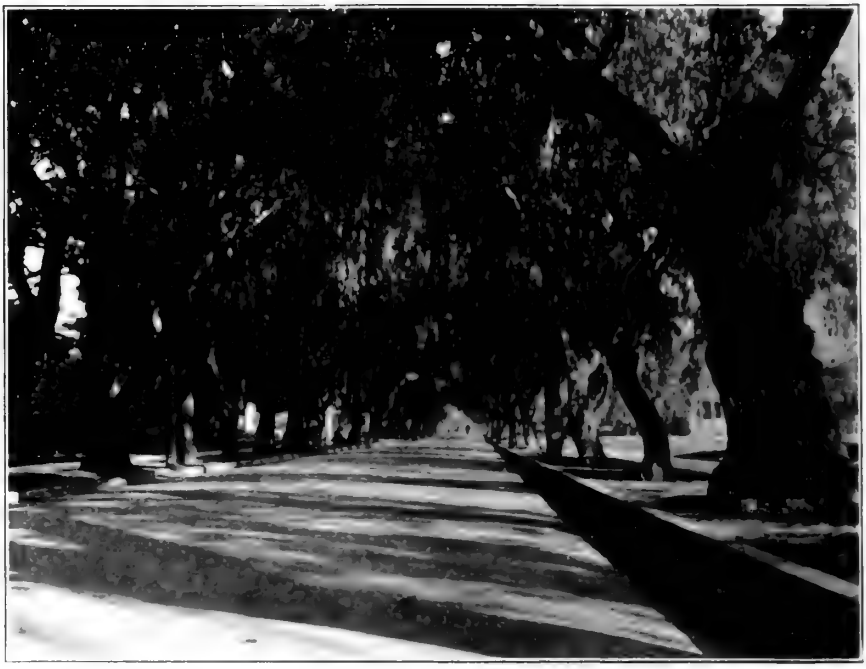


Figure 52. An avenue of peppers (Schinus molle) in Pasadena. No plantings can exceed in charm a well matured pepper avenue.

Figure 53. An avenue of Cedrus deodora in Altadena. This is a tree most unsuitable for avenue plantings in any country, but trebly so in a hot one.

it must practically be made over again at great expense of money and patience, and we frequently plant and replant without any comprehensive plan to follow when the time element is really of far greater moment than the expense involved.

The chief element of beauty—and of utility in the warm countries—lies in the border plantings of the avenue. It may be accepted as a foundation principle that the finest effects are to be obtained only by absolute uniformity in the plantings. Some of the later work on the Cuban country avenues has paved the way for utter destruction of some of the magnificent effects formerly produced there. This is resulting from a mixing of the plantings. Their finest avenues dating from former days are planted with *Enterolobium cyclocarpum, Pithecolobium saman,* and *Ficus nitida,* a portion of the Guines calzada planted with the last

Figure 54. Alternating Camphor and Chamaerops excelsa in Pasadena. A poor combination from any point of view. The palms cannot be permanent under the rapidly extending camphors, and merely interfere with their growth, besides destroying the fine effect always resulting from uniformity.

named tree giving one of the most magnificent avenue effects known to me in the two Americas. Unfortunately no attempt is made apparently to keep these plantings uniform, open spaces being filled indiscriminately with *Ficus religiosa, Albizzia lebbek, Poinciana regia,* and various other things, none of them so well adapted for avenue planting in Cuba as are the first three mentioned.

Ideal avenue plantings for warm countries should employ trees with broadly spreading tops which will shade the roadway, at least in the hottest season, and still permit open views to the surrounding country. In warm countries with wet

Figure 55. An avenue of Washingtonia robusta on the Huntington estate at Oak Knoll. One can almost feel the quiver of the heat down this hot, dry avenue of widely placed desert palms.

Figure 56. An avenue of Cocos plumosa on the Huntington estate at Oak Knoll. These palms give an effect of great delicacy but should never be used except for short distances.

winters a deciduous tree is often preferable. Palms are monotonous, and for this and other reasons most unsuitable for long avenues, though for short distances they sometimes make magnificent displays. Slender and spire shaped trees are very ill-adapted for this purpose in warm countries. Nothing can exceed the beauty of a well developed and well kept pepper drive, and this tree, together with camphor, *Eucalyptus viminalis* and *E. corynocalyx*, give splendid results in dry, warm countries. There are still others even finer than these which we as yet know but little and which are destined to add much to the beauty and interest of our avenues, as has frequently been indicated by Dr. Franceschi. We are trusting he will describe and illustrate these for us in future numbers of this Journal.

In the meantime several working principles may be brought sharply to the attention of all property owners of Southern California and other subtropical regions:

1. Plant *now!* A month or a year saved now means a matured avenue growth so much the sooner.

2. Place this work under the strict control of county, town, or park officials, and then urge them to immediate action. Left to the whim of individual property owners, uniformity of plan will certainly be impossible to attain, to the great and long-time detriment of the whole locality. Private individuals should no more be

Figure 57. Showing use of Phoenix canariensis as an avenue tree. After the many years required for full development this short stretch of solid Phoenix will be of great magnificence.

allowed to plant without permission and oversight, than they are allowed to cut down street trees without permission—and either is a fatal error.

3. Trees once planted should receive constant care throughout their lives. This is invariably the price of a perfect avenue. Watering and pruning, when not attended to by property owners, should be arranged for by the proper officials, and the costs levied against the property. This would be only right and just since the existence of a perfect avenue adds very materially to the value of all adjoining property, and the failure of one owner may not only spoil the effect of the whole but in this way actually detract from the value of surrounding property.

The Development of the Avocado Industry

F. W. POPENOE, ALTADENA, CALIFORNIA

Within the past twelve months interest in growing the avocado has increased many fold. The feeling has now become general among well-informed orchardists and nurserymen that this fruit is destined to play an important part in the economic horticulture of Southern California; and many wise growers already foresee great promise for this new industry. The adaptability of the avocado to out climatic conditions has become convincingly apparent, and belief is growing into conviction that it is to rival the orange as a semi-tropic product. As a future food product it is unquestionably an important factor to be reckoned with. Economists who have the ability to grasp matters horticultural are figuring the avocado into the future food supply of the country at large as a competitor of meat, and are estimating its possibilities for replacing animal products with a wholesome and delicious vegetable food. As eminent and practical a horticulturist as Mr. Parker Earle, formerly president of the American Pomological society, is convinced of an immense future for the avocado. In a recent letter to the editor of the Pacific Garden, Mr. Earle says: "We cannot help wondering, as we look ahead for a hundred years, how people will live—what they will eat—when there are four hundred millions to be fed out of the land that now supports one hundred millions. With this great density of population, will there be room for producing much animal food in that time? Will it not become a necessity of existence to utilize all of the land in a way that will yield the greatest tonnage of human food?

"An acre of land can produce, let us say, one quarter of a ton of beef, or other animal food, per year. It can produce one ton, or possibly two tons, of food in wheat, or corn, or rice. It can produce five, ten, or possibly twenty tons of an incomplete food ration in the form of apples, or grapes, or bananas. And there may be from one to two tons or more of very rich food in the form of nuts—notably pecans—from one acre of land. But with avocados there would seem to be a possible yield of food of very high nutritive value in tonnage equal to apples with their low nutritive value." Mr. Earle goes on to state that if men can produce many tons of food of best value from an acre of land in trees that can only yield a fraction of a ton in the form of animal food, it is pretty certain that they are going to plant trees. The crowding of men together in dense population will compel this. "In primitive conditions men turned to animals for food. It was a state of savagery. We are outgrowing it. Very soon there will be no room for animals that are grown to be eaten. It is compulsory. It is nature's way. We must get our food in greatest quantities from a minimum area of land. And we must have food containing the same elements that animals have been giving us. Among these substitutes does not the avocado offer itself as one of large possible importance?"

The one answer that can be made to Mr. Earle's inquiry is—it does.

Progress in Florida

Along both the lines of propagation and commercial planting Florida has so far been in the lead of California. The proximity of Cuba, where the avocado, or aguacate as it is called in all Spanish speaking countries, is commonly grown, and the fact that seedlings had been planted quite freely along the east coast in the earlier days, must have led horticulturists there to see the possibilities of this fruit, and have acted as a stimulus to the development of the industry. When, in 1901, it was successfully demonstrated that the avocado could be propagated by budding, considerable attention was at once directed to this fruit as a commercial possibility, and since then the progress of the industry has been steady.

Figure 58. Young avocado trees growing in nursery rows at Altadena, California, one year old and ready for budding.

One of the most important of the earlier commercial plantations, and in fact the first plantation of any extent, was that of Mr. S. B. Bliss of Miami. His orchard consists of twenty acres of the Trapp variety, planted six years ago, and now in bearing. The first crop of marketable fruit was produced last year, and though a heavy yield could not be expected from trees so young, the returns were satisfactory. Mr. Bliss is an experienced and careful grower, and has given intelligent consideration to the avocado as a commercial proposition both in Florida and in Southern California, and has great confidence in its extensive development.

Having had many years experience in both localities Mr. Bliss is well qualified to speak on the subject.

More recent than Mr. Bliss' plantation, considerably larger acreages of the avocado have been planted on the east coast, and planting is going on as rapidly as the budded trees can be supplied. As a considerable quantity of the fruit is now produced each year and shipped to northern markets, the Florida growers have learned a number of things regarding packing and shipping which will be of value to Californians.

Figure 59. A two year old head of the Trapp variety, top worked on an old seedling tree, at Sherman, California.

Mr. Joseph L. Hickson, of Miami, who grows the avocado extensively, writes under date of July 5, 1911, as follows: "We have never been able to supply our demands except for the varieties that mature in mid season (last half of August and first half of September). We are therefore growing and propagating more early and late varieties, Family and Trapp, respectively.

Figure 60. A fine type from Cuernavaca, Mexico. A thick skinned, purple, winter bearer.

"We have customers who place season orders with us for all the fruit we have at $6 per case, f. o. b. Miami, which price we are very well satisfied with.

"We pack according to size, sometimes only 18 fruits to the case, but usually 36, 45 or 48. Our fruit went to all the eastern markets and to Chicago and Cincinnati.

"The propagation of the avocado is done exclusively by budding now, with a success equal to 95 per cent.

Figure 61. One of the first avocados planted in California, being one of three trees brought from Mexico and planted at Santa Barbara by the late Judge Ord in 1870. (Photo from Dr. Franceschi).

"This section of the state is extending its planting very considerably. Personally we believe there is more money to be made on the finer varieties of avocado and mango than there is with either oranges or grapefruit. The avocado does not require nearly so much care and attention, and so far is practically free from all insect pests, nor does it require the amount of fertilizer that a citrus tree does.

"The budded trees come into bearing the second or third year from the bud and in heavy bearing the fourth year. The budded trees show a tendency to be dwarfed."

From Mr. E. N. Reasoner, of the Royal Palm Nurseries, Oneco, I have the following under date of June 30, 1911: "The avocado is being planted extensively

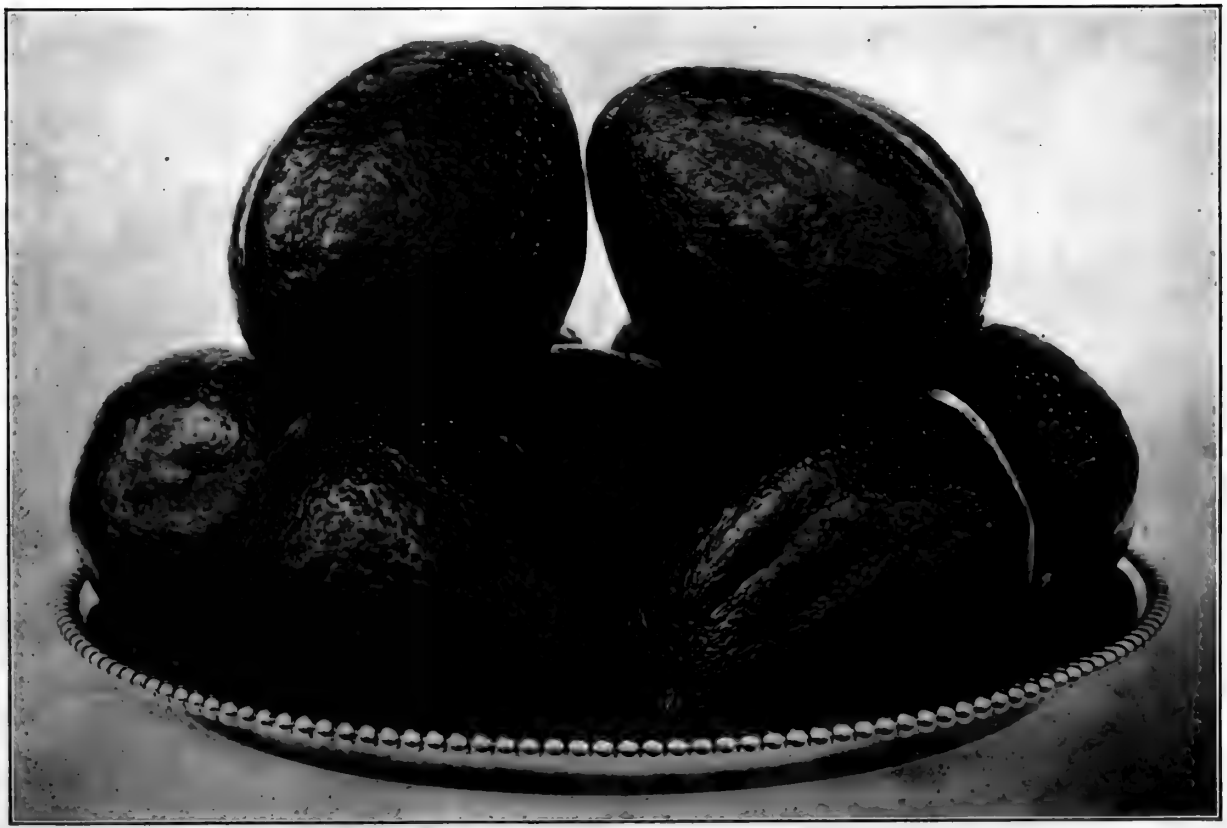


Figure 62. A thick skinned summer bearing type from Guadalajara, weighing about 14 ounces each.

by numerous people in both small and large lots; one man has 100 acres practically all to the Trapp variety, in fact the planting is more of this variety than of all others combined. There is a fine grove of 40 acres of Trapp, and two others of nearly 100 acres each, mixed avocados and mangos, of which the avocados are nearly all Trapp. The next important variety is Pollock.

"Budding is very successful, and a large percentage take. The buds are usually put in in spring, on trees of the preceding year's growth.

"Trees are being set about 18 or 20 feet apart. The trees are looking well and interest is high. The trees of sufficient age have a large crop of fruit this season."

Figure 63. A desirable type grown in Mexico at an altitude of 6000 feet. A winter bearing, very thick skinned fruit of fine quality. It is now being propagated in California.

Mr. John B. Beach, of West Palm Beach, who propagates the avocado quite extensively, writes as follows under date of July 1, 1911: "After November first there is always a good demand in New York for avocados, with ever increasing prices as the season advances, and often they sell well in October. Owing to its lateness we prefer the Trapp for general market planting, though there are many other varieties which are being tested, but have not been cultivated long enough to be well known.

"Budding is most successful in late autumn and winter, from November 1 to April 1. Fifty to ninety per cent of the buds will 'take,' but more or less loss

will occur after that from eyes dropping off, and from fungus attacking young sprouts. This trouble may not be so bad with you. Very likely the beginning of your dry season will be the best time for budding on this account. Our rainy season is in summer, and then we suffer most from fungus.

"Budding is most simple. Use well developed eyes on young wood, the bigger the shoot the better provided it is of last growth, otherwise you will have trouble with buds failing to start, and eyes dropping. We start the seeds in six inch pots, budding and removing at the same time into 6x6x12-inch shingle boxes, at five to seven months from the seed. Allow six months in these boxes for the buds to grow, then plant out."

California Plantings

The production of varieties suitable for commercial purposes here has so far been dependent upon chance seedlings, no systematic attempt to breed superior varieties having been made. The variation always exhibited by seedlings has resulted in the existence of numerous forms and types, a few superior to the average, but by far the greatest number inferior to or no better than the average. Realizing, however, the possibility of obtaining choice varieties by chance in this way, and varieties which would be especially well adapted to this climate, several experimental plantings have been made.

One of the largest of these is that of Mr. William A. Spinks, of Monrovia, who has obtained selected seeds from every available source and set out 150 seedling trees in orchard form. (See also the reference made below to his orchard planting of budded trees). Mr. Spinks' location is one of the most favorable in Southern California, and with this number of selected seedlings the possibility of obtaining something choice is certainly good.

Mr. Joseph Sexton, of Goleta, near Santa Barbara, has planted 140 seedlings, 100 of which were grown from selected Hawaiian seed and the balance from selected seeds from Mexico, Costa Rica, Guatemala, and Porto Rico. In addition to this plantation of his own, Mr. Sexton is planting for other parties in his vicinity over 600 Hawaiian seedlings, of his own raising, all of which will be allowed to grow as seedlings until they have had time to fruit. This extensive plantation of Hawaiian seedlings will form an admirable test of this type of avocado, and as the climate of Santa Barbara is notably mild, the possibilities of success are good.

These plantations have only recently been made and will require some time before the results will be known. Older than either of the foregoing is that of Mr. C. P. Taft, the well known horticulturist at Orange, whose work along various lines of experimental horticulture has been of great value to the state. Mr. Taft began planting avocados in a very small way seven or eight years ago. His orchard now consists of several acres of seedlings, may of which are producing fruit. So far Mr. Taft feels that he has not produced the ideal avocado, and is continuing his experimental work by selection of his most desirable seedlings rather than by securing buds from other countries.

Mr. E. S. Thacher of Nordhoff, another of the well informed and experienced horticulturists of Southern California, has been interested in the avocado for

Figure 64. A cluster of Hawaiian avocados, showing the typical Hawaiian fruit. Each of these fruits weighs from 15-24 ozs.

several years and now has a plantation of 120 seedlings just coming into bearing. Among those which are fruiting this year Mr. Thacher has one tree that at the time this is written, and before the fruits have matured, bears promise of being especially worthy of propagation.

Because of the impossibility of obtaining budded trees in sufficient quantity for orchard plantings, almost no plantations of budded trees have been made in Southern California up to the present time. Several parties, however, have made plantations of seedlings with the intention of budding the young trees to some desirable variety, and in this way saving considerable time. Probably the largest of these plantations is that of Mr. W. G. Davison, at La Habra. Mr. Davison has twenty acres set to Mexican seedlings and is now budding them to choice Mexican varieties.

Mr. William A. Spinks of Monrovia has a plantation of about 600 budded trees of various varieties, which is more in the way of an experimental planting, perhaps, than a commercial orchard. A few other plantings of seedlings have been made, with the intention of budding the trees as soon as it is possible to obtain budwood of choice varieties, but the majority of parties interested in the commercial production of avocados are waiting until they can obtain budded trees with which to make their plantings. Another year will see the work of planting orchards well under way, as the growing of budded stock is being given adequate attention. Among those engaged in this branch of the industry, the West India Gardens, a tropical nursery company at Altadena, has many thousand young Mexican seedlings in the field which are being worked to the choicest Mexican varieties. This company sent its own representative to Mexico to locate the trees bearing the most desirable fruits. The trees selected were marked, and budwood from them is now being sent up. As in the selection of this stock all points of desirability were considered, a choice lot of budded trees will be the result—a result which by the process of growing seedlings at home and selecting therefrom, it would have taken many years to bring about.

Co-Operation of the Department of Agriculture

Realizing the possibilities of the avocado as a commercial proposition in Southern California, the United States Department of Agriculture has become interested in the development of the industry, and has recently sent out a large shipment of budded trees for trial. This shipment consisted of four sets of about eighty trees each, all budded, which were propagated at the Subtropical Laboratory of the Department at Miami, Florida. These four sets have been planted by co-operators in San Bernardino, Pasadena, Whittier and Altadena, so as to test them out under different climatic conditions. The set includes all of the standard Florida varieties, Trapp, Pollock, Mitchell, Baldwin, Family, Wester, Blackman and Peacock; one variety from the Bahamas called Largo, and unnamed varieties from Mexico, Guatemala, Cuba, California, Canary Islands, Florida and Hawaii. It is expected that when these trees come into bearing several choice varieties will be obtained, and it will also give an opportunity to thoroughly test out the Florida varieties under the different climatic conditions obtaining in Southern California.

The Commercial Avocado

At the present moment the question of greatest importance to prospective avocado growers is "What are the best varieties for commercial purposes?"

We have as yet no standard varieties, and it will be well, therefore, before the industry becomes established, to consider the characteristics required in an avocado for commercial purposes, and to obtain only those that come nearest to the ideal in every respect. It would be dangerous, to say the least, to rush into such an extensive industry as this promises to become, without having thoroughly considered this question and having obtained the very best to be had for our plantings. Eventually the better varieties would come to the front anyway, and loss of time and disappointment will be avoided by giving careful thought to this matter in the beginning.

1. SEASON

It is the hope of those interested in the development of the avocado industry in California that it will be possible to obtain for this climate a set of varieties that will provide fruit of good quality continuously throughout the twelve months of the year. And it seems as though this desire is to be realized in the near future, for already we have mature fruit from September to June inclusive, which leaves only a small gap to be filled in. But these varieties we already have do not come up to our requirements in most respects, so that they are only of value to demonstrate what can be done in the way of extending the season. It will be a notable thing to have avocados in the market every month of the year, and will tend to greatly increase the consumption of the fruit. And when the avocado comes to be known and valued as a food product, there will be a steady demand for it throughout the twelve months of the year. At present, however, there is the greatest demand during the winter months, when other fruits are scarce. The Florida growers have almost ceased to plant anything but winter bearing varieties, not because there is no demand for the fruit in summer, but because at that season many small avocados are thrown on the markets of the east from the West Indies, and this fruit sells at such a low price that it is not profitable to compete with it. However, the greatest demand has always been during the winter months, when the markets of the country are not filled with other fruits, and it will doubtless be advisable for California planters to follow the precedent of the Florida growers to a great extent and plant mainly of winter and early spring bearing sorts.

2. HARDINESS

While there are doubtless limited areas in Southern California where avocados from the West Indies and Hawaii will thrive, our limited experience leads to the belief that for general culture in California we must have hardier varieties than those localities ordinarily produce. Avocados from the Mexican highlands have proved to be hardy almost anywhere in Southern California, and suited to as large an area as the orange. There are many locations in Mexico where avocados are produced in quantity, where fully as low temperatures are experienced as are ever felt here. Indeed, it is stated by G. N. Collins, a well known authority, that he found in one locality in Mexico avocados growing and thriving where snow fell

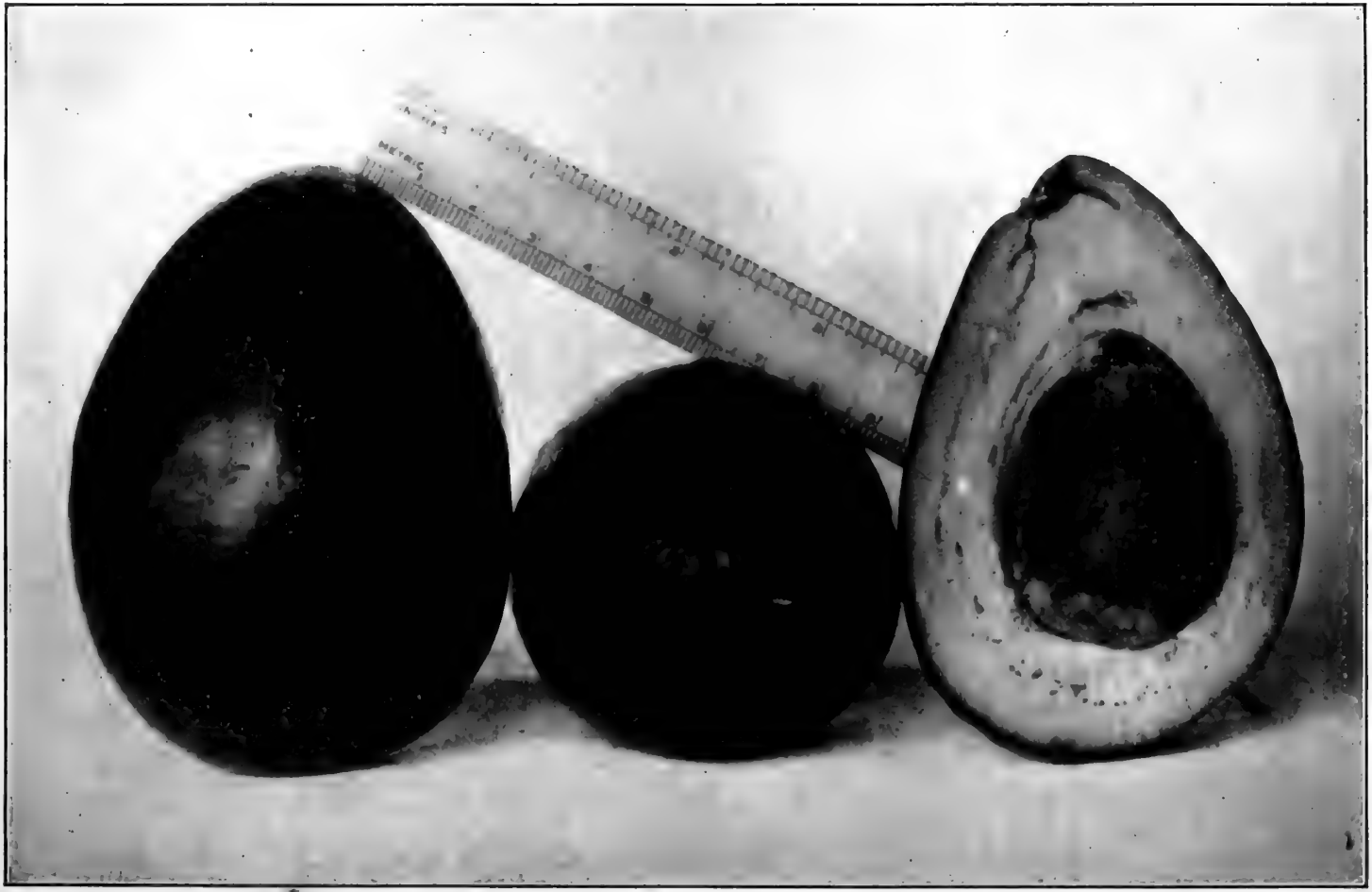


Figure 65. The common Mexican type of summer bearing, thin skinned, purple avocado.

every winter. If these hardier varieties were all small or inferior, we would of course prefer to take the chances with the more tender but superior ones, but there are many fine Mexican and Central American varieties which possess the requisite of hardiness in a very satisfactory degree.

3. YIELD

Through propagation by budding a great difficulty experienced with the seedlings has been done away with, namely, the liability of the tree to bear sparsely or not at all. The orchardist does not, of course, want to plant a tree on which he cannot depend for a good crop. While the smaller types of avocados are almost invariably prolific bearers, the larger varieties when grown from seed are inclined to considerable variation in this respect. Through budding the prolific varieties may be propagated and all danger from this source done away with. The avocado is ordinarily a good bearer. It is not unusual for mature trees of the larger varieties to produce a crop of five hundred to one thousand fruits each season, and the small purple varieties are sometimes extraordinarily prolific, a single tree bearing as high as four thousand fruits in one season, in some instances. To make a variety profitable commercially it must, of course, be a fairly prolific bearer, and it should be ascertained to a certainty that this is the case before planting a tree.

4. SIZE

A mistaken idea which is held by many prospective avocado growers is that the larger the fruit the better. The experience of the Florida growers has proven conclusively that this is not the case when it comes to a question of marketing the fruit. A two or three-pound avocado is certainly a regal fruit, but will not prove half so profitable commercially as a smaller and consequently more prolific variety. From fifteen to twenty ounces would seem to be the most resirable size.

5. FORM

It has been found very desirable for shipping to have fruits of oval or round form. The necked varieties necessitate considerable more care in packing, and are much more liable to injury in transit. For local consumption, however, a pear shaped or "bottle-necked"fruit is as good as any other form.

6. UNIFORMITY

To facilitate packing, the product should be uniform in size as well as in form, and this also improves the appearance of the fruit as it lies in market.

7. COLOR

The attractiveness of a fruit is affected considerably by its color. Locally the purple varieties have sold somewhat more readily than the green ones, and in Florida the dark crimson ones seem to be favored. But when the people are thoroughly familiar with the avocado the color will probably make little difference, unless some particular color or shade is found to denote a particularly good fruit.

8. SKIN

A skin sufficiently thick and tough to stand shipment to great distances is a prime essential. This is found in many of the Mexican varieties, and is partic-

ularly prominent in the Guatemalan type. Some varieties have a skin so thick and tough that it could almost be called a shell, while many of the Mexican varieties have a skin so thin and papery that the fruit when fully ripe will scarcely bear handling. A good tough skin will cut down the loss of fruit in transit to the minimum.

9. FLAVOR

As with all other fruits, there is considerable difference in the flavor and quality of avocados. This is, of course, a point which must be given first consideration, as a fruit of inferior quality would be undesirable in the extreme, even though it possessed all the other essential characteristics. Those containing the highest percentage of oil are naturally the most desirable from an economic standpoint, and having the highest percentage of fat they are ordinarily the finest flavored. Sometimes there will be found fibres or "strings," (fibro-vascular bundles) extending through the flesh from base to apex, and this is a very objectionable feature. It is, fortunately, rarely met with in the larger varieties.

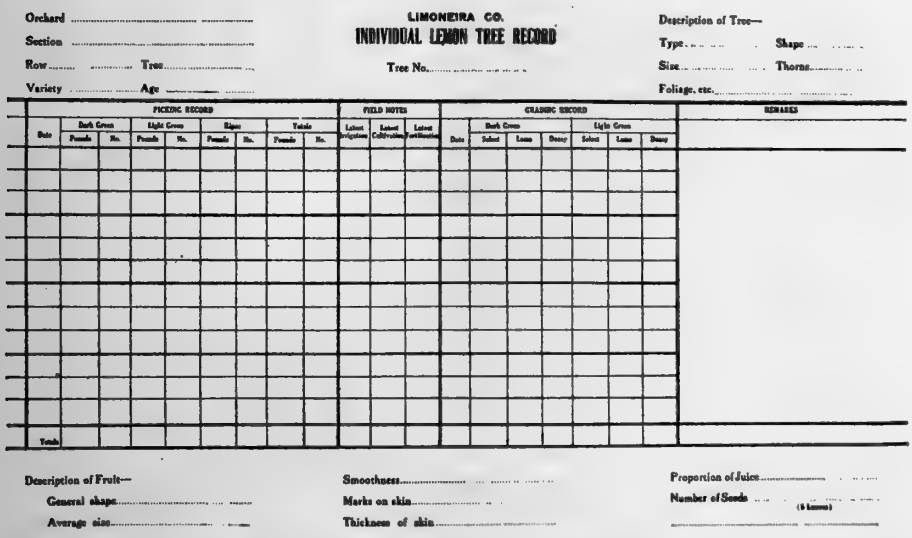
10. SEED

The seed should be tight in the cavity. It has been found that in shipping loose seeded fruits, the seed in transit pounds the walls of its cavity and causes considerable injury to the flesh. This is a difficulty seldom met with in Mexican varieties, but often encountered in Florida. In size the seed should, of course, be as small as possible. In time a seedless variety will no doubt be developed, as has been done with the orange and other fruits.

Improvement of Citrus Stock Through Bud Selection

ROLAND S. VAILE
LIMONEIRA RANCH, SANTA PAULA, CALIFORNIA

It is the opinion of the majority of men engaged in the citrus business that because of the rapidly increasing acreage of citrus fruits in Southern California the average selling price is bound to reach a somewhat lower level within the next few years. In the case of lemons, at least, there is the added danger from a possible reduction of duty on the imported fruit. In order that the industry maintain its high rank from the standpoint of the investor and land holder this decrease must be met by greater efficiency in some phase of the organization.


LIMONEIRA CO.
INDIVIDUAL LEMON TREE RECORD

Orchard ..... Tree No. ..... Description of Tree—
Section ..... Type ..... Shape .....
Row ..... Tree ..... Size ..... Thorns .....
Variety ..... Age ..... Foliage, etc. .....

PICKING RECORD									FIELD NOTES			GRADING RECORD							REMARKS
Date	Dark Green		Light Green		Ripe		Totals		Latest Irrigation	Latest Cultivation	Latest Fertilization	Date	Dark Green			Light Green			
	Pounds	No.	Pounds	No.	Pounds	No.	Pounds	No.					Select	Loose	Decay	Select	Loose	Decay	
Totals																			

Description of Fruit—
General shape .....
Average size .....

Smoothness .....
Marks on skin .....
Thickness of skin .....

Proportion of Juice .....
Number of Seeds ..... (6 lemons)

Figure 66. Reduced cut of blank used at the Limoneira Ranch for records of individual trees.

The California Citrus Union, with its wide advertising policy, its co-operative selling methods and its supply department, is already by far the most complete organization of its kind. Improved methods have reduced somewhat the cost of field and packing house operations. Careful handling has cut down the large losses through decay. While these matters will still permit of improvement and saving, one is led to wonder if the orchard itself can not be so intensely cultivated as to increase the average production. As one goes from orchard to orchard, or carefully through an individual grove, apparent differences are noted that show possibilities of materially raising the average standard.

A little less than two years ago Mr. A. D. Shamel of the Bureau of Plant Industry took up the work of gathering data which might lead to systematic bud selection for citrus stock improvement. The report of his first year's work was given at the State Fruit Grower's Convention held last March, and at that time a committee was appointed to consider the question of pedigreeing citrus trees. Mr. Shamel's work has been confined to oranges and grapefruit in the vicinity of Corona. A very full report of the first year's observations is given in his report to the Bureau of Plant Industry, published as circular No. 77.

About a year ago the Limoneira Company took up similar work on the Lisbon lemons in their grove, and later on Eureka lemons in the thirty-five year old orchard of Mr. N. W. Blanchard of Santa Paula. This work is being carried on because the company is planning large plantings in the near future and wish the best stock available from trees whose merits have been proven. Much of the data, however, is of interest to every nurseryman and orchardist.

In the first place the section of the orchard that has been consistently the best bearer for a number of years was chosen for the observations, and from the 2,000 trees in it the best 200 were picked. These trees were chosen for their apparent crop, the appearance of the fruit, the general form and foliage of the tree, and the absence of thorns. Later the number was reduced from 200 to 100, which were marked and numbered.

The next step was a description of the trees. The photograph method used by Mr. Shamel would undoubtedly have been better in many ways, but was not undertaken here. The written description included the size, shape, form, foliage, thorns and setting of fruit for each tree. With this preliminary work completed we were ready for the data of individual yields, the permanent record of which is kept in the form reproduced in the accompanying cut.

During the year the average yield per tree for the special trees was 13.45 field (45 lb.) boxes. The average for the rest of the section (all misses and extremely poor trees having been eliminated in the count) was 10.25 boxes, showing a difference of over 150 pounds to the tree. To the casual observer the trees in the section look very uniform, and yet this wide variation exists. If one-half of this difference could be overcome by raising the standard of the poorer trees the increase would be at least 100 packed boxes to every acre. Or on a percentage basis, an increase of about 3%.

To show that this work needs the accurate keeping of records, even the special trees varied from 15.4 boxes to 10.1, although the trees were chosen by experienced men who knew the groves.

The data from this first year's work is, of course, very preliminary. After these records have been kept for a number of years we will be able to tell whether the apparent differences are repeated. We will know whether certain trees are inherently summer bearers and others not. Then, too, we wish to determine whether the characteristics that may be proven for the parent tree will be transmitted to the offspring by budding, and in order to determine this the buds taken from each individual tree will be used in a definite block of the nursery, and later set in a definite part of the grove—records of which will be carefully kept.

In view of the large possibility of increase that this first year's records have shown, it is thought that others may want to adopt the same method, gradually becoming more and more familiar with good and bad types of trees, eliminating the latter, demanding more reliable data in regard to the source of nursery stock, and thus constantly raising the standard of citrus orchards in general.

Comments on the Pomona College Journal of Economic Botany

From Dr. Th. Holm, Brookland, D. C.

"Only a few days ago I asked a friend of mine at the Department of Agriculture why there was no Journal of Economic Botany in the United States, and you may imagine my surprise when I received your Journal the day after. I congratulate you on this fine idea, and I shall certainly subscribe for it. Perhaps I may be able to give you some contributions."

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From Prof. A. W. Morrill, State Entomologist of Arizona.

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Pomona College, Claremont

California, U. S. A.

POMONA COLLEGE JOURNAL
of ECONOMIC BOTANY

Volume I DECEMBER 1911 Number 4

The Mango in Southern California

F. W. POPENOE
WEST INDIA GARDENS, ALTADENA, CALIFORNIA

The mango, with which but few people of California are intimately familiar, is throughout the tropics where extensively grown, the fruit of first importance. While systematic cultivation on an extensive scale has been applied to it in comparatively few countries, in all parts of the tropics it is grown in the greatest profusion and valued about as those of temperate climates value the apple. To those who are familiar with its finer varieties it is held in the highest esteem, but it is a regrettable fact that in many localities it is found only in inferior seedling forms, and this is accountable for the misunderstanding which exists in the minds of some Americans in regard to this fruit.

In India the cultivation of the mango extends back to the remotest antiquity, and careful selection of seedlings has resulted in the production of the finest varieties now existing. These have been propagated to a limited extent by inarching, and the Indian mangos are now famed as the finest mangos in the world.

The fruit has been termed "the king of tropical fruits," or "the apple of the tropics." Its beautiful coloring and delicious flavor, together with its extensive use in all tropical countries, seem to warrant these appellations. In many countries it is one of the commonest of fruits, growing in a semi-wild state, and forms an important part of the diet of the natives during the season when it is to be obtained.

According to DeCandolle, the mango is a native of South Asia and the Malay Archipelago, but it has long ago spread from its native home to the most remote corners of the earth. In Florida it is now attracting attention as a commercial proposition, and plantings of considerable extent are being made. Through the introduction of some of the choicer Indian varieties, many of which have already produced fruit, the mango industry in Florida has become one of great promise.

Until late years the slow and laborious method of inarching had to be resorted to for the perpetuation of any desirable variety, but recently several methods of budding have been successfully practiced and by these means the production of trees of known varieties on a commercial scale has been made possible.

The value and esteem in which the mango is held are attested by an article in a recent number of the National Geographic Magazine, by no less an authority

than Mr. David Fairchild, in charge of the Agricultural Explorations of the U. S. Department of Agriculture, himself a man of wide experience in tropical countries and familiar with the mango in its native home. He states: "The mango is one of the really great fruits of the world. India, with its hundreds of millions of people, has for centuries held it sacred, and celebrates annual ceremonies in its honor. The great Mogul Akbar, who reigned in the sixteenth century, planted the famous Lak Bag, an orchard of a hundred thousand mangos, and some of these still remain alive. It is a fruit the importance of which Americans are at last beginning to recognize, notwithstanding the unfortunate discredit which some of the worthless seedling mangos of Mexico and the West Indies have given it in the minds of Americans generally.

"There are probably more varieties of mangos than there are of peaches. I have heard of one collection of five hundred different sorts in India. There are exquisitely flavored varieties no larger than a plum, and there are delicious sorts the fruits of which are six pounds in weight. In India, where the wage of a coolie is not over 10 cents a day, there are varieties which sell for $6.60 a hundred and the commonest sorts bring over a cent apiece.

"The great mango trees of India are said to reach a height of seventy feet, and are so loaded down with fruit that over $150 worth has been sold from a single tree.

"These fine varieties, practically as free from fiber as a freestone peach, can be eaten with a spoon as easily as a canteloupe. Trainloads of these are shipped from the mango-growing centers of India and distributed in the densely peopled cities of that great semitropical empire; and yet, notwithstanding the great importance of this fruit, the agricultural study of it from the new standpoint has scarcely been begun. I believe that it has never, for example, been tested on any but its own roots."

The mango has received only the slightest attention in California, but its inherent value and the fact that it has been proven to be a possibility for parts of the state have seemed to warrant the preparation of this preliminary paper on the subject.

Its Present Status in California

So few mango trees have been planted in Southern California, and these have been of such a nondescript character, that no adequate trial can be said to have yet been made of this fruit. Not until superior forms are given a trial under a variety of conditions, and afforded every possible assistance to make them a success, will we definitely know what can be expected of the mango in this state; and yet the results with the few seedlings now in bearing have been so encouraging as to leave little room for doubt as to the future possibilities of this fruit in California.

In considering the behavior of, and results obtained from the trees which have fruited here it is important to take into consideration the fact that they have, almost without exception, been subjected to the most adverse conditions—conditions which would prove fatal in a year to the majority of our temperate fruits—and under these circumstances the behavior of some of these trees is truly re-

markable. Planted in poor soil in some instances and left to shift for themselves, getting no care whatever and no water except from the skies, how could they be expected to do their best? When subjected to such conditions it is little wonder that their growth has been stunted and unhealthy, and that many of them have failed to mature their fruit. The few trees which have had reasonable care

Figure 67. Seedling mango on old Miller place at Hollywood, California.

have done much better, and although they have shown that the growth of the tree will be much slower here than in tropical countries, and the large proportions attained by the mango further south will probably never be reached, yet good healthy growth has been made, fruit has been produced abundantly, and no diseases have appeared to affect the tree or fruit.

The cultivation of the mango in California probably dates back not more than thirty years. One of the earliest trees planted was that on the Jacob Miller place in Hollywood. The seed came from Guatemala City and the tree was set

out in its present location almost thirty years ago. This tree has had the advantage of a very mild location, which though not favorable to the rapid growth of the tree or the perfection of its fruit, has enabled it to develop into a good sized tree without being cut back by the frost. The fruit produced is of little value, but the enormous productivity of the tree is surprising, it frequently carrying over a thousand fruits in one crop. Few of the fruits reach a mature size, however, and none ripen perfectly.

Other trees planted more recently are now in bearing, and being situated in several different localities their behavior may be taken as giving something of an indication of the situations in this part of the state best adapted to the culture of the mango. Many small seedlings planted in cool localities have succumbed to the frosts of winter, but in the milder locations or with some protection during the first few winters, several trees have attained sufficient size to withstand the frosts, and are now doing well, it being a well known fact that if afforded some protection for the first few winters the tree will withstand without injury frosts which would have been fatal to it in the young stage.

At Sierra Madre the mango has probably done best. This is probably due to the absence of severe frosts during the winter, coupled with the intense heat of such a location during the summer, Sierra Madre being directly at the foot of the mountains and receiving a large amount of reflected heat. Here two trees, planted quite a number of years ago and receiving practically no care, are bearing regularly and show that one of the principal requirements of the mango is a warm season of long duration, with high temperatures, for the fruits come much nearer ripening on the tree here than near the coast, where they are subjected to fogs during a great part of the summer and never experience the intense heat found further inland.

Two trees growing in the foothills near Sherman, and only a few miles from the ocean, are in a thrifty condition and bearing well, but also go to show that more heat than is experienced in such a location is necessary for the perfect ripening of the fruit. One of the trees is an inarched Red Number Eleven, sent out some years ago by the Department of Agriculture, and is of great interest on account of being, so far as known to me, the only inarched or grafted mango now bearing in California. This tree demonstrates very clearly some of the differences between a seedling and a grafted tree. It is a regular and prolific bearer, and the fruits are all of a uniform, normal development, a fact rare with the seedlings. If it could have been planted further inland there seems little doubt but that it would be producing first-class mangos, as it is only the lack of sufficient heat that prevents the fruit from ripening perfectly. It is never affected by frost, and one glance at the dark green, healthy state of its foliage is sufficient to satisfy the most skeptical as to the possibility of growing the mango in California.

A five year old seedling near Santa Ana has made a splendid growth and is producing regularly, although rather shyly. Not much can be said as yet as to the adaptability of this locality to the mango, but it would seem that it too lacks the necessary degree of heat during the summer months for the perfect ripening of the fruit, of this variety at least.

At Montecito, near Santa Barbara, there are several trees some sixteen or eighteen years old. These trees have never had a healthy look, and their growth has been stunted and their foliage yellow. From the appearance of other plants in the same vicinity it would seem that this was due more to the soil than to the climate. The trees bear regularly a fair crop of fruit, but it does not mature sufficiently to be of any value.

Figure 68. Seedling mango "No. 5" grown at Sherman, California.

Prof. C. V. Piper, Agricultural Explorer of the U. S. Department of Agriculture, writes as follows regarding the conditions at the Government Botanical Gardens, Saharanpur, India:

"Saharanpur is only a short distance from the Himalayan foothills, and the mercury commonly goes down to about 20 degrees in the winter. It is on this account that both tropical and temperate trees can be grown here successfully It is quite strange to see cherries, plums, pears and even apples growing alongside mangos, dates, guavas, etc. In a general way it is comparable to Chico so far as temperature is concerned, possibly a little hotter in summer, and hardly so cool in winter. Judging from this place, why won't mangos do well in California?"

It would seem that if there are varieties of the mango that will thrive in a locality similar in climatic conditions to Chico, California, which is in the northern part of the state and experiences much more severe winters than the orange growing districts of Southern California, then we can reasonably expect to successfully produce this fruit in the latter districts at least. It is interesting to note that many of the mangos which have proved successful in Florida, and are now under trial in California, were introduced to this country from the Saharanpur. Surely, with varieties which will thrive in a locality experiencing temperatures of 20 degrees above zero every winter, and scarcely hotter in summer than Chico, our chances of success are great!

From this short survey of the behavior of the mango in different localities several conclusions are reached, which it is believed will hold good, although sufficient experience has not yet been had to make them positive. First, the mango, as far as can be judged with the varieties tried out here, is much better adapted to the milder and so called "frostless" localities of the interior than to the seacoast for the reason that near the ocean there is a lack of sufficient heat during the summer months to properly ripen the fruit. It seems reasonable to believe that sheltered locations in the hot interior valleys, such as the San Joaquin, Imperial and Coachella, as free from frost as possible, will produce first-class mangos.

Second, the growth of the tree will be stunted here, and the tree will never reach the proportions attained in tropical countries, although in time it may attain considerable size, especially in the hottest locations.

Third, if given protection for the first few winters the tree will withstand considerable frost, and will be hardy here in many localities at least.

Fourth, the dryness of our climate will not prohibit the production of choice mangos nor seriously interfere with growth in any way, provided ample moisture is supplied at the roots.

It is extremely improbable that the above conclusions will hold good in the case of all varieties, and in fact it could not be expected that they would. The question of variety will have much to do with the success of the mango here, but statements made by many of the greatest authorities on this subject would maintain the contention that a climate such as found in certain parts of Southern California is well adapted to the growth of this fruit.

While there are certain limitations in regard to climate, soil and rainfall, the question of variety must be of great importance in varying these limitations. The mango having become acclimatized in such widely distant localities and under such varying climatic conditions, it is reasonable to believe that a variety which has become adapted to one locality through years of acclimatization would not necessarily be a success in another one of widely differing character.

It is agreed that a dry season of considerable duration is desirable for the most successful culture of this fruit. On this point Collins [The Mango in Porto Rico (Bur. Plant Industry Bul. No. 28) p. 13] states: "It may be considered as proven that the mango will be prolific only in regions subject to a considerable dry season. * * * * In Mexico and Guatemala the mango was found at its

best only where severe dry seasons prevailed." It is argued that rains at the time of flowering interfere with pollination, and that without some artificial means of checking the growth, such as supplied by an extended dry season, the tree is not encouraged to produce fruit." In regard to climatic requirements Macmillan [Handbook of Tropical Gardening and Planting, p. 154] states, "A hot and rather dry climate and a rich, well drained soil suit it best."

Whether or not a high degree of humidity is at any time of the year necessary is perhaps open to question, but it would appear from the statement of Woodrow [The Mango: Its Culture and Varieties, p. 7] that it is not. He says: "The mango requires an abundance of moisture either in the atmosphere or at the root." Higgins [The Mango in Hawaii (Hawaii Ag. Exp. Station, Bul. 12) p. 8] says: "The mango is better suited to an irrigated region than to one of natural rainfall, because of the bad effects of rain at flowering time, and indeed throughout the life of the tree where the mango blight is known; and further, because it is a distinct advantage to be able to apply water when it is most needed and withhold it when it would do harm." And the behavior of the tree in Southern California and in parts of Mexico with extremely dry summers would argue that the necessary moisture can as well be supplied by irrigation as through the atmosphere.

The amount of frost that the tree will stand could scarcely help depending in a large measure on the variety, those which have become acclimatized in cool localities being naturally less susceptible to frost than those from strictly tropical countries. On this point Woodrow [The Mango: Its Culture and Varieties, p. 7] gives the experience in India as follows: "A few degrees of frost for a short time destroys the leaves and young branches, and an occasional blizzard giving 10°F. below freezing point for a short time may destroy branches as thick as the forearm, but on these being pruned off the trees are little worse for the low temperature." It seems, therefore, that the tree will withstand quite low temperatures provided they are of not too long duration. But a high temperature is necessary during the fruiting season. On this point A. C. Hartless, superintendent of the Government Botanical Gardens, Saharanpur, India, states: "As regards the conditions under which the mango ripens its fruit, undoubtedly a high temperature is necessary, and moreover a dry one is preferred. The fruits ripen here from May to July and thus have the hottest and dryest time of the year in which to ripen. Generally there is during May a hot, dry wind that no doubt acts on the acids of the fruit."

It is not necessary that the fruit be ripened on the tree, and the practice of ripening it artificially is extensively used in India. Mr. Hartless says regarding this: "It is a common practice here to ripen the fruit artificially. This is done to save the expense of watching and protecting from predatory animals and birds. When the fruits attain the desired size they are taken off and packed in straw in closed boxes where they will ripen. In this way the taste may differ slightly from those ripened on the tree, but it is not uncommon for fruits on the same tree to differ materially in taste." Mr. H. C. Prinsen Geerligs of Java, writing in the International Sugar Journal, [From The Agricultural News, Barbados, Vol. VIII, No. 176, p. 21] says: "Mangos are usually picked when unripe. At that

time they are hard, acid and flavourless, but the after-ripening process renders them tender and full flavoured in a few days."

Future Possibilities

A careful study of the behavior of the few bearing mango trees in Southern California will leave little room for doubt as to the future possibilities of this fruit here. Past experiments, while limited in extent, and confined chiefly to the seacoast belt, have been amply adequate to demonstrate that the mango will be, some day, a success in California.

But the varieties which have originated here, or been grown here thus far, are scarcely worthy of consideration for future planting on an extensive scale. In India, and other tropical countries, the mango has been grown for centuries and has reached a high state of development, and the existing varieties are so far ahead of anything that could be produced here by many years of breeding and selection that it behooves us not to waste time and effort experimenting along such lines, but to obtain at once for trial in different locations and under varying climatic conditions inarched or budded trees of a great number of the best varieties. By making such an experiment, we can determine without long delay what varieties or types are adapted to this climate, and obtain for cultivation here varieties much choicer than we could develop in many years.

This work has already been started by the Department of Agriculture. A set of inarched trees, comprising about forty of the choicest varieties from India, Ceylon, Philippines and other countries, has recently been sent to several locations in Southern California for trial. The list includes Alphonse, Ameeri, Amini, Bhadauria, Bhurdas, Bombay Yellow, Brindabani, Bulbulchasm, Cambodiana, Carabao, Chickna, Davey's Favourite, Divine, Ennuria, Faizan, Fernandez, Itamaraca, Jamshedi, Julie, Kachmahua, Kistapal, Langra, Langra Hardoi, Langra Large, Malda, Maller, Mulgoba, Mullgoa, Paheri, Punia, Rajabury, Salamar, Sharbati Black, Singapur, Stalkart, Sufaida, Surkha, Totapari, and White Alphonse. Notes regarding these will be found in the appended list of varieties.

By such experiments as this there is little doubt but that a number of choice varieties will be found that are adapted to this climate, and we will be enabled to proceed at once to the production of the finest forms of this valuable fruit.

The mango being so highly esteemed and extensively cultivated in tropical countries there seems no doubt but that the industry will reach large proportions here when choice varieties are found which are susceptible of rapid acclimatization.

Propagation

It is a regrettable fact that up to the present time the mango has been propagated in California exclusively by seed. The entire lack of budded or grafted trees of desirable varieties from which to propagate and the inferiority of the local seedlings have not tended to stimulate attempts at asexual propagation of this fruit. A small number of seedlings has been grown by the nurserymen during the past few years, in order to supply the demand which has existed, but it is to

be hoped that in the future propagation in this way will be utilized only to supply the necessary stocks upon which to bud or graft superior varieties. As with nearly all other tree fruits, the mango does not come true from seed, and trees grown by this method are liable to prove inferior and disappointing in the majority of cases. With all the choice varieties now at our command it will be much more profitable to turn our attention at once to the asexual propagation of those found to be adapted to this climate, than to the development of new varieties through the selection of seedlings.

BY SEED: Propagation from seed is most simple, and no difficulties are encountered in growing the mango in this way. It has been found advantageous to remove the husk from the seed before planting, as this not only hastens germination, but does away with loss of seeds from insects or fungous growths which find their way inside the husks. A high temperature favors prompt germination, and for this reason seeds are usually started in a greenhouse. They can be planted singly in 4-inch pots, a light, well drained soil being best suited to the development of the young plant.

INARCHING: The simplest method of asexual propagation, and the only one practiced until very recently, is that known as inarching, or grafting by approach. This is the method that has been in use in India for centuries, and by which the choice varieties for which that country is famous have been perpetuated. Inarching provides a simple means for the perpetuation of good varieties, and while somewhat tedious and not suited to the production of trees commercially, propagation in this way may be much more successfully practiced by the inexperienced than budding. The following description of the process from the Sugar Journal and Tropical Cultivator will be of great assistance to those contemplating doing this work:

"The best method of propagating good varieties of mangos is by means of inarching, which is a very simple process. It is performed usually between a large tree of superior variety growing in the ground and a seedling growing in a pot,—small, cheap flower pots about eight or nine inches deep and six inches diameter do well for the purpose. The soil should be good potting soil, with a fair proportion of manure. A single large mango stone should be planted in each pot. The seedlings are ready for inarching, if well grown, in ten months or so; if not well grown, they should be older. Two-year-old seedlings are very successfully inarched. The stem of the seedlings should be in each fairly thick, with the wood fairly developed,—near the root the stem will be somewhat thicker than an ordinary workingman's smallest finger. Any number of seedlings in pots can be inarched in one tree by erecting a stage (for their support) under the lower branches. The stem of the branch to be inarched should be about the same thickness as the seedling, and like the seedling, should be fairly developed wood. The juncture where the inarching is performed should be about six or eight inches from the root of the seedling and about a foot or so from the growing point of the branch, unless the branch is making new vigorous growth, in which case the distance will be more. A straight, well-shaped branch should be selected, so that the future grafted tree will be well proportioned. A slice of wood and bark

should be cut from the seedlings and from the branch, so that the inner bark of both can be made to touch accurately; the two wounded surfaces are bound securely with tape or bast fiber, and grafting clay applied to keep out air. The juncture of branch and seedling should extend for a length of about 3 inches, but at no point should the wound in either be deep; the slices should in fact be of almost uniform thickness throughout and not thick. Tenacious clay should not be used to cover the inarch, it soon cracks and admits air. One part of fresh cattle dung, mixed with two parts good soil, kneaded together with a little water, serves the purpose excellently. Inarching can be done in India at any season, but it is most successful when the trees are in active growth. It takes some time (several months) before the inarched juncture is perfectly joined by the new wood and bark cells. Meantime the seedlings in the pots must be carefully and regularly watered. When the juncture is complete the leading shoot of the seedling should be removed immediately above the inarch juncture and some days afterwards the branch of the tree may be severed immediately below the juncture.

"Trees for inarching should be in a sheltered situation, because if swayed much by the wind the pots or the platform are disturbed from their position.

"In planting out young grafts the pots should be broken if the young plant can not be removed without disturbing the earth on the roots. If the earth on the roots is much disturbed the plant will almost certainly die. They should be planted with plenty of manure in pits three feet deep and wide."—[From "The Mango in Porto Rico," by G. N. Collins, (Bulletin No. 28, Bureau of Plant Industry), p. 15]

PATCH BUDDING: It would be almost impossible to propagate mango trees in sufficient quantities for large commercial plantings by the method of inarching as described above. With the recent development of interest in the extension of the mango industry, several methods of budding, which permit of the propagation of trees in commercial quantities, have been developed. And while these doubtless require considerable more skill and experience on the part of the operator than inarching, when the production of trees in quantity is desired, one of them will have to be resorted to. The first method of budding successfully practiced was that of patch budding, Mr. G. W. Oliver of the Department of Agriculture being the first one to succeed with it in this country. The method as practiced by him is described as follows: ["The Propagation of the Mango," by G. W. Oliver, in the Florists Exchange, New York, April 19, 1902, p. 461.]

"The method I wish to call attention to must be performed under certain conditions, the first and foremost of which is that the stock must be in active growth. The best time is when the new leaves are not far enough developed to show the bright green color. The bark is then most easily removed. Choose the thick part of the stem only a few inches above the surface of the ground; cut out a rectangular piece of bark about one and one-half inches in length, and from the variety to be propagated cut a similar piece with a bud in the center, not, however, from new wood, but from that which is at least two years old and which has lost its green color and assumed the grayish brown tint. Fit the section of bark, with bud attached, into the space formed by the removal of the bark from

the stock. If this piece of bark removed from the stock has a bud in the central part, the wood exposed to view will fit better with the section of bark to be applied. When the section has been put in place, with a small brush apply a light coating of liquid grafting wax in which there is a large quantity of resin, to the cut parts, and immediately tie firmly with thick pieces of raffia; then an 8-inch wide strip of strong wrapping paper wound round and round the stem a few inches above the bud, and tied above with a cord, completes the operation for the time being.

"If good material is selected and the operation carefully carried out at the proper time, there is no reason why a high percentage of successful unions should not be secured."

SHIELD BUDDING: In 1910 the Hawaii Agricultural Experiment Station issued a bulletin [Shield Budding the Mango (Bul. No. 20, Hawaii Ag. Ex. Station), Honolulu, 1910] by Mr. J. E. Higgins, describing a method of shield budding successfully practiced by him. Shield budding has several advantages over patch budding, the chief being that the buds can be set much more rapidly, and do not require skilled labor for the wrapping. If it can be successfully practiced here, it should be by far the most desirable method for nursery propagation. Mr. Higgins describes the process as follows:

"Budding by this method has been successfully performed on stocks from an inch to three inches in diameter. What the limitations are, on either side of these dimensions, is not known at present. Wood of this size, in seedling trees, may be from two to five years old. It is essential that the stocks be in a thrifty condition, and still more important that they should be in 'flush'. If not in this condition, the bark will not readily separate from the stock. It has been found that the best time is when the terminal buds are just opening. Unless the trees are watched carefully they will pass this stage before the flush is observed. When the young, brown leaves have appeared it is often too late to bud, and the operation must be postponed until the next flush.

"The budwood which has been most successfully used is that which has lost most of its leaves and is turning brown or gray in color. Such wood is usually about an inch in diameter. It is not necessary in this method of budding that the budwood shall be in a flushing condition, although it may be an advantage to have it so. It should, however, be healthy wood of normal growth.

"The incision should be made in the stock about six inches in length. At the lower end of this make an incision at right-angles to it, with the knife edge pointing upwards at an angle of about forty-five degrees with the stock, thus making a curved incision. Insert the sharpened end of the handle of the budding knife beneath the bark at the junction of these incisions, and push it gently upward, raising the bark so as to make a place for the bud. It is not necessary to push the handle far, but by gently prying, the bark may be separated from the stock, if the latter is in proper condition, without injuring the delicate cells against which the bud shield is to be placed.

"The bud is now to be removed from the budwood. With a rather heavier knife than is generally used for budding, in the right hand, and the budwood held firmly in the left, place the blade against the budwood with a very slight inclina-

tion, and cut so as to make as flat a surface as possible under the bud shield. This bud shield should be about three to three and one-half inches long, with the bud in the center. The small portion of wood, which will thus be taken off with the bud shield, may be removed if it slips readily. If not, it should be left in place. The lower end of the shield is taken between the thumb and finger and gently inserted in the incision prepared for it, pushing it up until it is held firmly in place by the surrounding bark.

"The stock must then be tied with raffia or some other soft, but strong, tying material so as to prevent drying out. The cut surfaces below the actual bud are usually covered with grafting wax, and the whole is then wrapped with a waxed cotton bandage, beginning at the lower part and winding spirally to the top, exposing only the actual bud. This method protects the bud and the wound from the access of water. The bud is shaded by a short piece of bandage hung over it and held in place by being laid under one of the upper strands of the spirally wound bandage.

"In about three or four weeks, if the bud remains green, the stock should be lopped at a point about seven inches above the bud. Care should be taken in thus cutting the stock partly off to avoid splitting downward. It should be made to split upward into that portion of the stock which is to be destroyed. This lopping will serve to force the bud into growth. Many other buds, on the sides of the stock, will start into growth before the new bud. These must all be cut off. It has not been found necessary to remove the tying and wrapping material until the bud has made two flushes, and often it is not necessary at all, since the raffia usually decays beneath the waxed cloth and the latter naturally expands with the growth of the stock. When the bud has started into growth the top of the tree may be cut off and destroyed. The stump remaining above the bud may be cut off with a sloping cut close to the bud, after the latter has made three or four flushes."

Influence of Stock on Scion

Very few experiments have as yet been made to determine the influence of the stock on the scion, and it is to be hoped that this important subject will be more thoroughly investigated in the near future. The following statement, by Prof. Rolfs, demonstrates that the field is an interesting and important one:

"At the present time we know very little as to the influence of the stock on the scion in the various groups of mangos. In this connection I may say that I have two trees of the Totafari, one tree budded on the scion of an unknown variety, probably belonging to the Eleanor group. This small tree began to fruit before it had been set out three years, and has been a constant fruiter and heavy bearer ever since. At exactly the same time that this tree [Rolfs, P. H., 'The Mango in Florida' (Proc. Am. Pomological Society, 1911] was set out, a spring was taken from that tree and inarched on a large number eleven tree. This inarch has grown most remarkably and has made a good sized tree, but up to the present time has shown no tendency to produce bloom. One would naturally have expected that when this scion was inarched on the fruiting tree, the scion would

begin to fruit in a very short time. Likewise, I have another case in which a Cambodiana scion has been inarched on to a number eleven mango, and on another limb of the same tree a Pakiri has been inarched. The Cambodiana and Pakiri are of about equal growth. They compose now the entire top of a large mango tree. The Cambodiana has been a regular and constant fruiter, while the Pakiri has shown no tendency to bloom, although some Pakiri trees on what is probably Eleanor stock are blooming and fruiting abundantly. From the isolated instances, it would appear the number eleven proves to be an excellent stock for Cambodiana, but proves to be a poor stock for Pakiri and Totafari groups."

These results seem to indicate beyond the possibility of a doubt that the question of stock is of the utmost importance. It will be both profitable and necessary, therefore, when a choice variety is found adapted to Southern California, to experiment extensively and determine what stock is best suited to it. But the subject will require thorough investigation and experimentation before it is clearly understood.

Varieties

While the following varieties do not by any means include all the mangos so far fruited in California, they may be considered as all which are worthy of notice or liable to be propagated, and hence the only varieties now grown here that it will be necessary to distinguish by name. With one exception, they have originated locally as seedlings. The exception is the variety Red Number Eleven, which, as described, is produced by an inarched tree sent out by the Department of Agriculture. The presence of this one inarched tree is of the greatest interest, and it has demonstrated a number of things which could not be determined by seedlings. Being of a variety whose habits are well known, its behavior can be taken as an accurate indicator of what the mango will do in Southern California, under such conditions as this tree has been grown. It has produced abundantly and regularly, and the fruit has been fully as large as that produced by the same variety in Florida or the West Indies. In addition the fruits are uniformly well developed, which is not the case with the fruits produced by any of the local seedlings. While the growth of the tree has been much slower than it would have been in a hotter country, it is in a healthy and vigorous condition, and is rarely affected by frost, although it has not been subjected to our average winter temperatures, perhaps, on account of being grown in a very mild locality. The locality in which it was grown being near the seacoast, it also lacks the intense summer heat found further inland, and this fact is accountable for the failure of the fruit to ripen perfectly, or even to as great a degree as at Sierra Madre. The cool nights and mild days have the effect of greatly retarding the development of the fruit, so that it reaches maturity just as the winter season is coming on and is unable to ripen for lack of heat. When picked and laid away for awhile, the fruits become soft and eatable but cannot be said to be up to the standard in this respect, by any means.

Most of the seedlings differ from this inarched tree in setting an enormous crop of fruit each year and then bringing only a few to maturity, probably the

earliest blossoms. The great difficulty experienced in many humid tropical countries, namely, the failure of the mango to set fruits, certainly will not be experienced here. But the cool winters check the growth of the tree, and it flowers much later than it normally would, and this results, of course, in making the fruits very late to mature. So that with the seedlings, as with Red Number Eleven, the fruits must be picked and laid away for a few days before softening up sufficiently to become eatable. Those fruits which have been grown farthest inland, and subjected to the greatest heat during the summer, always mature before those grown near the seacoast, and usually are in fact the only ones which mature at all.

Figure 69. The Fales mango. This tree should have been headed lower.

Fales

(Figures 69, 70, 71, 72)

This variety originated at Sierra Madre, on the property formerly owned by W. L. Fales, by whom the tree was planted and for whom it has been named. It

Figure 70. A plate of well developed specimens of the Fales mango.

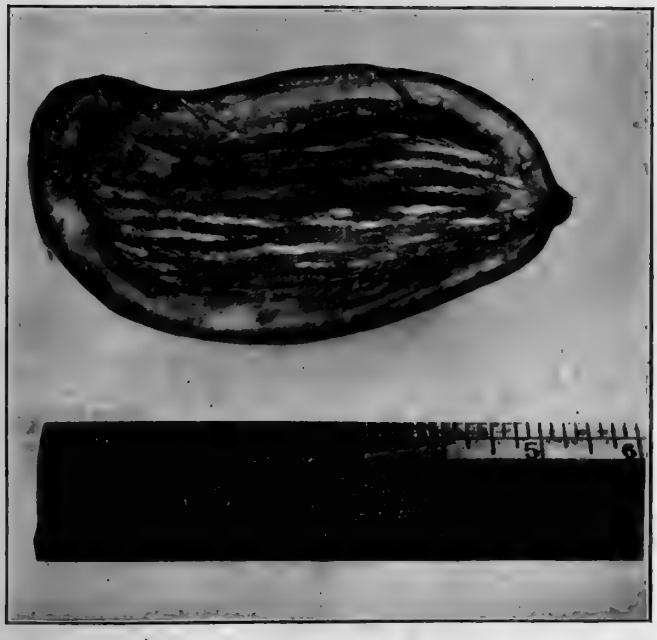

Figure 71. Longitudinal section of the Fales mango grown at Sierra Madre, California.

is probably the best of the local seedlings. This mango would seem to be one of the "Manila" type grown in Mexico, and it is probable that the seed was brought from some point in that republic, and was of that type. The tree has been subjected to the hardest possible usage, and under these conditions its behavior is truly remarkable. It is grown in a partially decomposed granite soil at the foot of the Sierra Madre mountains, and for a number of years has received practically no care whatever. And yet it bears regularly good crops of fruit,—fruit which will compare well in size with those of the Manila type produced in Mexico. If picked in December and laid away for a few days it ripens into a mango of very fair flavor and quality.

Description: General form long and slender, somewhat compressed, and terminating in a prominent curved beak; size large; weight ten ounces; dimensions, length five and one-half inches, width two and three-quarters inches, thickness two

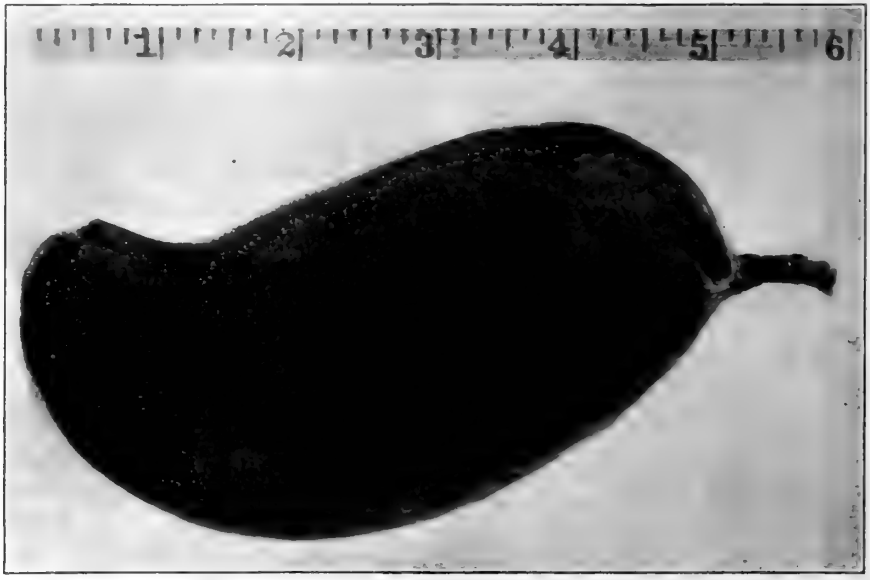

Figure 72. The Fales mango.

inches; base somewhat tapering, slightly extended where stem joins the fruit; apex very prominently curved and beaked, stigmatic point rather prominent and one-quarter inch above tip of beak; stem rather stout; fruits borne in clusters of two to six; surface somewhat undulating; bloom none; color greenish yellow, brightest at base and gradually shading downward to yellowish green at apex; dots numerous, small, rounded, some of them subcutaneous, dark brown, the subcutaneous ones light yellowish; skin medium thick, tough; flesh firm, orange yellow, juicy; fibre not very abundant, fine; seed very long, narrow, medium thick; flavor sweet, aromatic, very pleasant; quality fair to good; matures in December at Sierra Madre, but does not ripen perfectly on the tree.

Tree is upright, close headed, and a fairly prolific bearer. Here described for the first time.

Sierra Madre

(Figures 73, 74)

This also originated at Sierra Madre, and was planted by Mr. Fales at the same time as the variety first described. It is inferior to the Fales, and is mainly noticeable for its habit of producing small sterile fruits, as mentioned below.

Description: General form reniform, long, somewhat compressed, very prominently beaked; size large; weight nine ounces; dimensions, length five inches, width two and one-half inches, thickness two inches; base tapering toward stem, slightly extended where stem joins fruit; apex very prominently curved and beaked, stigmatic point a mere dot; stem medium stout; surface somewhat undulating; color yellowish green, exposed side blushed with brownish orange; dots numerous, small, rounded, some of them subcutaneous, dark brown, the sub-

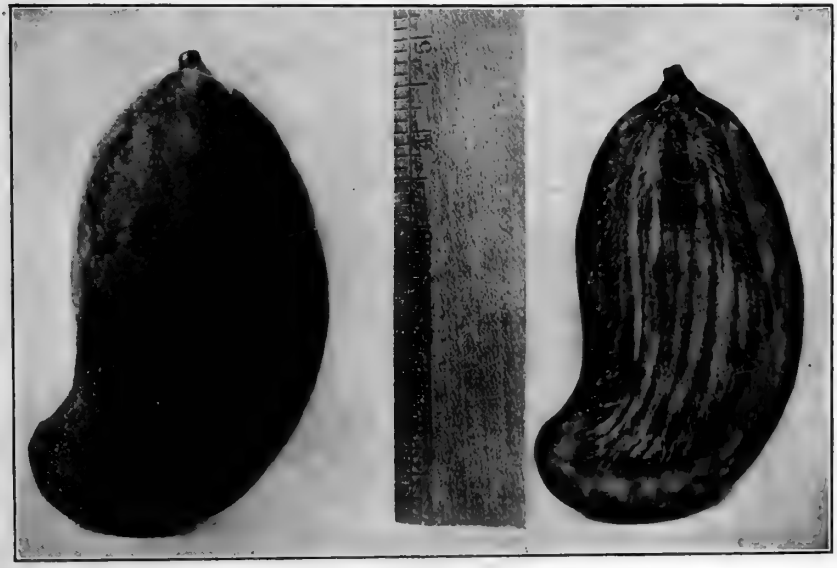

Figure 73. Normal type of the Sierra Madre mango, grown at Sierra Madre, California.

cutaneous ones light yellowish green; skin medium thick, tough; flesh light yellow, rather dry; fibre rather abundant; seed very large, oblong, rather thick; flavor subacid, strong; quality fair; matures in December at Sierra Madre, California, but does not ripen on the tree.

Tree upright, open headed, fairly prolific bearer. A peculiar thing about this variety is the fact that it produces a large number of small, sterile fruits, which ripen and fall to the ground in October. These sterile fruits are quite distinct in form from the normal type, are about two ounces in weight, and more highly colored than the normal fruits, being a dull orange yellow, overlaid with scarlet and bright orange around the base of the fruit. The seed is represented by a thin, empty husk. The flesh is light orange in color, contains considerable

coarse fiber, and is of a most delicious, sweet, spicy flavor. These sterile fruits are the only mangos known to me which mature in California during the warm season, and consequently have an opportunity to ripen perfectly under favorable conditions. They are really a choice little fruit, and far superior in flavor to any of the normal varieties which mature during the winter and do not ripen perfectly.

This is the first description of this variety.

Figure 74. The Sierra Madre mango. Small sterile form.

Santa Ana

(Figure 75)

Originated near the city of Santa Ana, on the property now owned by Mr. Chas. Eells. It is a common type of mango and a fruit of fair quality, its chief drawback being that it is (so far, at least,) a shy bearer.

Description: General form reniform, rather broad, thick, terminating in a curved beak at apex; size medium; weight seven ounces; dimensions, length four and one-half inches, width two and one-half inches, thickness two inches; base very slightly tapering, more or less plaited; cavity none; apex extended into a prominent curved beak, stigmatic point depressed, one-quarter inch above tip of beak; stem medium stout, swollen where it joins the fruit; surface slightly undulating; bloom none; color yellowish green, blushed with maroon on exposed side; dots numerous, medium large, rounded, sometimes subcutaneous, russet, the subcutaneous ones yellowish green, lighter than skin; skin rather thick, tough; flesh light yellow, sometimes tinged with greenish; fibre fairly abundant, but fine; seed rather long, narrow, thick, reniform, small in proportion to size of fruit; flavor rather acid, quality fair; matures in December at Santa Ana, but does not ripen perfectly on the tree.

Tree is of vigorous growth, but a rather shy bearer, producing only about one dozen fruits this season.

This is the first description of this variety.

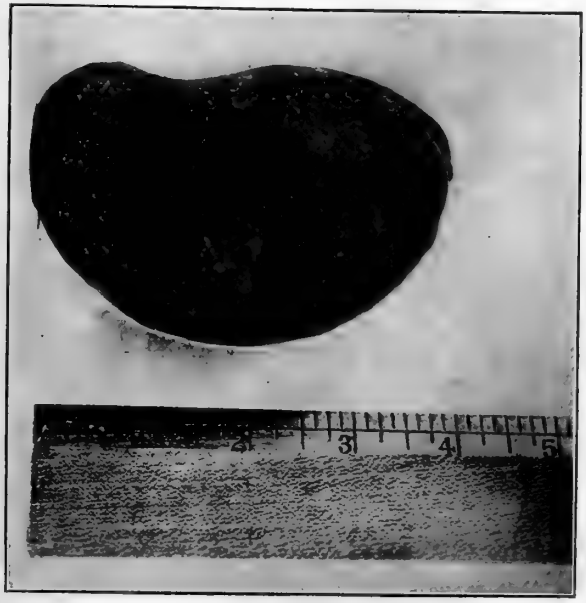

Figure 75. The Santa Ana mango, grown at Santa Ana, California.

Red Number Eleven

(Figures 76, 77, 78, 79)

A red cheeked form of the well known Number Eleven, one of the most popular mangos in the West Indies. The fruit as here described is produced on the property of Ed. Harman, at Sherman, by an inarched tree sent out some years ago by the Department of Agriculture.

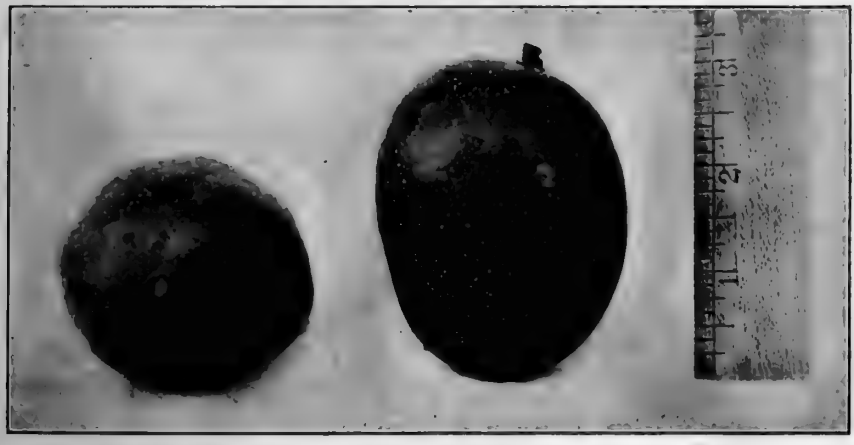

Figure 76. The Red Number Eleven mango as now grown at Sherman, California.

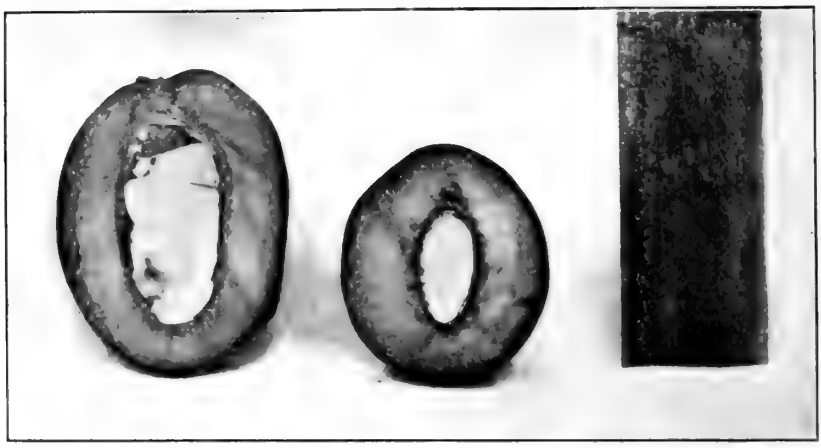

Figure 77. The Red Number Eleven mango as now grown at Sherman, California.

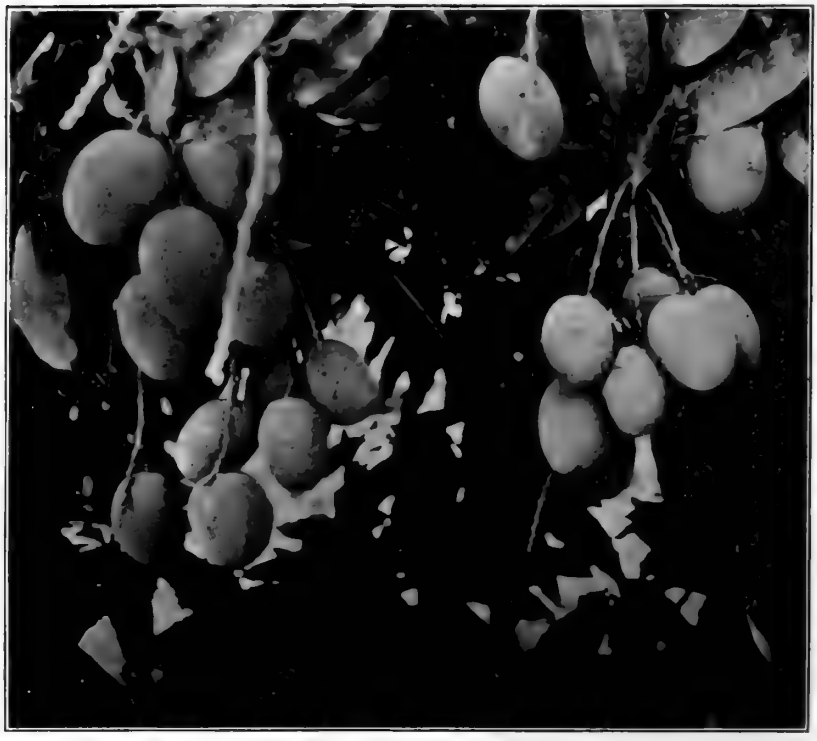

Figure 78. Clusters of fruit on inarched Red Number Eleven mango at Sherman, California.

Description: General form oblong, oblique, somewhat compressed; size small; weight four ounces; dimensions, length three and one-quarter inches, width two and one-quarter inches; thickness two inches; cavity very shallow, sometimes none, slightly plaited; apex rounded, not beaked, stigmatic point slightly depressed and one-half inch above longitudinal apex of fruit; stem rather slender; fruits borne in clusters of two to eight; surface slightly undulating; bloom none; color green, overlaid with magenta on exposed side; dots numerous, medium sized, irregular, russet; skin rather thin, tough; flesh deep yellow to orange yellow; rather dry; fibre slight; seed oblong, thick, very large in proportion to size of fruit; flavor subacid, spicy; quality fair to good; matures December-January at Sherman, California, but does not ripen perfectly on the tree.

Tree is rather spreading in habit, close-headed, of vigorous growth, and a prolific bearer.

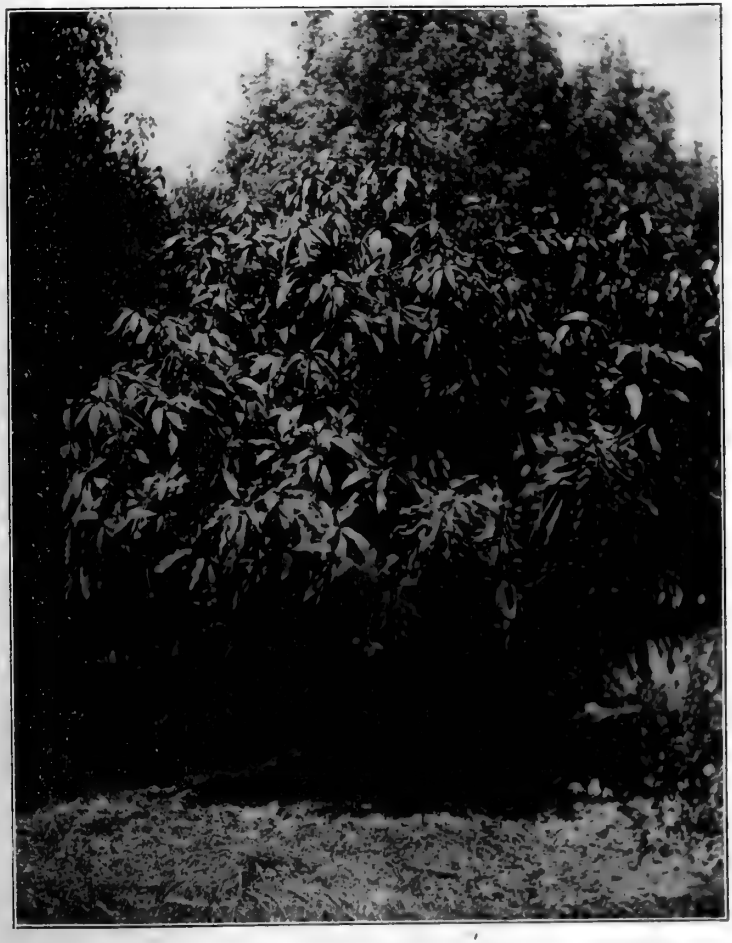

Figure 79. The Red Number Eleven mango at Sherman, California. This tree shows a fine orchard form for the mango.

CLASSIFICATION

Almost no attempt has ever been made to classify the immense number of mango varieties, either by a natural or artificial system. The one obstacle which has probably prevented this more than anything else is the extremely wide distribution of the fruit, making it an impossibility to gather all the varieties together in one place for study and comparison. There seems to be ample basis for a classification by natural characteristics, and if this could be done it would bring out vividly the relationship between many of the varieties, and establish the synonymy of many which are now considered as distinct, or known under different names in different countries. Few fruits are as widely grown as the mango, or exhibit as many variations, and this will make the task of gathering together and classifying the multitude of forms from all parts of the world a difficult one.

Prof. Rolfs has classified the mangos now grown in Florida into a number of distinct groups, based not only on a similarity of natural characteristics of certain fruits, but also on a similarity in growth and foliage of the trees. It is stated that persons naturally inclined to horticultural work will come to recognize these groups instinctively.

This grouping is as follows:

NO. 11 GROUP. Composed of a miscellaneous lot of seedlings distributed most largely along the east coast from the lower end of India River southward. The group, as far as Florida is concerned, originated in a shipment of about 1200 seeds of No. 11 sent [Rolfs, P. H., "The Mango in Florida" (Proc. Am. Pomological Society, 1911)] from Jamaica. The fruit weighs from three to twelve ounces, varies in color from crimson red to light orange, is quite fibrous, in general shape what has been called a modified kidney shape to almost round, and is the first group to ripen. The group contains two varieties, No. 11, which includes an assemblage of seedling trees, which seem to come more or less true from seed, and Roberts, a descendant from No. 11 which has been propagated by budding to some extent.

TURPENTINE GROUP. A miscellaneous lot of fruits, seeming to have come to Florida from various parts of the Antillean region. It is of so inferior grade that varieties have not been propagated.

CAMBODIANA GROUP. Considered by some botanists to be a distinct species from the other groups of India, and known under the name of Mangifera Cambodiana. It seems to be most common in the Malayan Peninsula and the Philippine Islands. In some instances the seed fails to develop and yet produces a good fruit, that is, the group seems to produce strains which are tending to become seedless. The characteristics of the group are a fruit of six to eight ounces in weight, deep lemon yellow color, weak fiber, much elongated form, and prominent stigmatic area. The varieties at present recognized are: Manila, an assemblage of seedlings that is to eastern Mexico what No. 11 is to the east coast of Florida; Philippine, an assemblage of seedlings grown in Cuba; Cambodiana, grown from seeds imported by U. S. Department of Agriculture; and Cecil, a very handsome variety originated at Miami, Florida.

PINEAPPLE GROUP. Composed largely of seedlings grown in Mexico, some of which have found their way into Florida. It is small in size, light orange or lemon yellow, streaked with red, fiber strong as in No. 11 group, shape distinct, shoulder not prominent, stigmatic area prominent. The varieties are: Pinna, seeds imported from Mexico; Totafari, received as inarched tree from India.

BOMBAY GROUP. This group has no distinct line of demarcation between it and the Eleanor group, which follows. Some of the varieties have come to Florida as seed from the Antilles, others have come from India as inarched trees. As a rule the fruit runs large; the ground color is dark lemon or bright orange in most cases, in some ripening with a distinct greenish color, or containing a considerable amount of red; fiber is rather weak; shape approximates as nearly spherical as any group of mangos; stigmatic area occurs well up on the fruit, where it is either prominent or slightly depressed. Varieties are: Bombay, a miscellaneous lot of seedlings from the Antilles; Indian, a variety of the Bombay group; Mulgoba, introduced by United States Department of Agriculture from India in the late eighties, in form of an inarched tree; Alphonse, derived from India; Bennet, derived from India.

ELEANOR GROUP. A miscellaneous lot of seedlings. Distinct from the Bombay group in color, and in coarseness of fiber. Varieties are: Eleanor, a rather handsome fruit; Apple, quite similar to Eleanor, but of apple-like flavor; Apricot smaller than two preceding, and of apricot-like flavor.

SOONDERSHA GROUP. Comprising a single variety, the only one of the group yet grown in Florida. Derived from India. The largest of the mangos that have been grown in Florida, color somewhat like Cambodiana group, lemon yellow with small dark colorations, fiber weak, season very late. The Soondersha is the only one of the group so far fruited in Florida.

An Annotated List of Better-Known Mangos

Of the almost innumerable varieties of the mango, which have originated in all parts of the tropical world, extremely few have ever been completely described or figured in any publication. Several of the most famous Indian mangos have received considerable attention, but the great majority of varieties are scarcely known even by name outside of the locality in which they have originated. The following list is of necessity very fragmentary, and incomplete, and only contains varieties which have received the attention of horticulturists. One authority records having collected five hundred distinct sorts in India, but no description has ever been published of the majority of these, and there remain vast numbers whose existence has never been recorded.

This list has been compiled in the main from the following sources, but extracts have also been made from a number of articles which have appeared in periodical publications, and I am personally indebted to Mr. E. N. Reasoner of Oneco, Florida, for notes regarding many of the Indian varieties as fruited in that state.

Woodrow, The Mango: Its Culture and Varieties, Paisley, 1904.

Collins, The Mango in Porto Rico (Bureau of Plant Industry, Bulletin No. 28) Washington, 1903.

Higgins, The Mango in Hawaii, (Hawaii Agricultural Experiment Station Bulletin No. 12) Washington, 1906.

Macmillan, A Handbook of Tropical Gardening and Planting, Colombo, 1910.

Jumelle, Les Cultures Coloniales, Paris, 1901.

Hartless, A Tabular List of Mangos grown at the Government Botanical Gardens, Saharanpur, U. P., India.

Yearbooks of the United States Department of Agriculture for 1901, 1907, 1908 and 1910.

Catalog of Government Botanical Gardens, Saharanpur, India, 1907.

Catalog of Tropical Fruit Trees, William Bros., Heneratgoda, Ceylon, 1907.

Catalog of Royal Palm Nurseries, Oneco, Florida, for 1911-12.

Inventories of Bureau of Plant Industry, U. S. Department of Agriculture.

And other publications.

ADA. A good sized, well flavored fruit.—William Bros., Ceylon.

AFONZA, India. Weight eighteen ounces; size four and five-eighths by three and seven-eighths inches; skin greenish yellow with dark specks; pulp very pale yellow, very sweet, slightly wooly; left shoulder high; beak slight.—Woodrow.

ALPHONSE, India. Introduced under S. P. I. No. 8440. (Synonyms *Alphonso*, S. P. I. No. 9517, *Alphonso, Alfonso, Alfoos,* and *Hafu*, S. P. I. No. 8733). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight twelve ounces; size four by three and one-quarter inches; skin greenish yellow, with reddish orange shoulder; pulp fine, dark cream colored, of the finest piquant and delicate flavor; beak none; left shoulder very slight. The keeping qualities of this mango are excellent, and it is generally admitted the best of all mangos. The name is applied to many distinct sorts of greatly varied merits, in the markets.—Woodrow.

A well known Bombay kind, tender in the United Provinces—Saharanpur.

This is the best Bombay mango, and is remarkable for its good shipping qualities. It can be picked while still green, laid or shipped in straw with plenty of air, and kept for six weeks. Even after ripe, fruits can be kept for a week or more. A much better shipper than Mulgoba, and more productive.—Fairchild.

Prolific bearer; medium size; quality good; color red and yellow; stone medium size; ripens mid season; good keeper; very fair flavor; tree tender.—Hartless, Saharanpur.

AMEERGOLA. Listed, but not described, by William Bros., Ceylon.

AMINI, India. Introduced under S. P. I. No. 7104. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

General form long, about five and one-half inches. Skin medium thick, yellow and red. Flesh meaty, tender, juicy, sweet.—Reasoner, Florida.

Amini has produced fruit as free from adhesion as Fernandez, and of excellent flavor. The shape is more nearly what is desired in a market fruit, i. e., it approaches more nearly to the spherical than most others. It is a very thick and short variety, with no noticeable point at blossom end.—Beach, Florida.

AMIRI or AMIRCOLA, India. (Syn. *Ameeri*, S. P. I. No. 8731). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight ten ounces; size five and one-half by two and seven-eighths inches; crimson yellow on skin shading downward to green. Described as a very high class fruit by Mr. Mahaluxmivalla of Bombay.—Woodrow.

ANNURRUA. Listed, but not described, by William Bros., Ceylon.

APPLE, Florida. Quite similar to the Eleanor. At its best has a decided apple flavor.—Rolfs.

APRICOT, Florida. Running somewhat smaller than either the Eleanor or the Apple. At its best has a decided flavor like the apricot.—Rolfs.

ARBUTHNOT, India. Introduced under S. P. I. No. 9504. Fruited in Florida.

A medium sized fruit, near the Bombay variety.—Saharanpur.

Prolific bearer; medium size; quality medium; color orange and green; stone medium size; mid season; good keeper; flesh firm; tree tender; slow grower.—Hartless, Saharanpur.

The fruits are rather long, weighing from eight to twelve ounces each, of excellent flavor and very little fiber.—Reasoner, Florida.

ARISTIDE, Mauritius. Introduced under S. P. I. No. 27926. The best of our mangos.—Regnard.

AUGUSTE, Mauritius. Introduced under S. P. I. No. 27853.

AUMINI. Listed, but not described, by William Bros., Ceylon.

BADA MAWA, India. Weight six ounces; size three and five-eighths by two and three-quarters inches; skin green, speckled pale green, and shaded yellow; pulp sweet and luscious, without piquancy.—Woodrow.

BADAMI, India. Introduced under S. P. I. No. 7103.

BADSHAHA, India. Weight fourteen ounces; size four and three-quarters by three and three-eighths inches; skin pale yellow, of agreeable flavor but woolly; beak small; shoulders yellow.—Woodrow.

BAHADURA, India. A small fruit of fine flavor, ripens in August and September.—Saharanpur.

BAISSAC, Mauritius. Introduced under S. P. I. No. 27927.

BANCHORE of Alandi-Keir, Poona. India. Weight four and three-quarters ounces; size three by two and one-half inches; skin deep crimson on exposed side, dark cream on shaded side; pulp very fine, creamy, delightfully piquant; beak none; shoulders level. —Woodrow.

BANCHORE of Dhairey, Poona. India. Weight seven ounces; size three and one-third by two and three-quarters inches; skin green, speckled pale green and shaded yellow; pulp very sweet, and luscious, without piquancy.—Woodrow.

BANKA, India. A twisted variety, highly popular.—Woodrow.

BARAMASI, India. (Synonymous with *Baromeshe* and *Baransi*). Fruits during several months of the year.—Saharanpur.

BARANSI, India. Prolific bearer; fruit small; quality fair; color yellow and green; stone large; ripens late; keeps well; fruits twice a year, latest to fruit; rather fibrous; medium hardy; slow grower.—Hartless, Saharanpur.

BAROMESHE. Or all the year round.—William Bros., Ceylon.

BATASI, India. A very small fruit of delicious flavor and very rare, with fine fibre. Beak none, left shoulder slightly higher.—Woodrow.

BATH, India. Introduced under S. P. I. No. 7038.

BELKASH. Listed, but not described, by William Bros., Ceylon.

BENNETT. Syn. *Douglas Bennett Alphonse,* which see.

BERESA. Listed, but not described, by William Bros., Ceylon.

BHADAYA. A late fruiting variety, ripens August to October, and one of the best as to flavor.—William Bros., Ceylon.

BHADAUREA or BHADUREA, India. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; size large; quality fair; color yellow and green; stone large; ripens late; poor keeper; texture fibrous; poor flavor; tree hardy; medium free grower.—Hartless, Saharanpur.

BHAO KAN. Listed, but not described, by William Bros., Ceylon.

BHOPALY, India. Weight fourteen ounces; size four by three and one-eighth inches; skin yellowish green; pulp deep yellow without fibre; flavor pleasing; beak none; shoulders level.—Woodrow.

BHUNGA, India. Weight eight ounces; size three and one-third by two and seven-eighths inches; skin yellow; pulp yellow, shaded dark yellow in center. Infested with mango weevil. Beak very slight; shoulders level.—Woodrow.

BHURDAS, India. Introduced under S. P. I. No. 9515. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; medium size; quality medium; color yellow and green; stone large; ripens mid-season; good keeper; pineapple flavored; medium hardy and free grower.—Hartless, Saharanpur.

BISHOP, India. Weight eighteen ounces; size five and three-eighths by four and one-half inches; skin yellowish with very small bright light yellow specks; pulp deep brownish towards stone, shading off to pale at the outside; slightly wooly, sweet and rich, without piquancy; beak scarcely perceptible; left shoulder slightly high.—Woodrow.

BISSANETH MUKHO. Listed, but not described, by William Bros., Ceylon.

BLACK (or *Green Gage*). A delicious mango from Jamaica, where it is considered their best sort. Small to medium size; regular oblong; green, with numerous black spots on the skin; pulp with exceedingly fine fiber hardly noticed, of a yellow color, and spicy, sweet flavor.—Reasoner, Florida.

BOLO, India. Weight thirteen ounces; size four by three and one-half inches; skin yellow; pulp pale yellow, with a few strong, dark fibers near skin; beak and shoulders none.—Woodrow.

BOMBAY BHUTO or BHUTA BOMBAY. Listed, but not described, by William Bros., Ceylon.

BOMBAY CALCUTTA GARDEN, India. Prolific bearer; large size; second quality; color green and yellow; stone small; tree hardy; ripens midseason; keeps well; medium free grower; good flavor.—Hartless, Saharanpur.

BOMBAY GREEN, India. Introduced under S. P. I. No. 9507. Now under trial in Florida.

One of the best kinds for general planting, prolific bearer.—Saharanpur.

Prolific bearer; medium size; quality good; color green; stone medium size; hardy; ripens early; keeps well; medium free grower; soft fleshed.—Hartless, Saharanpur.

BOMBAY JAIT. Listed, but not described, by William Bros., Ceylon.

BOMBAY SINGA. Listed, but not described, by William Bros., Ceylon.

BOMBAY SURAT. Listed, but not described, by William Bros., Ceylon.

BOMBAY WHITE. Listed, but not described, by William Bros., Ceylon.

BOMBAY YELLOW, India. Introduced under S. P. I. No. 9508. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

One of the best for general planting. A prolific bearer.—Saharanpur.

The best mango here. Fruit of medium size and yellowish when ripe.—Gollan, Saharanpur.

Prolific bearer; medium size; first quality; yellow and red in color; stone medium size; hardy; ripens mid season; keeps well; free grower; flesh firm; superior to Bombay Green.—Hartless, Saharanpur.

BORSHA, India. Introduced under S. P. I. No. 8442.

Weight ten ounces; size four and one-eighth by two and five-eighths inches; skin bright green, with minute yellow spots and bright crimson on exposed side; beak very slight; left shoulder very high.—Woodrow.

Fruit weighs on an average ten ounces, ripens by first of July. Flesh is as dry as that of Mulgoba or Alphonse and can be cut like cheese. It is three to four weeks later in ripening than Alphonse and considered almost its equal in quality. One large tree of this variety is said to have often yielded over $150.00 worth of fruit in a single crop. * * * This variety is distinguished from Mulgoba by its young shoots, which are distinctly reddish in color.—Fairchild.

BOTTLE, India. Introduced under S. P. I. No. 8420.

A good market sort of Bombay. Green in color, ripening to reddish yellow. Flesh is yellowish in color and not stringy. The fruit is very long and slender, hence the name "bottle." The stone is small. The fruit ripens, as do most of the Bombay mangos, from April to May.—Fairchild.

BRINDABANI, India. Introduced under S. P. I. No. 9506. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Medium sized, green colored fruit. Quality only fair. Gollan, Saharanpur.

Sparse bearer; size small; quality only fair; color green and yellow; stone large; tree tender; ripens midseason; keeps well; slow grower; juicy and of good flavor.—Hartless, Saharanpur.

BROJONATH DHUR (or *Brojo Nath Dhar*). Listed, but not described, by William Bros., Ceylon.

BULBULCHASM, India. Introduced under E. P. I. No. 9519. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; medium size; second quality; color green and yellow; tree hardy; stone medium; keeps well; ripens medium; free grower; ordinary—Hartless, Saharanpur.

CALCUTTA AMIN, India. Introduced under S. P. I. Nos. 9520 and 10644. Now under trial in Florida.

A long fruit, hooked and pointed. Has a very thin stone. Flavor good.—Gollan, Saharanpur.

Sparse bearer; large size; second quality; color reddish; stone small; tree hardy; ripens medium; keeps well; medium free grower; ordinary.—Hartless, Saharanpur.

CAMBODIANA, India. Introduced under S. P. I. No. 8701. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A very rapid grower, bearing medium to large fruit; early ripening, color yellow; shape long; rather more acid than most sorts if gathered before coloring, but when ripened on the tree is quite sweet. Very fine sort without any turpentine taste.—Reasoner, Florida.

Much like Totapari, but not so pointed. Free bearer.—Beach, Florida.

CARABAO, Philippine Islands. Introduced under S. P. I. Nos. 24927 and 25659. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A variety of merit. It comes true from seed and by that method has been reproduced in that country (Philippines) for generations.—MacIntyre.

CECIL, Florida. Form oblong reniform, rather slender; size large; cavity regular, small, shallow, slope gradual; stem medium slender; fleshy where it joins the fruit; tip an inconspicuous beak, usually about half an inch from the longitudinal apex of the fruit; surface nearly smooth; color rich greenish or golden yellow, marbled lightly with brownish yellow; dots numerous, russet, sometimes subcutaneous, green or gray; bloom whitish; skin medium thick, tenacious; flesh yellow, tender, juicy, with but very little fiber; seed thin, oblong, large; flavor sweet or mild subacid, rich, aromatic, pleasant; quality good to very good; season June to August at Miami, Florida.

Tree is said to be a very vigorous grower, symmetrical in form, and a heavy bearer. The fruit begins to ripen at Miami about the first week in June.—1910 Yearbook, U. S. Dept. of Agriculture.

Originated at Miami, Florida.

CHICKNA, India. Introduced under S. P. I. Nos. 9521 and 10660. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A medium sized fruit, light yellow, of good flavor.—Gollan, Saharanpur.

Prolific bearer; small size; quality only fair; color reddish green; stone small; tree hardy; ripens medium; keeps well; free grower; ordinary.—Hartless, Saharanpur.

CHINA of Guatemala. A very fine seedling race, common in the markets of Guatemala City, and considered the finest mango of that region. The form of the fruit is characteristic, being very thin and almost circular in outline, with a prominent blunt "nak" located some distance from the apex. The flesh is thick and remarkably free from fiber for a seedling, mild and aromatic, without suggesting turpentine.

This variety differs from others examined in having pronounced longitudinal ridges on the seed, which is thin and very broad. Like the Manila of Mexico, this form apparently comes true to seed. By some this form is called Mango de Brea. This name is, however, more appropriately applied to another form in which the fruit is more or less coated with a pitch-like exudation, *brea* meaning pitch.—Collins.

CHINA of Hawaii. Size very large, one of the largest mangos in Hawaii; form resembling the Strawberry mango, with a slightly depressed stem; color a shade of yellow on the unexposed side, and on the exposed side varying from orange to orange red; peeling qualities good; texture good; flesh abundant in proportion to the size of the seed, very bright in color like that of the Vanilla mango; flavor rather lacking in delicacy, though sweet. It would seem that this variety, the Vanilla, and the so-called Strawberry are all closely related. There is a similarity of flavor, form and odor of flesh. They differ in size and color of rind.—Higgins.

CHITTORO. Listed, but not described, by William Bros., Ceylon.

COBRIA, India. Weight six ounces; size two and three-quarters by two and three-quarters inches; skin smooth, yellowish green; pulp pale yellow, of fine flavor, no fiber; beak none; shoulders level.—Woodrow.

COLLECA, India. Weight ten ounces; size four and three-eighths by two and five-eighths inches; skin yellowish green; pulp shaded yellow, sweet, no fiber, a cooking fruit; beak very slight and broad; right shoulder slightly lower than the left one.—Woodrow.

COSTA, India. Weight eight and one-half ounces; size three and five-eighths by two and seven-eighths inches; skin yellowish green; pulp cream, of pleasant flavor; beak very slight; left shoulder very broad and slightly high.—Woodrow.

COWASJEE PATEL, India. Introduced under S. P. I. No. 7045. Synonymous with *Kavasji-Patel*, which see.

CRESCENT, Hawaii. Size medium to large; form crescent shaped, with a tendency toward greatest enlargement on the exposed side, even when ripe. In ripening, the exposed side takes on tinges of yellow, and when fully ripe becomes a shade of orange yellow. Peeling qualities poor; texture very good, quite free from fiber; flavor excellent, sweet, and spicy; flesh light yellow with a slight tinge of green, except at the center close to the seed, where it is quite bright, approaching yellow-orange; seed very thin and long, resembling the fruit in outline, greatly reduced within the husk and showing a tendency toward seedlessness. This is one of the most desirable of the sweet seedling mangos.—Higgins.

CRASSOUS, French West Indies. Oblong, clear green outside, very little fiber.—Jumelle.

CUILLER, Mauritius. Introduced under S. P. I. No. 27854.

CUSTODIO, India. Weight twenty-eight ounces; size six by four and one-eighth inches; skin yellowish green; pulp pale yellow, no fiber; season begins in July. Beak slight; left shoulder very high.—Woodrow.

DALBED, India. Weight ten and one-half ounces; size four and three-eighths by two and seven-eighths inches; skin yellow, shaded with green; pulp deep yellow, very sweet, but very fibrous; fruit stalk insertion high; left shoulder higher than right; beak medium.—Woodrow.

DAMARIA, India.

DAMPARA, Ceylon. Prolific; fruit small in size, of second quality, rather fibrous; skin yellow brown; seed small; ripens early and keeps fairly well. The tree is a free grower and is hardy. It is not much cultivated.—Dr. Drieberg.

DAVEY'S FAVOURITE, India. Introduced under S. P. I. Nos. 9522 and 10661. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry. A long thin fruit, yellow shaded red. A fine fruited variety.—Saharanpur.

Sparse bearer; medium size; second quality; color green; stone medium size; tree tender; ripens mid season; keeps well; free grower; somewhat sour.—Hartless, Saharanpur.

DAVIS No. 11, Hawaii. This is a seedling from the No. 11 mango, which has attained considerable fame in the West Indies and appears to come quite true to kind, as this variety is reported to do with a fair degree of accuracy. It was introduced by Mr. Henry Davis and has received his name to distinguish it from another and very inferior form which has been known locally as the "No. 11." Size medium; form short, rounded, much depressed at the stem end; color light green, turning to orange yellow in ripening; peeling qualities excellent; texture very good; flavor excellent; color of flesh very dark; seed small.—Higgins.

DEORUKHIA, India. Weight seven ounces; size four by two and one-half inches; skin clear orange; pulp deep yellow; very fine flavor; habit upright, vigorous; a first class mango; left shoulder slightly raised, right shoulder depressed; beak very slight.—Woodrow.

DILPASSAND, India. A very small leaved variety, described as of excellent flavor.—Woodrow.

DINIZ, India. Weight eleven ounces; size three and five-eighths by three inches; skin dark green; pulp yellow, very soft, creamy, sweet, without piquancy; shoulders level; beak very slight.—Woodrow.

DIVINE, French West Indies. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Elongated, slightly flattened, light brown pulp; no fiber. Strong turpentine flavor. A close relative of the Chinese mango.—Jumelle.

D'JOAO, India. Weight thirteen ounces; size four and one-half by three and one-half inches; left shoulder high and broad; beak none. A popular fruit.—Woodrow.

DOFASLI. Listed, but not described, by William Bros., Ceylon.

DOPHALA. Listed, but not described, by William Bros., Ceylon.

D'OR, French West Indies. Introduced under S. P. I. No. 28085. Fruited in Florida.

DOUGLAS BENNETT'S ALPHONSE, India. Introduced under S. P. I. Nos. 8419 and 8727. (Synonyms, *Bennett* and *Bennett's Alphonse*). Fruited in Florida.

In size it is three by four inches, and in color a golden yellow when ripe. The flesh is quite without stringiness, stone small, and flavor, according to Mr. Bennett, the best in the world. It is a large leaved variety and forms a good sized tree, but is of scraggly growth.—Fairchild.

Considered one of the best yet fruited in Florida. Medium sized, highly colored, very prolific.—Reasoner, Florida.

Fruit nearly round, with short, blunt, curved point at blossom end, obliquely impressed on one side. Pale greenish yellow in color, occasionally shaded with pink on

exposed side. Weight eight to twelve ounces. Skin firm and tough, flesh pale yellow, melting and juicy, slightly acid with pleasant aromatic flavor. Seed medium small and thin. Fiber very short and coarse, tree strong grower.—Cellon, Florida.

Its fruit is smaller than Mulgoba, running from eight to twelve ounces, while the former runs from twelve to sixteen. In flavor and aroma as well as other qualities it is equal to Mulgoba, differing enough to make some prefer one, some the other, according to individual taste. So far as it has been tested it appears to be more prolific than the former, and we presume as good a shipper, though it has not yet had the test of time to determine. This is the only one of the famous Alphonse type that has fruited with us yet.—Beach, Florida.

DULCE, India. Weight twelve ounces; size four and three-eighths by three and one-quarter inches; skin pale greenish yellow; sweet piquant, no fiber; shoulders level; beak slight. —Woodrow.

DUN OR TWICE BEARING. Listed, but not described, by William Bros., Ceylon.

DURMA, India. A round yellowish mango about eight ounces to one pound in weight. It has an exquisite vanilla flavor.—C. Maries, Woodrow.

ELEANOR, Florida. A rather handsome fruit which gives a name to a group. It has considerable of a reddish blush, over the yellow ground color.—Rolfs.

ENNUREA, India. (Sometimes spelled *Ennuria*). Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A very large fruiting variety.—Saharanpur.

Sparse bearer; large size; first quality; color yellow and green; seed long and thin; tree tender; ripens medium; does not keep well; slow grower; flesh firm and good flavored.—Hartless, Saharanpur.

Medium sized, oblong, highly colored, exquisitely flavored, mid season in ripening. Has a very little fiber.—Reasoner, Florida.

FAIZAN, India. Introduced under S. P. I. No. 9523. (Sometimes spelled *Fizan*). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A large long fruit, brownish green, flavor good.—Gollan, Saharanpur.

Sparse bearer; medium size; second quality; yellow and green; stone small; tree hardy; ripens medium, keeps well; free grower; very good flavor.—Hartless, Saharanpur.

FAJRI LONG and FAJRI ROUND. See *Fijri Long* and *Fijri Round*.

FAQIRWALA, India. Introduced under S. P. I. No. 9526. Fruit superior.—Saharanpur.

Sparse bearer; fruit large; first quality; color yellow; stone medium sized; tree hardy; ripens late; keeps well; free grower; very good.—Hartless, Saharanpur.

FERNANDEZ, India. Introduced under S. P. I. No. 7039. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight six ounces; size three and one-eighth by two and one-half inches; skin on exposed side bright red, with small yellow specks, gradually shading downward, and on sheltered side to yellowish green; pulp bright yellow, fiber very slightly wooly; flavor very fine, sweet and piquant; shoulders both low; beak scarcely perceptible. A very superior sort.—Woodrow.

Fernandez is a small fruit, with a bright red cheek, and small seed. It is the only one of the imported sorts so far that has a distinct sub-acid flavor. Some specimens are so absolutely free from fiber that by making an incision around the center of the fruit, the bottom half of the pulp with the skin can be slipped off from the seed, like a freestone peach. It has very distinctive foliage, and is further distinguished from all others by a whitish bloom which covers the new bark so long as it remains green, disappearing only when the latter turns brown with age.—Beach, Florida.

FERNANDINO, India. Weight nine and one-half ounces; size three and seven-eighths by two and seven-eighths inches; skin bright crimson on the upper half, shading to pale yellow at the lower end; pulp very pale yellow, sweet and of piquant flavor, but wooly; left shoulder level, right shoulder low; beak none.—Woodrow.

FERNANDINO II, India. Weight ten ounces; size four and three-eighths by three and three-eighths inches; skin green; pulp white, a cooking mango of special value; left shoulder level, right shoulder low; beak none.—Woodrow.

FIFINE-GABRIELLE, French West Indies. Listed, but not described, by Jumelle.

FIJRI LONG, India. Introduced under S. P. I. Nos. 9524 and 10646. (Sometimes spelled *Fajri Long*). Now under trial in Florida.

A large, longish fruit, ripens late. Dark green when ripe.—Gollan, Saharanpur.

Sparse bearer; large fruit; second quality; green in color; stone medium size; tree hardy; ripens late; keeps well; medium free grower; very fair.—Hartless, Saharanpur.

FIJRI ROUND, India. Introduced under S. P. I. Nos. 9525 and 10647. (Sometimes spelled *Fajri Round*). Now under trial in Florida.

Similar to Fijri Long, but roundish shape.—Saharanpur.

Sparse bearer; large size; second quality; green in color; stone medium size; tree hardy; ripens late; keeps well; medium free grower; very fair.—Hartless, Saharanpur.

FREDERICO, India. Weight eight ounces; size three and one-half by two and seven-eighths inches; no fiber. Gathered while green. A valuable preserving fruit. Left shoulder level; right shoulder slightly lower; beak slight.—Woodrow.

FRENCH, Hawaii. Sometimes locally known under this name, a term whose significance is uncertain. It might well be called the Wine, because of its exceedingly beautiful wine-colored rind, which takes a very high polish if gently rubbed with a soft cloth. Size medium to large; form oblong, rounded; texture fair; peeling qualities good; flavor rather too strong for the average taste.—Higgins.

FREYCINET, French West Indies. Rosy outside, reddish pulp, without fiber.—Jumelle.

FRIEL, Hawaii. Size small; form resembling on side view the Davis No. 11, but viewed from the back it shows a rather gradual narrowing toward the stigmatic end; stigmatic point depressed; forming a small hole where there is often an elevation; stem very slightly depressed; color on the exposed side orange yellow when fully ripe, the unexposed side lighter, mingled with green; peeling qualities fair; texture fair; flavor fair; color of flesh light. Both this and the Walnut would probably be considerably changed by cultivation. They are now much neglected.—Higgins.

FURTADO, India. Weight eleven and one-half ounces; size four by three and one-eighth inches; skin smooth, green, becoming rich yellow green; pulp deep orange, puffy, rather coarse; left shoulder high and broad, right shoulder level; beak none.—Woodrow.

FURTADO II, India. Weight eight ounces; size three and one-third by three inches; skin yellow and green in blotches; pulp dark yellow; flavor rather high; left shoulder slightly high; right shoulder slightly low; beak very distinct, one-quarter inch.—Woodrow.

FUSLI BEWA, India. (Syn. *Fuzli*, of William Bros., Ceylon). Is said by Maries to bring 1 rupee each. August is its season.—Woodrow.

GADA MAR, India. Introduced under S. P. I. No. 7107.

GADGYA, India. Weight eighteen ounces; size four and one-half by three and seven-eighths inches; skin greenish yellow, pulp pale yellow, of piquant flavor, slightly fibrous; shoulders nearly level; beak slight but distinct.—Woodrow.

GANCHIR. Most renowned.—William Bros., Ceylon.

GENERAL GORDON. See *Gordon*.

GOA, India. (Syn. with *Goa Alphonse*). Now under trial in Florida.

Weight seven ounces; size three and one-eighth by two and seven-eighths inches; skin pale yellow; pulp very soft, sweet; left shoulder high, right shoulder low; beak none.—Woodrow.

GOLA, India. Introduced under S. P. I. Nos. 9527 and 10662. Now under trial in Florida.

A variety with small round yellow fruit. Flavor superior.—Saharanpur.

Sparse bearer; medium size; second quality; color green and yellow; stone medium size; tree hardy; ripens late; keeps well; free grower; juicy, of good flavor.—Hartless, Saharanpur.

GOLAPKHASH. Listed, but not described, by William Bros., Ceylon.

GOLLAN, India. Our own importation from Saharanpur, named in honor of the late Superintendent of Government Gardens there. Fruit large, oblong, weighing from twelve to twenty-four ounces each; pale yellow in color. Small quantity of fiber; flavor excellent.—Reasoner, Florida.

GOPALBHOG, India. Introduced under S. P. I. No. 9509. (Synonyms, *Gopal Bhog, Gopalbogh, Gopal Bhoga* and *Gopalbhogy*). Fruited in Florida

A superior variety coming into market at the end of June. Weight six ounces.—Woodrow.

Prolific bearer; medium size; first quality; color green and yellow; stone medium size; tree hardy; ripens medium; keeps well; free grower; pleasant aroma.—Hartless, Saharanpur.

GOPAL DHOBA. Listed, but not described, by William Bros., Ceylon.

GORADYA, India. Weight twelve ounces; size four and one-eighth by three and seven-eighths inches; skin very rough, with large obtuse projections; pulp sweet but wooly; left shoulder high, right shoulder low; beak indistinguishable.—Woodrow.

GORDON, West Indies. (Syn. *General Gordon*). Fruited in Florida.

This is probably the smallest fruit in our collection, averaging around six ounces. Short, kidney shaped, flavor delicious, high color, quite prolific.—Reasoner, Florida.

This variety is rather dwarf in habits, which renders it suitable for cultivation where space is limited or protection is necessary. Introduced by the U. S. Dept. of Agriculture from Trinidad, West Indies. Fruit long, yellow, shaded on exposed side with carmine; pulp fine, rich and melting, with pleasant aroma, and scanty fiber, confined mostly to the thin edges of the seed. The trees come into bearing while very young.—Cellon, Florida.

GREEN GAGE. Synonymous with *Black,* which see.

GREEN FLESH, Hawaii. Size small, form resembling the common Hawaiian Sweet; color a bright green with traces of yellow and brown on the exposed surface; peeling qualities good; texture poor; flavor sour and unpleasant; seed long, thin.—Higgins.

HADEN, Florida. Originated from a seedling planted by the late Captain J. A. Haden at Coconut Grove, Florida, whose name it bears, and is apparently of the East Indian type.

Size medium to large; shape oblong, nearly round, only slightly impressed on one side at blossom end, which is nearly the same size in circumference as the stem end, making it of convenient shape for packing; color rich golden yellow, washed over the greater portion of the surface with rich crimson and scarlet; skin smooth, tough and of firm substance, medium thin; flesh golden yellow color; flavor rich, aromatic and spicy; seed medium small, fiber short and coarse, extending only from the thin edge of the seed; quality best; season July. The fruit can be easily separated in halves and the seed extracted without leaving any fiber in the pulp, which can be eaten from the fruit with a spoon.—Cellon, Florida.

HAFU. Synonymous with *Alphonse,* which see..

HASTINGS. Listed, but not described, by William Bros., Ceylon.

HATHIJHUL, India. Introduced under S. P. I. No. 9258. (Sometimes spelled *Hathi Jhul*, S. P. I. No. 10648). Now under trial in Florida.

A variety with a very superior flavored fruit, one of the best. A very large fruit. —Saharanpur.

Moderate bearer; fruit large; second quality; green and yellow; stone small; tree hardy; ripens late; keeps well; free grower; the largest fruiting kind, and of good quality.—Hartless, Saharanpur.

HAWAIIAN SWEET, Hawaii. (So called). This was the first variety to be introduced in the islands, having come probably from Mexico. It is now found everywhere in Hawaii where mangos are grown. Size medium; stem depressed; color light green with slight brownish tints before ripening, the green changing to yellow and the brown to pink as ripening proceeds; flavor good when well grown; juices abundant; texture fibrous; seed large; tree a free bearer.—Higgins.

HEART, Ceylon. This is also called the *Bombay* and is the commonest variety found on the market. Prolific; fruit medium in size, not much longer than broad, of second quality; skin golden yellow; seed of medium size; ripens early and is a fair keeper. The tree is a free grower and is hardy.—Dr. Drieberg.

HERBERT No. 9, Hawaii. The seed from which this variety was grown was introduced at the same time as the No. 9, and was supposedly identical, being planted under the same number. The fruit, however, is very distinct, but bears a close resemblance to No. 9. The writer has designated it in honor of Mr. Allan Herbert, who planted the tree. Size rather smaller than No. 9; form resembling that variety, but with the peculiar "S" shape, still more marked; color dark yellow when ripe, with a very beautiful bright red on exposed side, thus making it very distinct and one of the most attractive mangos. In other respects it is similar to No. 9, but is apparently more subject to blight.—Higgins.

HIMSAGAR. Listed, but not described, by William Bros., Ceylon.

HONEY, Ceylon. A small roundish fruit, of sweet flavor.—Macmillan.

INERMA, India. A Durbhanga variety of great size. Reported four pounds in weight.—Woodrow.

ITAMARACA, Brazil. Introduced under S. P. I. No. 23426. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A small yellow mango with a thin skin, without fiber, and with a very delicate flavor, bringing a high price in the market. Occurs in Pernambuco. (Bello)—Bureau of Plant Industry.

JAFFNA, Ceylon. Introduced under S. P. I. Nos. 8411 and 8680.

Large oval fruit of excellent quality when well grown; probably equal to *"Alphonso"* of India.—Macmillan.

A long fruited, medium sized mango, green in color. The seed is fairly large, flesh golden yellow. It is edible before fully ripe. A vigorous grower and a good bearer. This is the best market mango in Ceylon, and is the one generally planted about the villages.—Fairchild.

The favorite variety here. Prolific; fruit medium in size, twice as long as broad, of first quality; skin green; seed of medium size; ripens early and is a fair keeper. The tree is a fairly free grower and is hardy.—Dr. Drieberg, Ceylon.

JALIBANDHA. Synonymous with *Maldo*, which see.

JAMSHEDI, India. Introduced under S. P. I. No. 8734. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Skin thick, tough, shrivelled, blotched yellow and green, intruded at apex (almost like an apple). Tip rounded; beak short and strong; pulp yellow with a brownish tinge, free from fiber; flavor strong, excellent, distinct. (R. K. Bhide)—Woodrow.

JAPAN. Listed, but not described, by William Bros., Ceylon.

JAVA. Listed, but not described, by William Bros., Ceylon.

JAVA of Hawaii. Synonymous with *Kauai Chutney*, which see.

JEEPRIA, India. Weight twelve ounces; size four and three-eighths by three and one-eighth inches; skin green when brought to market, pulp pure white, a good cooking sort; both shoulders low; beak none.—Woodrow.

JOBOS, Porto Rico. A common form in the San Juan market in the early part of the season. A very poor kind, considered to be the wild or unimproved form. It is green in color, with a large seed, and very stringy meat, frequently ripening unevenly and having a strong turpentine flavor. In form it is slightly asymmetrical, stem not depressed.—Collins.

JOHNSON. Listed, but not described, by William Bros., Ceylon.

JOSE, Mauritius. Introduced under S. P. I. No. 27855.

JOSEPHINE, French West Indies. Listed, but not described, by Jumelle.

JULIE, French West Indies. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry. Listed, but not described, by Jumelle.

KABUTRIA, India. Weight seven ounces; size four and three-eighths by two and one-half inches; skin greenish yellow, red on shoulder; pulp deep yellow, without fiber, of rich piquant flavor; shoulders nearly level; beak small but distinct.—Woodrow.

KACHAMITHA, India. The fruit of this variety is sweet and eatable when in a green, unripe state.—Saharanpur.

Prolific bearer; fruit small; first quality; red and green in color; stone medium size; tree hardy; ripens early; keeps well; free grower; very sweet even when unripe.—Hartless, Saharanpur.

KACHMAHUA, India. Introduced under S. P. I. Nos. 9527 and 10649. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

KAELIA, India. Weight fourteen ounces; size three and seven-eighths by three and one-eighth inches; skin greenish yellow; pulp deep yellow; flavor luscious; fibres few; left shoulder high, right shoulder low; beak very slight.—Woodrow.

KAGDI-ALPHONSE, India. Weight ten ounces; size three and seven-eighths by three and one-eighth inches; skin greenish yellow, suffused with crimson; pulp deep yellow, fine, creamy; left shoulder from the stalk falling slightly, then rising; right shoulder gently falling; beak none. A thick-skinned Alphonse mango.—Woodrow.

KAKARIA, India. Introduced under S. P. I. Nos. 9530 and 10650.

A large fruited, dark green mango. Good flavor.—Saharanpur.

Prolific bearer; fruit small; second quality; color yellow and red; stone medium; tree hardy; ripens mid season; keeps well; free grower; good flavor.—Hartless, Saharanpur.

KALA, India. Introduced under S. P. I. Nos. 9531 and 10666.

A longish shaped fruit. Free of stringiness. Pale green, good.—Saharanpur.

Sparse bearer; medium size; second quality; color dark green; stone medium; tree hardy; ripens mid season; keeps well; free grower; juicy and nicely flavored.—Hartless, Saharanpur.

KALA ALPHONSE, India. Introduced under S. P. I. No. 7041. (Syn. *Kala-Alfoos*).

Weight fourteen ounces; size four and five-eighths by three and three-eighths inches; skin dark green with red on shoulder; pulp fine, dark yellow, creamy; flavor luscious; no fiber; left shoulder level, right shoulder low; beak very slight, obtuse.—Woodrow.

KALIA, India. Weight nine ounces; size four by three and one-fourth inches; skin dark green, slightly yellow on shoulder; pulp pale yellow, very sweet; left shoulder high, right shoulder low; beak distinct, small.—Woodrow.

KANCHAMITHA (PANCHANANDA). Listed, but not described, by William Bros., Ceylon.

KAPAT BHANGA. Listed, but not described, by William Bros., Ceylon.

KAUAI CHUTNEY, Hawaii. Also known as the Java, etc. It is improperly called a chutneym as it lacks the characteristics of that group. (See explanatory note under *Lemon Chutney*). Size large; form thick at the shoulders and almost round, while it tapers rapidly to a point at the stigmatic end; color varying from lemon yellow to saffron where exposed and when thoroughly ripe more or less dotted with red spots which have a gray center where the epidermis is ruptured; peeling qualities fair; flesh rather brighter yellow than is found in the No. 9; texture exceedingly good for a seedling, there being no fiber except close to the seed; flavor very good; a distinguishing characteristic of this form is the large size of the leaves.—Higgins.

KAVASJI PATEL, India. (Sometimes spelled *Cowasjee Patel*).

Weight twenty-one ounces; size five and one-fourth by three and three-fourths inches. Gathered green, with white pulp, for cooking. A fine large cooking sort. Both shoulders falling; beak prominent.—Woodrow.

KHAJYA, India. Sparse bearer; medium size; first quality; color yellow and red; stone small; tree tender; ripens late; keeps well; medium free grower; fair in flavor.—Hartless, Saharanpur.

KHAPARIAH, India. Introduced under S. P. I. Nos. 9510 and 10641. (Also spelled *Khaparia* and *Kahpariah*).

Medium size; medium sparse bearer; third quality; color green and yellow; stone small; tree hardy; ripens medium; keeps well; free grower; fair in flavor.—Hartless, Saharanpur.

KHATKIA, India. A longish, hooked, pointed fruit. Color yellow, shaded red.—Saharanpur.

Weight seven ounces; size four and one-half by two and five-eighths inches; skin doubtful; pulp sweet and piquant, but stringy; both shoulders low; beak depressed. A popular mango, to be sucked.—Woodrow.

KHETUBASEK. Listed, but not described, by William Bros., Ceylon.

KHEERSHAPOTTEE, India. Probably synonymous with *Khirsapati*.

KHIJURA GOORKA. Very sweet.—William Bros., Ceylon.

KHIRPOOLI. Listed, but not described, by William Bros., Ceylon.

KHIRSAPATI, India. Now under trial in Florida. Listed, but not described, by William Bros., Ceylon.

KHOONT, India. Weight eight ounces; size three and three-fourths by three and one-eighth inches; skin dull red and yellow, blotchy; pulp very fine, creamy, dark yellow, but puffy. A very fine fruit, but with an unattractive color.—Woodrow.

KHRISHNAKALI. Listed, but not described, by William Bros., Ceylon.

KISSEN BHOGA (or KISSENBHOG.) Now under trial in Florida. Listed, but not described, by William Bros., Ceylon.

KISTAPAL, India. Introduced under S. P. I. Nos. 9536 and 10656. (Sometimes spelled *Kistaphal*.) Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A large fruit. Flesh highly colored and of good flavor.—Saharanpur.

Sparse bearer; medium size; second quality; color yellow and red; stone small; tree tender; ripens late; keeps well; medium free grower; good.—Hartless, Saharanpur.

KRISHNA BHOG, India. Introduced under S. P. I. 9532. (Sometimes spelled *Khrishna Bhog*).

Sparse bearer; large size; second quality; color yellow and green; stone medium size; tree tender; ripens late; keeps well; slow grower; good.—Hartless, Saharanpur.

KUMRAJALI. Listed, but not described, by William Bros., Ceylon.

KUMUKHT, India. Described by Maries, has a rough skin, a large beak, eight ounces in weight, and has a fine flavor.—Woodrow.

KUTNA, India. A favorite variety.—Saharanpur.

Sparse bearer; medium size; second quality; color yellow; stone medium size; tree hardy; ripens late; keeps well; slow grower; fair.—Hartless, Saharanpur.

LAMBA BHADRA, India. Introduced under S. P. I. No. 9537. Fruited in Florida.

Sparse bearer; fruit large; first quality; color green and yellow; stone large; tree hardy; ripens mid season; keeps well; free grower; nicely flavored.—Hartless, Saharanpur.

Fruited in Florida for first time in 1911, and said by Reasoner to be so inferior as to be worthless.

LANGRA, India. Introduced under S. P. I. No. 9511. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight six and one-half ounces; size three and five-eighths by two and five-eighths inches; skin very thin, green, with a yellowish tinge when ripe; pulp creamy, and of delicious flavor; no fiber and small stone; both shoulders falling; beak very small. This is *Maldah,* described in Botanical Magazine, t. 4510.—Woodrow.

Prolific bearer; medium sized fruit; first quality; color green; stone small; tree medium hardy; ripens mid season; does not keep well; free grower; fine flavored.—Hartless, Saharanpur.

LANGRA BENARSI, India. One of our introductions from India which bore in 1910 for the first time. Promises to be very prolific and is a strong grower. The fruit is the largest we have ever seen, weighing up to three pounds one ounce each. Very little fiber, flavor rich and spicy. Fruit is yellow or greenish when ripe.—Reasoner, Florida.

LANGRA HARDOI, India. Introduced under S. P. I. Nos. 9538 and 10651. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A thin seeded variety of good flavor, ripens late. Medium sized fruit, pale yellow, flesh very rich.—Saharanpur.

Prolific bearer; medium size; second quality; green in color; stone medium size; tree hardy; ripens medium; keeps well; free grower; similar to Langra, but more stringy.—Hartless, Saharanpur.

LANGRA LARGE, India. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Sparse bearer; medium size; second quality; green in color; stone medium size; tree hardy; ripens medium; keeps well; free grower; similar to Langra, but more stringy.—Hartless, Saharanpur.

LARGO, Porto Rico. A form common on the south side of the island and at Mayaguez. Long, nearly straight, stem not depressed, green in color. The flesh is very firm, moderately thick, and with very few fibers. At Yauco slightly shorter specimens were called *"Mangotina,"* a name used very loosely in all markets, this form selling for ten for one cent. The flavor is fine, though the taste of turpentine is pronounced, and to those who do not object to this feature it will appeal as one of the best of the Porto Rican forms.—Collins.

LATANIA. A creeping variety.—William Bros., Ceylon.

LATE MULCARRI, India. Fruited in Florida. Fruit small to medium, yellow, highly flavored, usually late to ripen, contains but little fiber. Prolific.—Reasoner, Florida.

LATHROP. Introduced by the Division of Seed and Plant Introduction, U. S. Dept. of Agriculture, and fruited in Florida for the first time in 1911. Said by Reasoner to be so inferior as to be worthless.

LEMON CHUTNEY, Hawaii. Size large for this class; color, a light lemon yellow, dotted with lighter yellow after the manner of the chutneys; peeling qualities good; texture good; flavor good; seed medium size.—Higgins.

Explanatory Note: The term chutney should be used as the name of a class rather than of a variety, and does not signify a mango used chiefly for the manufacture of chutney, as might be supposed. The flavor of the members of this class is characteristic, and though not so sweet as most of the other varieties, it is nevertheless very agreeable and more esteemed by many than any of the sweeter kinds. There is a delightful acidity and spicy character, with a pleasant aroma and usually a characteristic odor in all parts of the plant. The difference between the forms is sometimes very slight, but in other cases it is well marked. They are sometimes separated into so-called acid chutneys and sweet chutneys, but it is quite probable that most of the forms classed as sweet chutneys are really the result of crosses between acid chutneys and some of the sweet mangos.—Higgins.

LERRUA, India. A variety described by Maries, chiefly valued for its fine coloring, orange and red and green in stripes and blotches.—Woodrow.

LONG MANILA, Hawaii. Size medium to large; form long, narrow; color light yellow; texture good; flavor very good; seed thin, flat. It appears to be the same as that known in Porto Rico under the name Manila.

It will be observed that the term Manila is applied to several varieties grown in these islands, and means very little except that the original of the variety is supposed to have come from Manila.—Higgins.

LYON, Philippines. Introduced under S. P. I. Nos. 27835 to 27838.

Grown from S. P. I. No. 25940, which was introduced under the class name of Pahutan.—Bureau of Plant Industry. See *Pahutan*.

MADRAS, India. Now under trial in Florida. Prolific bearer; small size; second quality; color greenish red; stone medium; not very hardy in the United Provinces; ripens medium; keeps well; free grower; fairly good.—Hartless, Saharanpur.

MALDA, India. (Syn. *Jalibandha*). Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Prolific bearer; large size; third quality; yellowish green in color; stone medium; very hardy; early ripening; does not keep well; medium free grower; very large; insipid in taste.—Hartless, Saharanpur.

Synonymous with *Langra* (which see).—Woodrow.

MAHARAJAH. Introduced under S. P. I. No. 27848. Now under trial in Florida.

Fruit roundish oblique, flattened, four and one-eighth by three and three-sixteenths by two and seven-eighths; cavity shallow, with a distinct suture extending two inches from stem; beak medium, about one inch from end of fruit; surface moderately smooth, some fine undulations; color, greenish yellow, shading to rich yellow; dots very numerous, yellow; skin thick, tenacious; flesh rich yellow, tender, but very fibrous; flavor sweet, pleasant quality, if fiber was not so abundant would be good; seed flat, oval, covered with a dense coat of fiber; medium size, three by one and eleven-sixteenths by seven-eighths inch.—W. A. Taylor.

MAISON ROUGE, Mauritius. Introduced under S. P. I. No. 27928.

MALCOA. Listed, but not described, by William Bros., Ceylon.

MALIABAD. Listed, but not described, by William Bros., Ceylon.

MALLER, India. Introduced under S. P. I. No. 23747. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

MANECKJEE RUSTOMJEE. Listed, but not described, by William Bros., Ceylon.

MANGALORE, India. Introduced under S. P. I. No. 27849. Now under trial in Florida.

Fruit oblong, flattened, four and one-sixteenth by three and five-eighths by two and five-eighths inches; cavity shallow, small furrows without suture; stem very slender, with bracts; beak small, one-sixteenth inch above general surface, seven-eighths inch from end center; surface moderately smooth; color yellow, with marblings of

green; dots numerous, yellow; skin thick, tenacious; flesh deep yellow, tender except for fiber, juicy; flavor mild subacid; quality good; seed flat, oval, three and one-half by two and one-eighth by seven-eighths inch.—W. A. Taylor.

MANGO, Porto Rico. A large, rather straight form, with a very square base, somewhat resembling Largo, but slightly more symmetrical and thicker. Large quantities were seen in the San Juan market on June 22, a month later none were to be found. The flesh was fairly thick and of good quality.

This name may possibly be a contraction of *mangon*, which would not be at all inapplicable, as this is one of the largest Porto Rican forms. Stahl gives *mango* as the common name of *Mangifera indica* in Porto Rico.—Collins.

MANGOSTEEN, Hawaii. Improperly so-called. Size small; form rounded, unlike most mangos; color green with a dull red on the exposed side before ripening, but turning to a very beautiful bright red, thus making it one of the most ornamental of the mangos; flavor poor; seed very large. It is very subject to mango blight.—Higgins.

MANGOTINA, Porto Rico. A very small yellow form, with one side red. Similar to Mayaguez, seen at San Juan, but longer, with rounder base and stigmatic point nearer the apex.—Collins.

MANILA of Mexico. A Mexican race, almost entirely free from fiber, and of mild, pleasant flavor. The skin is uniformly light yellow and thin; the flesh is also light colored and firm. The seed is very thin and small in proportion to the amount of flesh.

This is really a high grade mango, not unlike the *Mulgoba* in flavor. Its shipping qualities have not been tested, but perfectly ripe fruits purchased in Mexican markets kept in good condition for several days. This mango was very popular in the City of Mexico about the end of June. It was sold in all the markets and hawked on the streets, the price usually being four cents apiece Mexican. The uniformity of the fruit as it appeared in different markets, taken with the absence of asexual methods of propagation in Mexico, would argue that it is a form that comes true from seed.

The name of this race suggests that it came from the Philippine Islands, and indeed it is not impossible that it was brought to Mexico from those islands by one of the Spanish galleons that during the seventeenth century plied regularly between the Philippines and Mexico.

A form resembling this in Guam is there commonly supposed to have come from the Philippines, but as ships only touched at Guam on the return voyage from Mexico, the fruit must have reached Guam by way of America, and would naturally have become established in both countries. Possibly a further confirmation is to be found in the occurrence of the same or a very similar form in Cuba, known as the Philippine mango.—Collins.

MANILA of Hawaii. This is sometimes spoken of as the Double-Pointed Manila. Size very large; form roundish with stigmatic point giving rise to descriptive name; color light green tinged with yellow, approaching orange yellow when fully ripe; peeling qualities good; texture very good, with no fibers except close to the seed; flavor good, sweet, juicy; color of flesh yellow orange; seed thin.—Higgins.

MARTIN, French West Indies. Beautiful yellow, sometimes almost rose colored, slight turpentine flavor.—Jumelle.

MAYAGUEZ, Porto Rico. A small yellow form, with comparatively large seed, but with good flavor, soft flesh, and few fibers. This form, for sale in the San Juan markets, is considered one of the finest. It has very little of the turpentine taste, but its flavor did not appear to be better than that of several others, while its small size and thin flesh make it seem on the whole inferior. In shape it is asymmetrical, with depressed stem. The color in the early part of the season is a uniform yellow, later many specimens were seen with one side red.—Collins.

MAZAGON, India. Introduced under S. P. I. No. 7042. Now under trial in Florida.

MEKONGENSIS. Now under trial in Florida.

MELOCOTON, Porto Rico. A small yellow and red form seen at Yauco, said to have come from a grafted stock brought from Martinique. Base very square, stem slightly depressed, skin thin, meat with few fibers, mild in flavor.—Collins.

MOANALUA LONG RED, Hawaii. This is in all probability a cross between some form of chutney and the sweet mango. The seeds which produced this tree and several others of the more normal type of chutney in the same locality are said to have come from a single parent tree on the island of Maui. The variety is so named because the tree producing this rather peculiar form is located at the Moanalua gardens. Size large; form long and pointed; color before ripening green on the unexposed surface, with a dull red on the exposed side, which brightens to a red orange in ripening, a rather unusual color for a chutney; peeling qualities fair; texture fair; flavor lacking somewhat in the character of the chutneys; color of flesh rather dark; seed medium.—Higgins.

See explanatory note under *Lemon Chutney*.

MOHANBHOGA. Listed, but not described, by William Bros., Ceylon.

MOHAN THACOOR. Listed, but not described, by William Bros., Ceylon.

MORADABADI AMIN, India. Introduced under S. P. I. No. 9541.

Flavor superior.—Saharanpur.

MORIA, India. Weight eight ounces; size three and five-eighths by three and one-eighth inches; skin yellowish green, reddish on shoulder; pulp very sweet, slightly fibrous; left shoulder broad, gently rising, right shoulder falling; beak small, sharp. A good keeping sort.—Woodrow.

MULGOBA, India. Introduced in 1889 by Division of Pomology, U. S. Dept. of Agriculture. First fruited in Florida in 1898, being the first of the Indian varieties to fruit in this country. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Weight twenty ounces; size five by four and seven-eighths inches; skin yellow and green, blotched; pulp pale yellow, no fiber, flavor piquant and sweet; stalk scar very prominent; left shoulder level, right shoulder falling; beak large, sharp. Plants of this variety were sent to Florida in 1889 by the writer and have given much satisfaction.—Woodrow.

Form roundish, oblique, reniform; size large, weighing from three-fourths pound to one pound; surface smooth and undulating; color yellow, beautifully blushed with red and faintly dotted with numerous brown dots; skin thin, tough, tenacious; seed reniform, oval, rather large; fiber scanty, fine, and tender; flesh rich apricot yellow, very tender, melting and juicy, sweet, rich, fragrant; quality very good.

The *Mulgoba* surpasses in flavor and quality the seedlings previously grown, but its most distinctly marked features of superiority are the tenderness of the flesh and absence of objectionable fiber and strong turpentine flavor common to most of the seedlings grown in this country. The tree is a strong symmetrical grower, and appears to be abundantly productive.—1901 Yearbook U. S. Dept. of Agriculture.

MULLGOA, India. Introduced under S. P. I. No. 7102. Fruited in Florida.

Fruit large (twelve to sixteen ounces), almost round, fiberless, and of good flavor. —Reasoner, Florida.

MUSSARATA, India. Weight fifteen ounces; size four and one-fourth by three and three-eighths inches; skin, exposed side yellow, shaded side green; pulp cream colored, fine rich flavor; left shoulder high, right shoulder rising slightly; beak none.—Woodrow.

NAJIBABADI AMIN, India. Introduced under S. P. I. No. 9542. Now under trial in Florida.

Flavor superior.—Saharanpur.

Sparse bearer; small fruit; second quality; color yellowish red; stone medium; tree hardy; ripens mid season; keeps well; free grower; fairly good.—Hartless, Saharanpur.

NAJI HAHADI AMIN, India. Introduced under S. P. I. No. 10668. (Same as *Najibabadi Amin.*)

A medium sized, dark green fruit, ripens late—Saharanpur.

NARALYA, India. Weight ten and one-half ounces; size four by three and one-fourth inches; pulp pale yellow, slightly fibrous; flavor piquant; left shoulder very high and broad, right shoulder broad, falling; beak very small.—Woodrow.

NARAYAN ROPRA, India. Weight ten ounces; size three and three-fourths by three and five-eighths inches; skin green with yellow shading near the stalk; pulp deep yellow, of fine flavor, but fibrous; shoulders both falling, or level; beak small.—Woodrow.

NASPATI, India. A variety with a pear shaped fruit. Not a good bearer.—Saharanpur.

Sparse bearer; medium size; first quality; pale yellow in color; stone small; tree hardy; ripens late; keeps well; slow grower; good flavored.—Hartless, Saharanpur.

NAYAB, India. Sparse bearer; small size; second quality; brown in color; stone medium; tree hardy; ripens medium; keeps well; slow grower; good kind.—Hartless, Saharanpur.

NAWAB BHOGA. Listed, but not described, by William Bros., Ceylon.

NAWSHARWANI, India. Weight about sixteen ounces; size four and seven-eighths by four and one-eighth inches; both shoulders high; beak sharp.—Woodrow.

NECTARINE, Hawaii. Locally known under this name. Size small; form short, rounded, rather heaviest on the dorsal side and about equal in length and breadth; color dark, dull green, acquiring slight yellow tinge in ripening; flavor peculiar, attractive, having a slight biting taste, supposed by some to resemble the nectarine. The flesh is characteristic, being the most highly colored the writer has seen in any variety of mango.—Higgins.

NOWSHARI, India. Weight about twenty ounces; size four and seven-eighths by four and one-eighth inches; skin shaded yellow on shoulders, darker downward. A fine large mango, of which definite information is wanting.—Woodrow.

NUCKA, India. Introduced under S. P. I. Nos. 9544 and 10659. Now under trial in Florida.

A long, hooked, pointed fruit, slightly fibrous, but flavor good.—Saharanpur.

Sparse bearer; fruit small; second quality; color brown; medium size stone; tree hardy; keeps well; slow grower; good.—Hartless, Saharanpur.

No. 5, Hawaii. Locally known under this name. This was among the introductions of Mr. Marsden. It very closely resembles the common Hawaiian Sweet mango, but is rather broader at stigmatic end. Color, flavor, peeling qualities and texture are also much like those of the latter.—Higgins.

No. 7, Hawaii. Locally known under this name. This variety was introduced, together with No. 9 and others, by Mr. Marsden. Size rather small, form exceedingly variable, great differences being noticeable on the same tree; color a dull, somewhat dingy shade of yellow orange, overlaid with a beautiful orange red on the exposed side; peeling qualities poor; texture inclined to be fibrous; flavor peculiar and not very pleasing; flesh dark; seed of medium size.—Higgins.

No. 9, Hawaii. This variety, now quite common in Hawaii, was introduced about twenty years ago under this name by Mr. Joseph Marsden, who at the same time added several other forms to the local collection. Form resembling the letter S, stem prominent; size from three and one-half to four and one-half inches long, and two and three-eighths to two and seven-eighths inches broad, and from two to two and one-half inches thick; color before fruit is mature, green, turning to pale yellow when ripe, with a slight blush of pink on the upper end of exposed side; peeling qualities very good; texture variable but most specimens rather fibrous; flavor sweet but watery; flesh light yellow; seed small; tree an abundant bearer. The fruit appears to be quite resistant to the attacks of the mango blight.—Higgins.

No. 11, Mauritius. This variety, the original stock of which was among the first mangos introduced into Jamaica by Captain Marshall, in 1782, is still the most popular variety in the island. It is a fine fruit, though somewhat stringy, and is said to come true to seed. Mr. Hart identifies this variety with the *Reine Amelie* of Martinique. As Martinique received a large part of its early introduced plants from Mauritius, the source of this variety in Jamaica, this identification doubtless means identity of origin, and the fact that these distinct strains are still identifiable would argue great constancy for this variety. Budded stock of this variety is also grown in Florida.—Collins.

A variety from Jamaica, but originally from the East. A spicy-flavored sort, with almost unobjectionable fiber (very fine), and of good, large size. The shape is slightly oblong; round, not flat, and in color usually a yellow or green, but we have one tree, out of nearly three dozen bearing specimens, which has a highly colored red cheek, rendering it a valuable market sort. (See *Red No. 11*).—Reasoner, Florida.

OGEE, India. Weight thirty-one ounces; size seven and one-eighth by four and one-eighth inches; skin golden; pulp sweet, free from turpentine, but not luscious; stone comparatively small, left shoulder falling gently, right shoulder falling abruptly; beak small but distinct.—Woodrow.

PAHERI, India. Introduced under S. P. I. No. 8730. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Iudustry.

Fruited in Florida in 1910 for the first time. One of the finest sorts grown in India. General form is roundish, about three and five-eighths by three and three-eighths inches. Skin thick, yellow and green when ripe, touched with garnet red on sunny side, very attractive. Flesh yellow, tender and juicy, very aromatic. Of high quality. —Reasoner, Florida.

From India. Size medium; color yellow, blushed with red and pink on side exposed to light; shape nearly round, slightly flattened and obliquely impressed on one side, with a point protusion at blossom point; skin medium thin, of firm substance; flesh rich golden yellow color, fine grain, tender; flavor rich and melting, highly aromatic and spicy. The fruits can be easily separated in halves without leaving any fiber in the pulp, which can be eaten from the fruit with a spoon.—Cellon, Florida.

PAHUTAN, Philippines. Introduced under S. P. I. No. 25940. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

From my viewpoint this is the best, *not* horticulturally, other than being a vigorous grower, early fruiter, and enormously prolific. Its very serious defects,—small size, scanty flesh, and excessively large seed,—are from my point of view fully offset by a smoothness, sweetness, juicyness, and flavor unapproached by any other. I have eaten the famous Alphonso mango in Calcutta and do not consider it ace high with Pahutan. Pahutan further has a very thick rind. This, while still further diminishing its scanty flesh, probably adds to its shipping qualities.—Lyon.

PAIRI, India. Probably a synonym for *Pyrie*, which see.

PAKRIA, India. Introduced under S. P. I. No. 8444.

Weight seven ounces; size four by two and five-eighths inches; skin pale yellow; pulp pale yellow, of delicious flavor without fiber; both shoulders falling; beak none. The leaves are of medium size, pale green, and acute at the base.—Woodrow.

PANCH SERA, India. Very large fruit.—William Bros., Ceylon.

PANDRIA, India. Weight nine ounces; size three and one-fourth by three and one-eighth inches; skin greenish yellow; pulp sweet but wooly; both shoulders falling; beak none.—Woodrow.

PARNASSE, French West Indies. Oval, flattened; light green skin; fiberless, delicious.—Jumelle.

PARROT, Ceylon. Medium sized, oblong fruit; with a distinct beak. Piquant and pleasant flavor.—Macmillan.

Fairly prolific; fruit medium to small, of second quality; skin dark green; seed of medium size; ripens late and is a fair keeper. The tree is a free grower and is hardy. This variety has a slight turpentine flavor and is not very common.—Dr. Drieberg, Ceylon.

PEACH, Hawaii. This variety has some local reputation under this name. The original tree of the variety, at least in these islands, is in the Henry Davis homestead in Honolulu. Size medium; form resembling the Samoan; color before ripening bright green overlaid with dull red on exposed side, the red brightening and the green becoming yellow during the ripening process; peeling qualities fair; texture good, quite free from fiber except near the seed; flavor very good, abounding in sweet juice; color of flesh almost as light as that of No. 9; seed long and of medium thickness.—Higgins.

PERE LOUIS, French West Indies. Introduced under S. P. I. No. 3707. Fruited in Florida.

It is not large, weighing but seven or eight ounces, but it has a very distinct and delicate flavor, is almost absolutely free from fiber, and the meat is soft and custardy and can be eaten with a teaspoon. In this Mr. Gale has a prize, as it is one of the most delicate, highly flavored and aromatic of the family of mangos, and is a valuable addition to the varieties being grown in Florida.—The Homeseeker.

PERRINE, Florida. The fruit is very fragrant when ripe; size medium to large; plump oblong, obliquely impressed on one side; color greenish yellow, with greater portion of the surface a bright carmine fading to delicate pink tints; skin thin but firm; flesh pale yellow color, fine grained, tender, melting and juicy; flavor very delicately aromatic; seed very small and thin, fiber fine and short, only on edges of seed. Tree a good grower and prolific bearer.—Cellon, Florida.

PETERPASAND, India. Introduced under S. P. I. No. 7101.

PETERS, West Indies. (Syn. *Peters No. 1*, S. P. I. No. 3706). Fruited in Florida.

Form roundish oblong, heavily shouldered at base and plump at apex; size medium; stem rather stout, inserted in a small, shallow cavity; apex swollen, with a broad, strong beak an inch or more from the extremity of the fruit; surface moderately smooth; color greenish yellow, blushed, striped and splashed with light and dark red; dots numerous, yellow; bloom bluish white; skin moderately thick, tenacious; seed small, oblong, thin, adhering tenaciously; flesh thick, yellow, meaty, tender and juicy, with but little fiber; flavor sweet, aromatic, rich; quality good to very good; season July 15 to August 1 in Manatee Co., Florida.

The tree is described as of broad, spreading habit.—1908 Yearbook U. S. Dept. of Agriculture.

PHILLIPS No. 9, Hawaii. This is the form of the No. 9 distinct from the ordinary form and from that described as Herbert No. 9. Size smaller than either of the other varieties to which it is related; form decidedly like No. 9, but with the stem end drawn out into a protuberance from one-fourth to one-half inch long; color similar on the unexposed side to No. 9, on the exposed side a dull red before the fruit is ripe, turning in ripening to a tint of orange red; peeling qualities excellent; texture fair; flavor fully equal, if not superior to its allied forms.—Higgins.

PIA POSHA, India. Weight fourteen ounces; size five and three-eighths by three and one-eighth inches; skin rich cream colored, suffused pale crimson on the exposed side; pulp pale yellow, very sweet, and agreeably flavored but stringy; both shoulders falling equally; beak large. A very showy fruit with a delightful fragrance.—Woodrow.

PICO, Philippines. Introduced under S. P. I. No. 24170. Now under trial in Florida.

A variety of merit. It comes true from seed and by that method has been reproduced in that country (Philippines) for generations.—MacIntyre.

PINA, Porto Rico. A short, thick form found in the San Juan market before the middle of June, green, slightly asymmetrical, with rather oblique base, stem depressed. The meat is thick, of good texture and flavor.—Collins.

PINEAPPLE, Hawaii. A tree producing fruit known by this name locally is found on the Punchbowl slopes near Alapai street, Honolulu. It has received this name because of a resemblance in flavor, fancied or otherwise, to that of the pineapple. Size small; form resembling the Davis No. 11; color yellow splashed with red about the stem end; peeling qualities excellent; texture fair; flavor very fine; color of flesh light, approaching orange yellow; seed large. This is a pretty mango and well suited for home use, but its large seed and its texture are against it.—Higgins.

PIRIE, India. Introduced under S. P. I. No. 8421. (Syn. *Pyrie*).

A green, pointed shaped variety from the Cooper estate at Göregon. Said by the owner, an inspector in the Bombay markets, to be, next to the Alphonse, the best of the Bombay mangos. The seed is larger than that of Alphonse and the flavor excellent. Has the undesirable quality of being a poor keeper, losing its flavor quickly after ripe.—Fairchild.

PIRU, India. Weight five and one-half ounces; size three and five-eighths by two and five-eighths inches; skin green and golden.—Woodrow.

POINTED CHUTNEY, Hawaii. (See explanatory note under *Lemon Chutney*). Size medium; form rather long, tapering to a sharp point; color yellow; peeling qualities good; texture fair, many specimens found with peculiar white lumps in the flesh, which, however, are not thought to be normal but due to the work of mealy bugs in large numbers on the exterior of the fruit throughout its time of growth; flavor decidedly acid; color of flesh very light just beneath the skin, ripening from the center outward with the outer layer quite firm, while the interior has become softened, a character found in many of the chutneys; seed of medium size, resembling the outline of the fruit; tree a vigorous grower and heavy cropper.—Higgins.

POOTOO. Listed, but not described, by William Bros., Ceylon.

PUNIA, India. Introduced under S. P. I. No. 10655. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A medium sized, stringy kind. Flavor very good.—Saharanpur.

Prolific bearer; small size; first quality; color reddish yellow; stone small; tree tender; ripens late; keeps well; slow grower; lemon scented.—Hartless, Saharanpur.

PYAREKHAS. Listed, but not described, by William Bros., Ceylon.

PYASEE, India. Introduced under S. P. I. Nos. 9545 and 10663.

A medium sized fruit of subacid flavor. Good.—Saharanpur.

Sparse bearer; medium sized; third quality; color yellowish brown; stone medium; tree tender; ripens mid season; keeps well; medium grower; somewhat sour at times.—Hartless, Saharanpur.

PYRIE, India. Weight eight ounces; size three and three-fourths by three inches; skin varying from red on the shoulder to pale yellow at the beak, very brightly colored; pulp soft, creamy, of delicious delicate flavor; stalk scar prominent; beak large. A first class sort.—Woodrow.

RAGU, India. Size five and seven-eighths by two and one-eighth inches; skin yellow; pulp deep yellow; flavor distinct and agreeable; no fiber; both shoulders falling; large depression in place of beak.—Woodrow.

RAINBOW, Hawaii. Known to a limited number of people under this name, the one tree of the variety known to the writer being in the Henry Davis homestead at Punahou, Honolulu. Size medium; form resembling that of the so-called French or Wine mango; color light green on the unexposed side before ripening, the exposed side being overlaid with dull red which brightens in ripening to orange red in dots or stripes, much

brighter red than in the French; peeling qualities good; texture fair; flesh light yellow; flavor good, resembling No. 7.—Higgins.

RAJIA, India. Weight seven ounces; size three and one-eighth by two and one-half inches; skin yellowish green, tinged red on shoulder; pulp deep yellow, of rich sweet flavor, and no fiber; left shoulder level, right shoulder falling; beak none.—Woodrow.

RAJPURY, India. Introduced under S. P. I. No. 7105. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry. (Also spelled *Rajpuri*, *Rajabury*, and *Rajapurri*).

Average size about ten ounces in weight, a trifle elongated, flavor rich and buttery. Both flavor and aroma distinct from any other mango; very attractive and very prolific.—Reasoner, Florida.

This is a fruit averaging from eleven to twelve ounces, and while it is practically free from fiber and of a delicate texture and flavor, its remarkable characteristic is its perfume, which is entirely different from any other mango yet grown in this section. This perfume, fascinating and delicate as it is, is hard to describe, and this mango, like many others that are being propagated here, is bound to become of great value, as it promises to be a prolific bearer and a great favorite.—The Homeseeker.

It weighs from seven to fourteen ounces, seventy-five per cent. of all the fruit weighing from ten to eleven ounces, and is more nearly globular in shape than any other of our mangos. It has a fine aroma and flavor, which are distinct and peculiar to itself, preferred by many to Mulgoba or Alphonse. Yellow, with delicate pink cheek where exposed to the sun. As nearly spherical in shape as a mango ever is.—Beach, Florida.

RASPBURY, India. Introduced under S. P. I. No. 7106.

RASPURI. Listed, but not described, by William Bros., Ceylon.

RAYNAUD, French West Indies. Native of the Indian archipelago. Small, round, light colored outside, flesh whitish and aromatic.—Jumelle.

REDONDO, Porto Rico. A large, thick-meated form, common in the Ponce market. In form it is quite symmetrical, with a decidedly depressed stem. In color it varies from green to red, the difference being in some instances so marked as to suggest a distinct type. The color seemed the only difference, however, and the market people insisted that the green and the red might come from the same tree. The flesh is very juicy, moderately free from fiber, and of a very good flavor.—Collins.

RED No. 11, West Indies. A West Indian descendant of a fine Indian sort, having high color, but is small and somewhat fibrous.—Reasoner, Florida.

REINE AMELIE, French West Indies. Skin very thin, slightly spotted, easily separated from the pulp.—Jumelle.

ROBERTS, Florida. This is a descendant from No. 11 and has been propagated by budding to some extent. It is distinctly to be preferred to the usual run of No. 11's, being highly colored and having less fiber.—Rolfs.

ROMANI, India. Introduced under S. P. I. No. 10658. A medium sized fruit, subacid, of very fine flavor.—Saharanpur.

ROOS, India. Introduced under S. P. I. No. 7043.

ROSA, Porto Rico. A nearly spherical form, seen at Yauco, yellow in color, with one side a beautiful red. The skin is very thin, the meat comparatively free from fiber, very mild and pleasant, without a trace of turpentine flavor.—Collins.

RUNTRA. Listed, but not described, by William Bros., Ceylon.

RUPEE, Ceylon. Introduced under S. P. I. No. 8412. The largest fruited mango grown in Ceylon. It is called the *Rupee*, or two shilling mango, because of the price paid for a single fruit. Its origin is unknown. It is very large, sometimes five inches long, nearly globular, light green in color when ripe. A shy bearer. Skin tender and easily

bruised, rendering the fruit a poor shipper. Flesh is golden yellow. Seed small in proportion to size of fruit. A rare variety even in Ceylon. Flesh free from stringiness and flavor delicious, but only when perfectly ripened on the tree. The tree is not very robust, and Dr. Drieberg does not recommend the variety for general planting. —Fairchild.

Very large and somewhat round, pulp luscious and free from fiber; similar to *Inerma* of Bombay.—Macmillan.

This is also called the *Two Shilling*. It is a sparse bearer; fruit the largest of the local (Ceylon) varieties, of first quality; skin pale green; seed small compared to size of fruit; ripens late and is not a good keeper. The tree is not a free grower and is tender. This variety is scarce and expensive. Requires very careful ripening. —Dr. Drieberg.

RUSSET, Hawaii. Introduced under S. P. I. No. 12930.

RYOTYA, India. Weight eight ounces; size three and three-eighths by two and three-fourths inches; skin bright crimson on exposed side, creamy on shaded side; pulp creamy yellow, of extra fine quality, and no fiber; both shoulders falling equally; no beak; exactly obovate. A really fine fruit, handsome and prolific.—Woodrow.

SA PACHAND. Listed, but not described, by William Bros., Ceylon.

SAFAIDA. Listed, but not described, by William Bros., Ceylon.

SAFEDA. Listed, but not described, by William Bros., Ceylon.

SAFFRON, Hawaii. Size medium; form rather short, resembling *Wooten Chutney;* peeling qualities fair; color rich saffron; texture good; flavor good. The original tree of this variety in the islands is a seedling growing at Kalihi. It is one of the most esteemed of the local seedlings.—Higgins.

SAHARANPUR No. 1. Listed, but not described, by Reasoner Bros., Florida.

SAINT AIME, India. Weight fifteen ounces; size four by four inches; skin greenish yellow; pulp deep orange, of coarse grain but rich flavor; left shoulder high and broad, right shoulder low and broad; beak none.—Woodrow.

SALAMAR, India. Introduced under S. P. I. No. 9535. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

SALGADA, India. Weight twenty-four ounces; size five and one-fourth by four and one-half inches; skin greenish yellow on shoulder, shading downward to yellow; very sweet and agreeably flavored; right shoulder very high, left shoulder level, then descending.—Woodrow.

SALGADINA, India. Weight seven ounces; size three and three-eighths by two and three-fourths inches; skin rich crimson, shading to yellow; pulp deep yellow; left shoulder level, right shoulder falling; beak none.—Woodrow.

SALIBUNDA, India. Introduced under S. P. I. Nos. 9513 and 10642.

A distinct variety, a large fruit, subacid flavor, color greenish yellow.—Saharanpur.

Prolific bearer; small size; second quality; yellowish red; stone medium; tree hardy; ripens medium; keeps well; medium vigorous grower; good.—Hartless, Saharanpur.

SAMAR CHIST, India. Introduced under S. P. I. No. 9534.

SAMOAN, Hawaii. So called by Mr. Allan Herbert, who introduced the seed from Samoa. Size medium; form oblong; color pale yellow with a bright tinge on the exposed cheek, occasionally striped; peeling qualities fair; texture good for a seedling, the fibers being very fine; flesh light yellow just under the rind, slightly darker within; flavor sweet, with abundant juice.—Higgins.

SANDERSHA, India. Fruited in Florida. (Synonyms *Sandershah, Sandershaw, Soondershah* S. P. I. No. 7108, and *Sundershah* S. P. I. No. 10665).

A long fruit, stringy, flavor peculiar and only liked by some people.—Saharanpur.

Prolific bearer; size small; third quality; color green; stone large; tree hardy; ripens mid season; does not keep well; free grower; fair.—Hartless, Saharanpur.

So far as known the latest to ripen. Fruit long, yellow, of the very largest size, sometimes weighing two pounds. Somewhat acid.—Reasoner, Florida.

Form long, compressed, and rather slender, tapering toward stem and terminating in a distinct curved beak at the apex; size very large, averaging around twenty ounces in weight, and occasionally attaining a weight of two pounds; stem stout, apex prominent, curved and beaked; surface smooth; color clear yellow, with faint pinkish blush in the sun; dots numerous, small, russeted; skin moderately thick; seed long, curved, thin, small in proportion to size of fruit and thickness of flesh; flesh rich reddish yellow, juicy and tender, almost entirely free from fiber; flavor sprightly and refreshing in the fresh state, though with rather less aroma than *Mulgoba*. Its higher acidity will doubtless render it more acceptable for serving in sliced form than are most of the mangos thus far obtainable in our markets. Season very late, ripening in the latter part of August at Miami, Florida.—1907 Yearbook U. S. Dept. of Agriculture.

SANDURIA, India. Introduced under S. P. I. Nos. 9547 and 10667. Now under trial in Florida.

A small long shaped fruit. Stringy but of fine flavor.—Saharanpur.

Prolific bearer; small size; second quality; color red; stone medium; ripens mid season; keeps well; medium grower; good.—Hartless, Saharanpur.

SANS-PAREILLE, French West Indies. Largest of all, but of mediocre quality.—Jumelle.

SARI. Listed, but not described, by William Bros., Ceylon.

SARIKHAS. Listed, but not described, by William Bros., Ceylon.

SEED-MANGO, Ceylon. A small oval fruit, with scanty juicy pulp of a distinct piquant flavor.—Macmillan.

SHAH-PASSAND, India. Is a much esteemed variety said to be the same as Malda, and two pounds in weight, and of irregular shape.—Woodrow.

SHARBATI BROWN, India. Introduced under S. P. I. No. 9548. Now under trial in Florida.

Prolific bearer; small size; second quality; color brown; stone medium; tree hardy; ripens early; keeps well; medium grower; good.—Hartless, Saharanpur.

SHARBATI BLACK, India. Introduced under S. P. I. Nos. 9547 and 10669. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Prolific bearer; small size; second quality; color black; stone medium; not hardy in United Provinces; ripens early; keeps well; medium grower; good.—Hartless, Saharanpur.

SHENDRIA, India. Weight seven ounces; size four and one-eighth by two and three-sevenths inches; skin deep yellow, spotted and flushed with carmine; pulp very fine, creamy, and rich in flavor, with a few fibers near the skin; left shoulder rising slightly, right shoulder falling abruptly; beak none.—Woodrow.

SHRAWANI ALPHONSE, India. Weight fourteen ounces; size four and seven-eighths by three and three-fourths inches; skin yellow; pulp deep yellow of fine flavor; stone large; left shoulder very broad and rising slightly, right shoulder falling; beak marked by an abrupt contraction.—Woodrow.

SINGAPUR, India. Introduced under S. P. I. No. 9550. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A small fruited variety of Bombay mango, flavor excellent.—Saharanpur.

Sparse bearer; medium size; second quality; color yellow; stone medium; tree hardy; ripens medium; keeps well; slow grower; taste resembles a loquat.—Hartless, Saharanpur.

Fruited for the first time in 1911, and proved to be all that was claimed for it by our Indian correspondent. The skin is green and golden yellow, finely mottled, thick and strong, with a grayish-blue bloom, clean and free from spotting. The flavor

is distinct, rich and sweet, with characteristic true mango flavor. The fruits are remarkably uniform in shape, meaty, thick and solid, perfect, weighing from fourteen to twenty ounces each, and we judge will be a remarkably good shipper. The seed is medium and flat.—Reasoner, Florida.

SITALOHOGA. Listed, but not described, by William Bros., Ceylon.

SOCIETY'S. Listed, but not described, by William Bros., Ceylon.

STALKART, India. Introduced under S. P. I. No. 9514. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A small fruited variety of Bombay mango, flavor excellent.—Saharanpur.

Prolific bearer; medium size; first quality; color yellowish red; stone medium; tree hardy; ripens early; keeps well; free grower; resembles the Bombay.—Hartless, Saharanpur.

STRAWBERRY of India. Introduced under S. P. I. Nos. 9515 and 10643. Fruited in Florida.

Medium sized, with a strawberry flavor. A longish, hooked, pointed fruit. Flavor good.—Saharanpur.

Fruited in 1910 for first time. Fruit small, of delicious flavor. Contains some fiber. A medium strong grower.—Reasoner, Florida.

Sparse bearer; small size; second quality; color yellowish red; stone medium; tree tender; ripens medium; keeps well; free grower; strawberry flavored.—Hartless, Saharanpur.

STRAWBERRY of Hawaii. Size large; form roundish, uniform; color before ripening very light green overlaid on exposed side with dull red, which brightens on ripening; flavor very good; flesh light in color; seed medium.—Higgins.

SUCRETINO, India. Weight twelve ounces; size four by three and one-fourth inches; skin slightly yellowish at top but deepening to green at base; pulp sweet, with an agreeable subacid flavor; both shoulders falling; beak, place slightly depressed.—Woodrow.

SUFAIDA No. 1, India. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Prolific bearer; size large; first quality; color green; stone large; tree tender; ripens late; keeps well; slow grower; very good flavored; flesh firm.—Hartless, Saharanpur.

SUFAIDA No. 2, India. Prolific bearer; size large; second quality; color green; stone large; tree tender; ripens late; keeps well; medium free grower; fairly good.—Hartless, Saharanpur.

SUMMER APPLE, Hawaii. In size and form this closely resembles the Davis No. 11, but it is very unlike it in other respects. Color a very light green and yellow, slightly orange tinted on the exposed side, and dotted with orange red; texture fair; flavor very poor; color of flesh rather light; seed medium size.—Higgins.

SUNHARA, India. Introduced under S. P. I. No. 9551.

SURKHA, India. Introudced under S. P. I. Nos. 9552 and 10652. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

A stringy kind, but of good flavor.—Saharanpur.

Prolific bearer; medium size; first quality; yellowish red; stone medium; tree hardy; ripens late; keeps well; moderate grower; good.—Hartless, Saharanpur.

SURKHYA, India. Weight four ounces; size three and one-eighth by two and three-eighths inches; skin rich creamy yellow, with crimson speckled shoulders; pulp pale cream colored, not fibrous, but of cloying flavor; left shoulder rising, right shoulder falling abruptly; beak none. A very showy fruit produced in great abundance.—Woodrow.

TAMANCHA, India. Introduced under S. P. I. Nos. 9553 and 10653.

A large fruit, greenish yellow, flavor good.—Saharanpur.

Sparse bearer; size small; second quality; color yellowish red; stone medium; tree tender; keeps well; ripens medium; free grower; sweet.—Hartless, Saharanpur.

THURSTON, Ceylon. Introduced under S. P. I. No. 8413.

Fruit is of medium size, short, and somewhat globular. The stone is of medium size and the skin is dark green when ripe. It ripens well off the tree. It is a vigorous grower, has a sweet flavor, and according to Dr. Drieberg is acid when not fully ripe. The flesh is greenish in color near the skin and slightly fibrous.—Fairchild.

TOASHAIK. Listed, but not described, by William Bros., Ceylon.

TOTAPARI, India. (Synonym *Totafari*). Introduced under S. P. I. No. 8732. Fruited in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

Skin very smooth, altogether yellow, moderately tough, pulp concolorous with skin. Slightly fibrous, flavor excellent. It measures four and seven-eighths by two and seven-eighths inches. Both shoulders fall equally, beak small but distinct (Bhide).—Woodrow.

A good midseason sort, resembling Sandersha, but only about half the size. Bears when very small.—Reasoner, Florida.

This has proven to be a good fruit. It is about the size of *Bennet*, but has not the same aroma or flavor, still it is very desirable and a valuable acquisition. Weight eight to ten ounces. Rather long and pointed at blossom end, much like *Sundersha* on a smaller scale. A free bearer.—Beach, Florida.

VANILLA, Hawaii. Size medium to large; form approaching roundness, with the stigmatic point more or less prominent; color quite uniform when ripe, passing through shades of yellow to those of orange yellow when ripening; peeling qualities good; texture fair to good; flavor rather too pronounced, with a slight bitter principle close to the seed; color of flesh orange; seed medium to large.—Higgins.

WALNUT, Hawaii. Size small to very small; some specimens being not much larger than a walnut; form rounded, but not full on the stigmatic side, the stigmatic point being almost obliterated; color a shade of yellow on the unexposed side, the exposed side blushed with red and orange at the stem end; peeling qualities fair; flavor fair; texture fair; seed large. It is valuable chiefly as a curiosity.—Higgins.

WHITE ALPHONSE (or *Safeda Alfoos*), India. Introduced under S. P. I. No. 22970. Now under trial in Florida. Sent to California for trial, in 1911, by Bureau of Plant Industry.

The Advocate of India has this to say of the White Alphonse mango: "We have at this moment on the office table a specimen of mango which has been sent us,—the like of which has never before been grown. It is a *White Alphonse*, perfect in shape, with a beautiful satin skin and a subtle aroma which faithfully indicates the delicate flavor of its golden pulp. It is a triumph in every respect, with the smallest stone for its size. Yet it is gigantic in weight and proportions. A good specimen of our Golden Alphonso, so far our best mango, does not weigh more than about four ounces. The *White Alphonse* just fails to tip the beam at the weight of two and one-half pounds." Michael.—Bureau of Plant Industry.

WOOTTEN CHUTNEY, Hawaii. See explanatory note under Lemon Chutney.

This name has been given to the variety because the only tree of the kind known is growing on the residence property of Mr. Harry Wootten in Honolulu. Size medium to large; color when ripe a shade between orange yellow and yellow orange, with tinges of pink and red at stem end; peeling qualities fair; texture very good; flavor excellent; seed rather small for the size of the fruit. An important characteristic of this variety is that while still solid it has a very beautiful color as if ripe, making it a desirable market form. It is one of the best of this class of mangos.—Higgins.

New and Little Known Trees Suitable for Southern California Avenues

DR. C. F. FRANCESCHI
SANTA BARBARA, CALIFORNIA

Southern California has started at last to build good roads, and there is no reason whatever why we should not have them as perfect as any in the world, because we are able to employ the best talent and the best materials, while our exceptionally equable climatic conditions are ideal for the maintenance of good roads.

If we need perfect roads we also need them to be beautiful, and it is obvious that more careful attention is going to be bestowed on the selection of trees which will prove best adapted either for ornament or for shade.

Everybody in Southern California is aware of the fact that we are able to draw upon almost any part of the world for ornamental trees, just as we do for all sorts of shrubs and other plants. Consequently, there will be much too many for this especial purpose. In this paper I am going to mention only such trees as have already proven themselves particularly desirable for planting along avenues or roadways of considerable length, and between sixty to one hundred feet wide.

The selection of trees best adapted for planting on streets in the residence sections of our towns is obviously subject to more special requirements and restrictions, and will not be treated in this paper. The question whether in Southern California deciduous trees must entirely be supplanted by evergreens I am not going to discuss, believing that either one class or the other might be preferable under different conditions.

As I understand it, the beauty of an avenue of trees resides principally in their uniform growth and in each individual tree being allowed to display its particular character and features, and not to become entangled with its neighbors.

Along such avenues, sixty to one hundred feet wide, and which, very likely, will not have cemented or asphalted sidewalks, trees which will eventually attain sixty to one hundred feet in height will not be objectionable, even if they grow a very big trunk.

Native Evergreen Trees

The following California native trees have already been planted on a more or less extensive scale and are sure to prove satisfactory:

Prunus integrifolia, "Island Cherry," "Islay," by some botanists considered to be only a form of the "mountain" or "wild cherry," but a native (exclusively) of Santa Cruz, Santa Rosa and Santa Catalina islands. Of rapid and pyramidal growth, the glossy foliage much varying in shape and size, but never holly-like. Will thrive in almost any kind of soil, and stand well heavy winds. May attain sixty to eighty feet; should be planted twenty-five to fifty feet apart.

Quercus agrifolia, the common "California Live Oak," will grow fast enough in tolerably good soil, and with plenty of moisture at the roots; in poor and dry soil will develop slower but will attain large size and a great age, as shown by the huge trees among the sandstone boulders on the ridge at Montarioso. May attain sixty feet, or over; being of spreading habit, should be planted not less than forty feet apart.

Quercus chrysolepis, "Golden-leaf Oak," "Canyon Live Oak," generally found higher up in the mountains than the preceding, and attaining about same size, but not such a fast grower.

Lyonothamnus floribundus var. *asplenifolius,* "Palo Fierro" or "Ironwood" of Santa Cruz and Santa Rosa islands; of regularly pyramidal shape, very conspicuous for its aromatic, fern-like foliage, and large umbels of white, strong scented flowers. May attain fifty feet and over, should be planted twenty or twenty-five feet apart.

Umbellularia californica, "Native Bay" or "Laurel," of dense, columnar growth, quite heavily foliaged, the strong scented, deep green leaves persisting for several years. Will not succeed far from water, may attain sixty to eighty feet, and occasionally much more, like the gigantic specimen at Cathedral Oaks, five miles north of Santa Barbara. Should be planted twenty-five or thirty feet apart.

Chamaecyparis lawsoniana, "Lawson Cypress." Surely one of the most desirable among conifers, on account of its feathery branches and pleasant green color. Will succeed even in poor soil and with little moisture, but much better under more favorable conditions. To retain its full beauty, not unlike most other conifers, its lower branches ought to be allowed to droop to the ground, and therefore it should not be planted at less than forty feet. There is no doubt that the most picturesque effect will be obtained if conifers are used only on sloping ground, in which position they will also thrive much better.

Libocedrus decurrens, "Incense Cedar," another very tall native conifer, more columnar in habit than the preceding, and not such a fast grower. Could be planted twenty-five to thirty feet apart. Not of feathery effect, but the emerald green of its foliage is very attractive.

Exotic Evergreen Trees

A certain number of conifers belong to this section, which have been planted more or less in our gardens and parks, but hardly at all for avenues.

Araucaria excelsa, the "Norfolk Island Pine" or "Star Pine," leads the list for its wonderful beauty and fast growth. I do not know of any other tree, no matter from whatever country, possessing such a distinctiveness of character, and such a solemnity of outline. But it could not be used for avenues under one hundred feet wide, and should be planted from sixty to eighty feet apart. It is not at all particular about soil, as shown in Santa Barbara where most numerous and most beautiful specimens are growing, both in the rich moist soil down town and on the dry hard-pan in the upper part of town.

Araucaria bidwillii, the "Bunya-bunya" of Queensland, will, at least in this country, grow not as tall and much slower than the preceding, and it appears to need also deeper soil and more moisture. But it is most impressive for its dense

pyramids of a dark green color. Should be planted not less than fifty feet apart.

Cunninghamia sinensis, from China, offers about the same outline as *A. bidwillii,* but with branches more drooping, the foliage of distinctly glaucous color. It will stand more cold and more heat, but needs deep soil and plenty of moisture at the roots, otherwise losing its lower branches and looking very unsightly. The finest specimens that I know of are at the Tevis place near Bakersfield, where the range of temperature is pretty wide, but soil is deep and moist. Plant fifty feet apart.

Cedrus deodara, or "Himalayan Cedar," is well known in gardens, but has never been much used as an avenue tree. I know only of the Santa Rosa avenue in Altadena, which is certainly very striking, but the effect is spoiled by the avenue not being wide enough and by the trees having been set much too close together. It should not be less than forty feet.

Cupressus sempervirens, the "Italian" or "Oriental Cypress," has been, of late much used (and abused) in California gardens. It is sure to make splendid avenues, like those of the most ancient and more beautiful villas in Italy, but one must not forget that in rich soil and with plenty of moisture, it is sure to lose its character and "to grow fat," its lateral branches spreading out under the overweight of foliage; also that the full effect of a cypress avenue cannot be obtained in only a few years. The spreading form of the Italian cypress, much despised in California, will make splendid trees, even in the poorest soil, having the same outline and offering the same scenic effect as firs and spruces, which are an impossibility here. If planted in rich and moist soil *Cupressus horizonthalis* will be at its best, displaying more fully its above mentioned character. The "columnar" form can be planted as close as sixteen or twenty feet, the "spreading" one will require at least twice as much.

Cupressus guadalupensis, "Blue Cypress" of Guadalupe island, not over seventy feet in height, and normally of a peculiar "ovoidal" outline, at least up to a certain age. Particularly recommendable for dry, rocky locations, growing naturally upon disintegrated lava currents. Quite "blue" in the young age, and its bark peeling off, just like cherry trees and *Araucaria cunninghamii.* With age it is much liable to vary, both in color and in outline, as I had the opportunity of remarking when in Guadalupe island many years ago. Plant from twenty-five to forty feet apart.

Cupressus arizonica, (Figure 80), from the mountains in northern Arizona, will retain its silvery color, better than the preceding. It will grow not quite as tall and will spread more at the base, while it will stand much more cold and any amount of drought. Plant from thirty to forty feet apart.

Australian Eucalyptus are recommendable for avenues, including the common *E. globulus,* "Blue Gum," which to this date has been used along roadways, probably more extensively than any other tree but rather as a most effective windbreak than for beautifying the same. The following kinds appear to be more particularly recommendable for avenues:

Eucalyptus citriodora, "Lemon-scented Gum," quite unique for its smooth, ivory white, tapering trunk, rising to one hundred and fifty feet, and for its

comparatively small but very regular crown, from which such delicious perfume exhales in foggy weather. Should be planted thirty to forty feet apart.

Eucalyptus rostrata, "Red Gum," almost as fast a grower as the "Blue Gum," and having the advantage of standing more cold in the young stage, and of being more graceful in shape and more uniform when full grown. Plant about forty feet apart.

Figure 80. Cupressus arizonica on its dry native heath.

Eucalyptus cornuta, "Yate," up to eighty feet high; highly recommendable not only for its standing saline and alkaline soil better than any other, but also for the very peculiar shining and plumy effect of its foliage. Should be planted at about forty feet apart.

Eucalyptus botryoides, "Bastard Mahogany, up to one hundred feet; a handsome, symmetrically shaped tree, standing drought well. Plant at forty feet.

Eucalyptus saligna, "Grey Gum," up to one hundred feet, of weeping effect like the "weeping willow," leaves also willow shaped. Plant at about forty feet.

There are also a number of species of *Ficus,* "rubber trees," from different countries which are particularly suitable for wide avenues.

Ficus macrophylla, "Moreton Bay Fig," is the most widely known, and it makes a magnificent tree, as one can judge from the few large specimens which escaped destruction during the wonderful extension of building in our Southern California cities. This should not be spaced under seventy-five to eighty feet, and it should be excluded from locations subject to heavy winds which may break too easily its heavily laden limbs.

Ficus rubiginosa or *australis,* also from Australia, will grow not as large. It has also smaller leaves, and it will stand more cold; will also stand the wind much better. Plant from forty to fifty feet apart.

Ficus bellingeri, from Queensland, appears to be a decided improvement on the preceding, but there are no large enough specimens as yet to form a positive judgment.

Ficus retusa, from India and Southern China (synonym *F. nitida*), is probably the species which has gained the widest reputation as an avenue tree. Much planted at Hongkong, in Algeria and in Sicily; there used to be some fine specimens in the center of Los Angeles, which had to give room to sky scrapers. It appears not to grow as fast as *F. macrophylla;* its foliage is thick and somewhat in the shape of the "strawberry guava." It will need good soil, plenty of moisture and plenty of heat to develop in the proper way. Plant at about forty feet apart.

Hymenosporum flavum, Queensland, up to one hundred feet; related to the *Pittosporums,* but finer than any of them. Fast and pyramidal growing, its branches slightly drooping and laden in spring with a profusion of jasmine shaped and jasmine scented, yellow flowers. Not at all particular about quality of soil, but not recommended for very dry places. Plant at thirty or forty feet apart.

Pittosporum rhombifolium, Queensland, up to eighty feet high; probably the tallest and the handsomest of all kinds introduced so far, not only for its very regular pyramidal shape, and peculiar foliage, but also for the great profusion of its yellowish white, fragrant flowers in summer, and of its shining bright yellow berries which persist almost all winter. Plant at thirty or forty feet apart.

Quercus suber, the "cork oak" of the Mediterranean basin. It has about the general outline of our native live oak, but will make faster growth, and is also interesting for its bark. Plant forty feet apart.

Sterculia gregori, (Figure 81), from Western Australia; the very best of all kinds of *Sterculia* or *Brachychiton,* "bottle trees," "flame trees," introduced so far, the finest specimen to be seen at Alhambra. Clothed down to the ground with glossy, coriaceous foliage which persists for many years, and sets out well the heavy bunches of salmon colored flowers which are produced for several months. May attain one hundred feet in height. Plant at forty or fifty feet.

Pircunia dioica, Argentina, the "Ombu" of the Pampas, "Bella Sombra" of the Spaniards who introduced it to Europe. In good soil will beat almost all other trees for quick growth and for beautiful shade, but will also stand drought won-

derfully well. It will in time build huge buttresses at the base, like those of many species of tropical *Ficus*. Should be planted about fifty feet apart.

Tipuana speciosa, Argentina, there called "Tipa," and considered one of the finest among native trees. May attain one hundred feet, and builds a straight

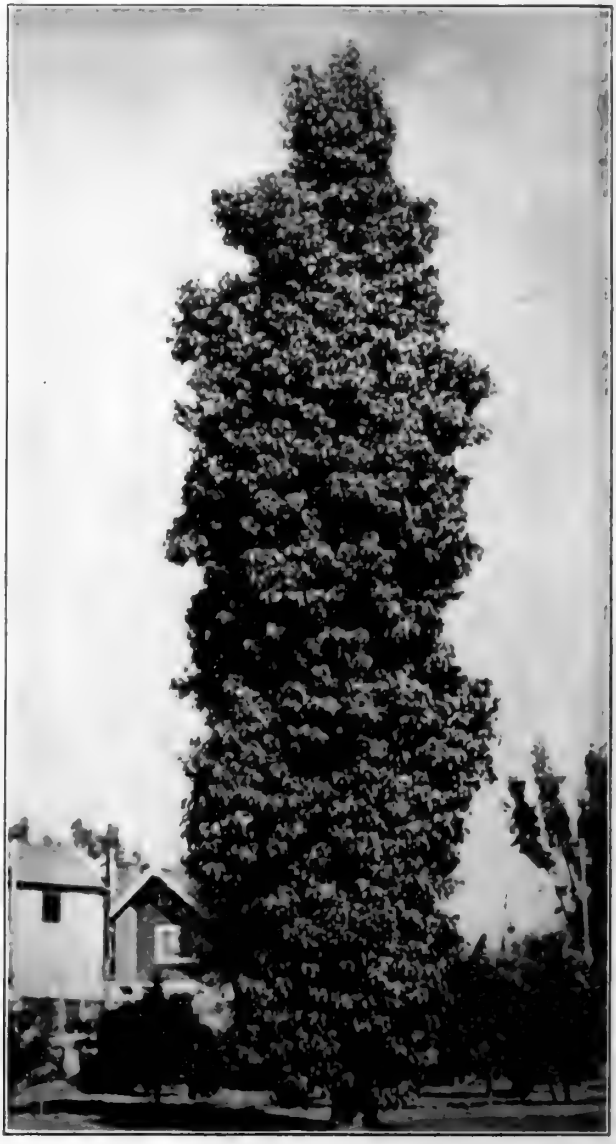

Figure 81. Sterculia gregori at Alhambra, California.

trunk, crowned by feathery foliage of light green color and drooping bunches of yellow flowers. Plant about forty feet apart.

Dendrocalamus latiflorus, from the island of Formosa, "upright giant bamboo." For low lands, and even where moisture might be excessive for other trees, clumps of this giant bamboo will make magnificent avenues, in the same way as they will make the most efficient wind breaks (if planted closer together). Does well also on drier ground, as can be seen in Montecito, etc. For avenues should be planted thirty to fifty feet apart.

Deciduous Trees

Acer macrophyllum, California. This has broader leaves than any other kind of maples that are found scattered on the northern hemisphere, and it is certainly one of the finest. In order to grow well and to retain its foliage until late it will need plenty of moisture at the roots, as otherwise the leaves will begin to drop in August or earlier. Same remark applies to other deciduous trees. This grows up

Figure 82. Cedrela fissilis planted in 1897.

to eighty feet, and should be planted thirty to forty feet apart.

Quercus lobata, California, "Valley Oak," "Roble" of the native Californians. In deep soil and with plenty of moisture this makes a truly magnificent, widely spreading tree, but could not be used under different conditions. May attain sixty or eighty feet; should be planted eighty to one hundred feet apart.

Platanus racemosa, native "Plane" or "Sycamore." While the oldest trees are often distorted in the most extraordinary ways, young trees can be easily trained to any desired shape, and this kind has a beauty of its own unrivalled by other deciduous trees. It may attain sixty feet or more, and should be set at least thirty feet apart.

Fraxinus velutina, "Arizona Ash." Grows fast and very symmetrical in shape, with branches gracefully drooping, and it has the great merit of growing well in alkaline soil where hardly any other tree will do. Grows up to sixty feet or more. Should be planted thirty to forty feet apart.

Cedrela fissilis, (Figure 82), Paraguay and Brazil, "Brazilian cedar wood." For avenues where not much shade is required this is sure to be a first class deciduous tree, its trunk rising up straight to a considerable height without branching, the branches never very heavy and forming a symmetrical head. Finest specimen to be seen in my old garden on State street in Santa Barbara which I planted in 1897, and must be now about sixty feet high. Timber is also very valuable, much like "Cuban" or "Spanish Cedar," *Cedrela odorata.* Should be planted thirty to forty feet apart.

Plants and Plans for Small Places, II

R. D. CORNELL
LONG BEACH, CALIFORNIA

"True art is the art of concealing art." This is especially true in landscape work. The most beautiful landscape effect, produced by man, is that which most closely resembles nature's own creations, and which reveals no trace of man's invasion. Such an effect can, however, be produced only on a large scale.

The grounds of the city home afford too confined an area to make possible such an attempt. But the smallest plot will respond to proper treatment in a way at once surprising and delightful. We must take conditions as they are, weigh them, and make the best of them. In our selection of plantings, interest is greatly increased by choosing those plants that are unusual and seldom seen. Among the rarer trees proven hardy in Southern California are: The silver tree or *Leucadendron argenteum,* a tree of pyramidal growth and silvery foliage; *Lyonothamnus floribundus,* native to our Channel islands and worthy of more attention; *Maytenus boaria,* which is a low growing tree of delicate foliage and graceful habit; *Salisburia adiantifolia,* or the maiden hair tree; *Parkinsonia aculeata,* and *Lagunaria patersonii.* These, with a possible list of many others, are both obtainable and desirable.

Among the shrubs are numbers of the *Bauhinias* and *Hibiscus; Choisya ternata* which is a frequent and abundant bloomer;*Gardenia florida,* or the fragrant cape jasmine; and *Coprosma baueriana,* whose glossy foliage is remarkably dust proof.

Among the vines are the passion vines, *Bignonias, Jasminums, Solanums* and *Bougainvilleas. Bougainvillea laterita* is especially beautiful with its abundance of brick-red bracts.

Landscaping is considered by many to be a luxury. It is economy; economy of the most practical sort. A home site with a few thrifty trees and shrubs growing upon it will bring a price far greater than the same plot before it was planted, and will pay a good big interest on the added expense of improvement.

Where the limited space of restricted quarters must necessarily be considered, it is well, both from the standpoint of economics and of personal satisfaction, to combine the useful with the decorative. This can very readily be done. There are now many subtropical and tropical fruits of unusual flavor and food value, as well as beauty, which have become acclimatized to our Southern California conditions, and which are fast becoming popular with the people. Among the most important of these may be classed the avocado (*Persea gratissima*), which seems destined to become an important factor in the horticultural sphere of Southern California. The *Feijoa sellowiana* is an exceptionally showy shrub with beautiful flowers, silvery foliage and fruit of rare quality. This shrub will stand a wide range of temperature and is a great drought resistant. The mango bids fair to

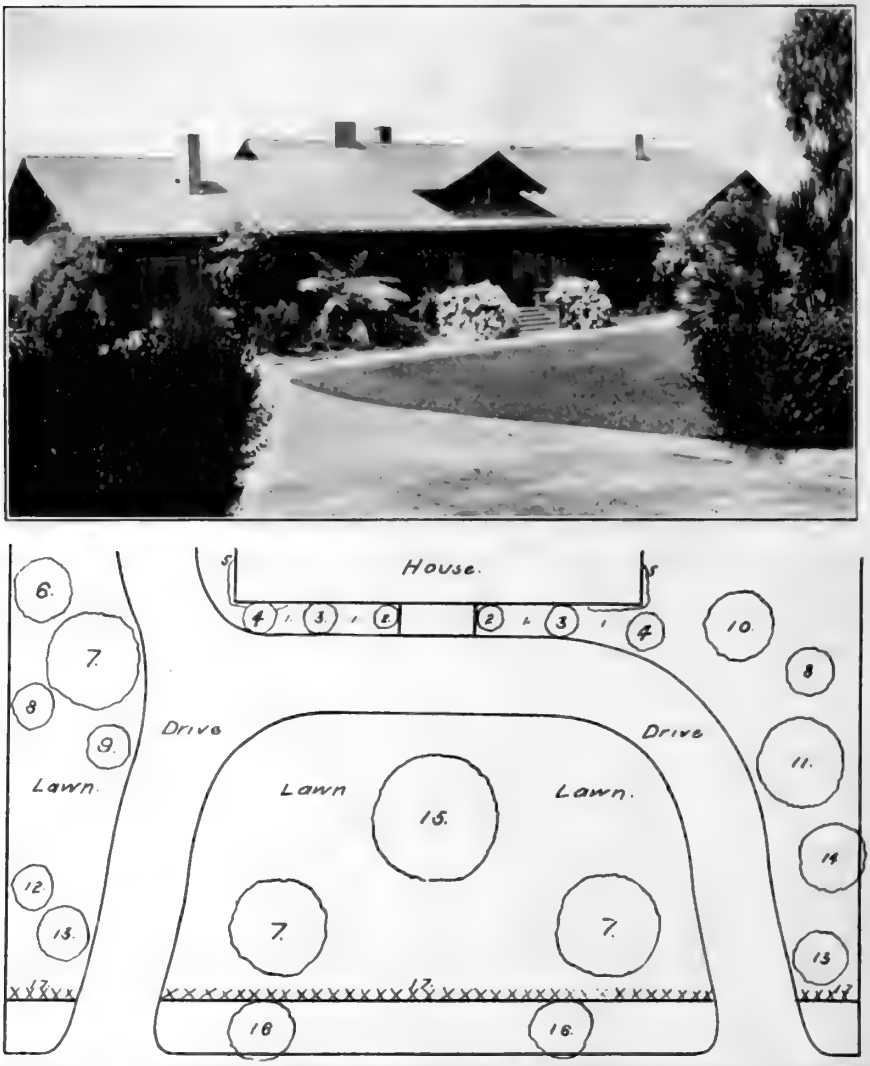

Figure 83*. 1, annuals; 2, Hydrangea hortensis; 3, Alsophila australis; 4, Grevillea thelmanniana; 5, climbing rose; 6, Streptosolen jamesoni; 7, Washingtonia robusta; 8, Plumbago capensis; 9, Pittosporum tobira; 10, Pittosporum undulatum; 11, Cedrus deodora; 12, Genista canariensis; 13, Yucca gloriosa; 14, Acacia floribunda; 15, Phoenix canariensis; 16, Schinus molle; 17, hedge of Ligustrum.

* The home shown in Figure 83 would make a beautiful picture if the three palms were taken from the center of the front yard and if the hedge were grubbed out. As it is, the place is almost entirely hidden from the street. The plantings close to the house are in harmony and the groupings at the sides are good with one exception—the cedar should have been placed behind the smaller shrubs. Here we find the possibilities of beauty but cannot enjoy it because of the barrier of foliage in front.

The tendency, generally, seems to be to overplant and to place things hit or miss. This can be avoided by giving the matter a little attention at the time of planting and construction. One should have in mind, or on paper, a clear idea of the home-to-be, before any planting should be done. Decide upon the impression you would have your home make, determine the motif of the picture, and subordinate the details to the main theme.

become a permanent resident of this locality, and the Queensland nut (*Macadamia ternifolia*) has already proven to be a successful fruiter here. In addition to these, are the *Anona cherimolia,* Sapote blanco, numerous of the guavas (gen. *Psidium*), the loquat, citrus fruits and several of the *Eugenias,* all of which are useful and desirable as ornamentals aside from their fruiting value and interest.

From what I have just said, do not infer that, in landscape art, stress should be placed upon the individual or specimen tree. This would be contrary to all

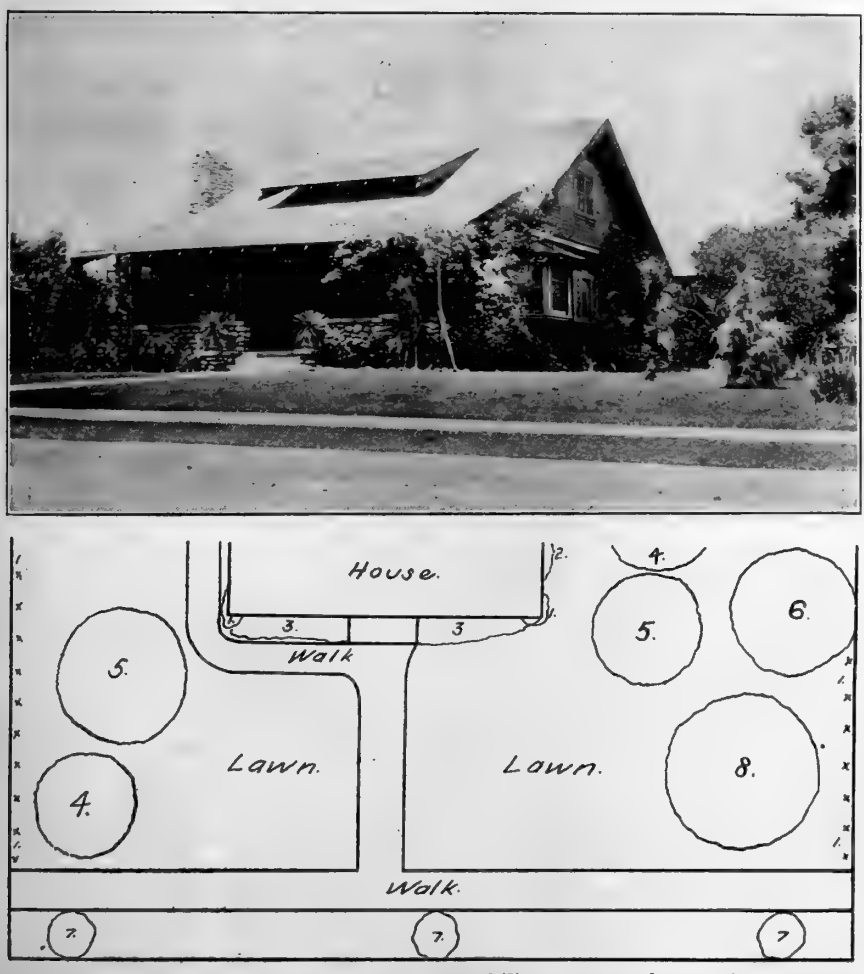

Figure 84*. 1, roses; 2, Bougainvillea spectabilis; 3, geraniums; 4, oranges; 5, Phoenix canariensis; 6, Cocos plumosa; 7, Washingtonia robusta; 8, Cedrus deodora.

* The accompanying half tone and diagram, Figure 84, shows more than ordinary taste in the arrangement of plants on a small scale. The vines on the porch, the hanging baskets and the herbaceous plantings along the foundation all tend to soften the outline and give a pleasing, comfortable appearance. The trees are assembled at the sides, leaving an open front and giving the impression of spaciousness and ease. The cedar should, by all manner of means, have been placed at the extreme rear of the group, as it will in time attain to such a size as to conceal everything now planted behind it; while if properly placed it would lend strength and majesty to the group, instead of completely hiding it.

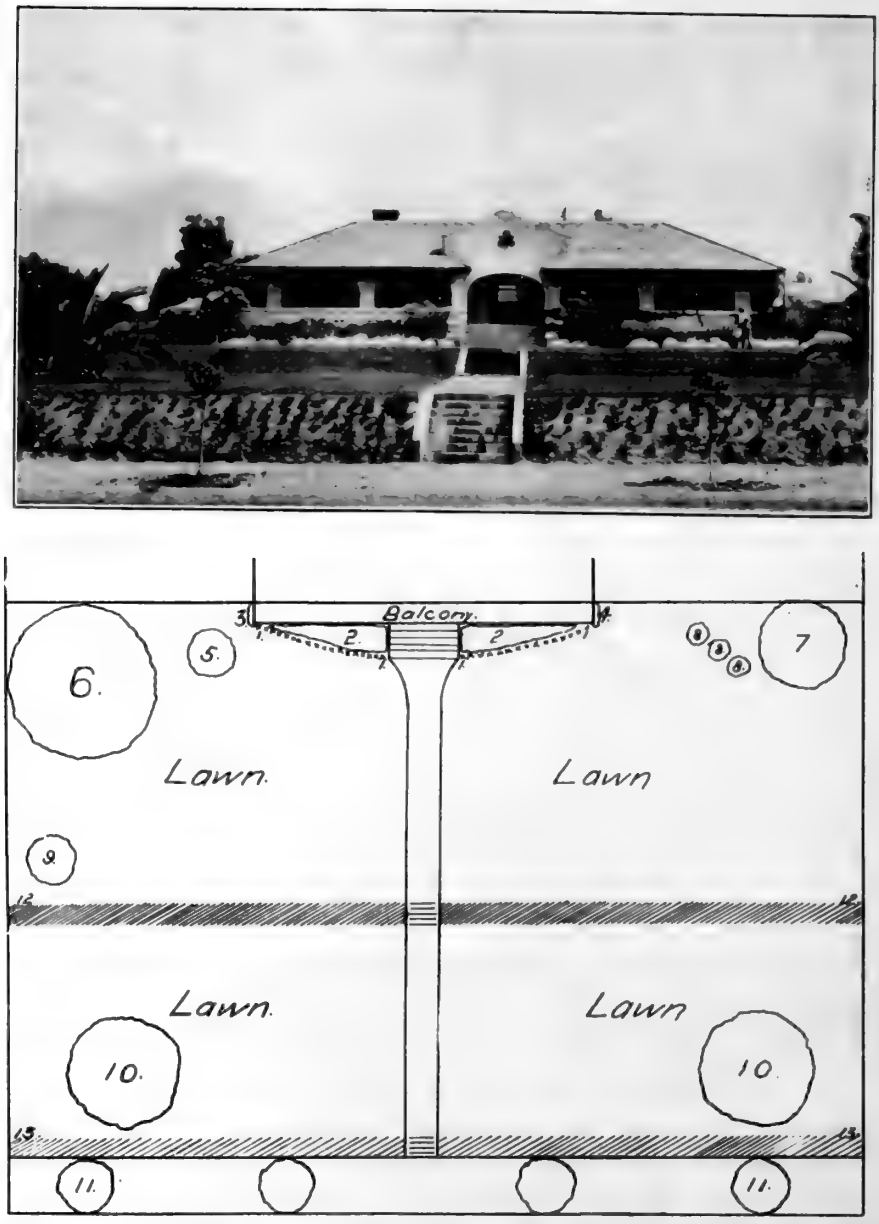

Figure 85*. 1, Centaurea gymnocarpa; 2, Scarlet geranium; 3, Bougainvillea spectabilis; 4, climbing rose; 5, Fatsia papyrifera; 6, Cedrus deodora; 7, Dendrocalamus strictus; 8, Fourcroya; 9, Grevillea thelmanniana; 10, Phoenix canariensis; 11, Cinnamomum camphora; 12, terrace in lawn; 13, terrace in Mesembryanthemum.

* Figure 85 is representative of a neat but rather stiff treatment of a yard in which a medium grade is encountered. The planting along the foundation is good and the open front is commendable, but the terracing is poor.

The grading should have been done by making one long, easy slope, convex at the upper part and concave at the lower; gradually approaching a level, though always falling away from the level of the house. Or the grade might be carried down by a double curve, of like character, and two terraces. See Figure 86 for cross section diagram of the grade as it now is and as it might be.

The planting would be improved by the massing of shrubs along the sides and rear of the yard.

ideals of landscaping. As the name implies, we are striving for a picture in color, in outline, in effect. Anything which attracts attention because of its individual appearance, detracts from the motif of the picture, and one soon finds himself studying the details, with no impression of the place as a whole. "Landscape pictures are not collections of interesting objects" says a prominent landscapist. Their impression should be as that of a picture on canvas, with one predominating idea, to which everything else is subordinate. In the city home the house should be the main theme, with the yard and plantings as the setting and background.

Everything should be planted in groups or masses. Do not stick trees and shrubs into miserable little holes in the lawn. Do not mar the beauty of your home by inserting flower beds in the centers of open spaces. Always keep the front open, as well as the views from the windows, unless it should be desirable to conceal some unsightly object. Trees and shrubs should be massed along the sides

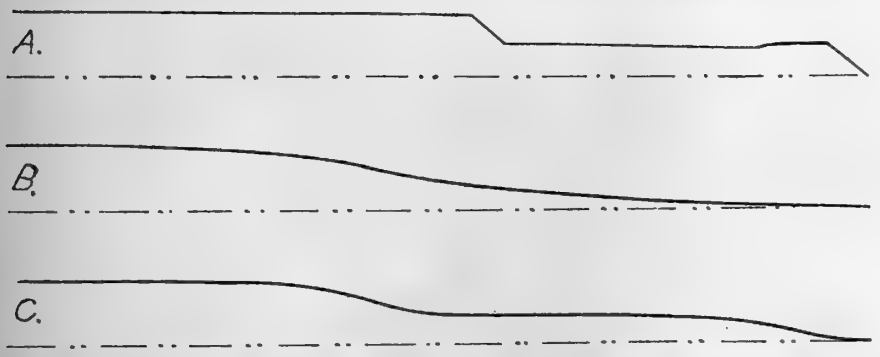

Figure 86. Showing grading of yard in Figure 85 as it is and as it might have been.

of the lot with the taller ones in the rear, thus forming a bank of foliage. An excellent place for your flower bed will be in irregular form along the edge of your shrubs. The angles and the masonry of the foundation can be softened by judicious planting of low growing things, arranged in natural and easy positions.

Sidewalks, drives and masonry should never be used unless absolutely necessary, as they detract from the desired effect and should come under the head of formal gardening. The fearful and wonderful creations made by the pruning shears and seen in the carpet beds belong to ornamental and formal gardening. Formal and ornamental gardening are widely separated from landscape gardening. The former two require skill in architecture, in stone work, in plant butchery. The latter requires love and appreciation of nature, a true ingenuity and a sense of beauty, harmony and fitness.

And thus, while it is interesting and often desirable to plant specimens for their individual value, if you wish a pleasing picture, do not allow the individual to attract undue attention, but place it with its comrades. Plant in groups. Strive for harmony in flower and foliage, ease in outline and natural effect. Have in mind the picture and work to that end. At the same time, every detail of the picture should possess interest as well as beauty.

Southern California and Java

A STUDY IN HORTICULTURAL ENTERPRISE

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Java is not a large country—only a little larger than Southern California. It is a country rich in soil and vegetation, yet only about forty per cent. of its territory is said to be under cultivation. It supports a very large population for the size of the country. Its government is administered by the Dutch in a very paternal fashion, but by far-sighted and most intelligent methods. The natives are not highly intellectual nor energetic, so that the present prosperous state of the Island of Java with its now above $150,000,000 of agricultural products per year, must be attributed to those who administer its internal affairs. Other countries and colonies the world over have studied the Javan results with deepest interest. Especially interesting to Southern California, with what is said to be the most highly educated farming community in the whole world, and which aspires to great success in agriculture and horticulture, will it be to examine into the causes of the Javan results with a community largely illiterate.

In the recently published English translation of that wonderful study by Cabaton, "Java and the Dutch East Indies," we do not find it hard to read the cause of the magnificent success of the Dutch in Java, in their painstaking and unremitting efforts to investigate scientifically and thoroughly all of their conditions, and their agricultural problems, and to apply the results. For instance, in connection with the culture of coffee, Cabaton says: "In view of the important part which the cultivation of coffee plays in the colony, the laboratories of Buitenzorg and the experimental gardens are busily increasing their research work with a view to attacking the parasites of the precious shrub, and to introducing the more productive and resistant varieties. The planters themselves have even founded a station at Buitenzorg which deals with coffee, and they do not, as a rule, undertake the planting of coffee until they have undergone a serious course of study at the Agricultural College of Wageningen in Holland, where the department of tropical agriculture and arboriculture, together with the courses in Malay and the ethnology of the Archipelago, afford them a very excellent training for the purpose."

Has Southern California any similar activities to show in connection with orange culture, or any other of our great horticultural interests? We are willing to pay thousands to develop and protect the sale of our products but nothing to bring about more efficient and more effective and more economical production, while as a matter of fact our margin of profit is as likely to be built up by the latter method as by the former. Our growers pay shocking prices for experience laboriously gained without previous preparation or technical knowledge to back it up. Thousands upon thousands of dollars are annually lost in the citrus business in our present lack of system in fumigation work, and in the wide-spread unwisdom with

which commercial fertilizers are used. For the more exact knowledge that we must have, we sit back and await the tardy, long distance action of the Federal Government, or the action of state institutions that cannot adequately serve the other agricultural interests of the state, to say nothing of our own peculiar subtropical interests. Young men come to us in numbers, inquiring where they shall go for technical preparation for citrus culture, exactly such as is described above as splendidly in operation in the interests of Javan coffee culture. What can we tell them? Simply this—that there is *no place of the sort to go to in the State of California—not even in Southern California, where citrus culture is supposed to be the greatest industry!*

We have county organizations to serve our horticultural interests, that might be built up into towers of strength to us, that might attract to our service the best specialists in the country, that might yield to us much of the many urgent expert services that we so much require, while almost without exception we have relinquished these whole possibilities to become the spoils of politicians, and to men of no technical training whatever. While all intelligent growers groan under this abuse, they have not acquired the courage to take advantage of the recall which the law provides as a ready means of relief from this irksome and clogging parasitism.

It almost makes the horticulturist wish he was a Javanese to read further from Cabaton, as follows: "The State has demonstrated its ardent desire to assist both colonists and natives in the intensive agricultural development which is making the fortune of Java. The Botanical Institute of Buitenzorg is not the least happy of its efforts. This establishment, which has no rival in the world, is not merely a marvellous assemblage of all the products of the Archipelago; its object is practical as well as scientific. Beauty is only its outward form; truth and utility are its inner purpose. It comprises the Botanical Garden proper of 145 acres at Buitenzorg itself, and as annexes the experimental gardens at Tjikeumeu, of 180 acres; the mountain gardens of Tjibodas, which have a much larger area; and finally the virgin forest of Tjibodas, of 700 acres. At each of these establishments are laboratories, museums, libraries, herbaria, and collections, directed by scientists of the highest rank, from the founder of the Institute, Professor Reinwardt of Amsterdam, to the last Director, the eminent Dr. Treub. In the experimental gardens attempts at the acclimatization of foreign plants and trees of agricultural value are carried on uninterruptedly; the degree of resistance which they offer under determined conditions is studied; experiments are made in the crossing and improvement of the flora of the country; in short, the practical value and uses of the whole flora are investigated. In the laboratories, on the other hand, are studied vegetable parasites, noxious insects, chemical manures, etc.—all that is capable of destroying or enriching that flora. The service which these laboratories have rendered in investigating the maladies peculiar to sugar cane, tobacco, and coffee, has been so great *that private individuals have built such laboratories at their own expense in many parts of Java, for the better guidance of their own plantations!* This Botanical Institute, so noted for its purely scientific labors, as well as for its practical advice, costs the East Indies 342,400 florins

a year, or £29,360, while the budget of agriculture alone amounts to 7,200,000 florins (£600,000) which sum is employed in the introduction of new crops or the improvement of those already existing in Java."

And little Jamaica, almost exactly the size of San Diego county, has two great botanical gardens which have been of equally great utility, manned by equally well trained scientific men, and which have played equally as important a part in the development of the country they serve.

Coming directly from her own resources and support, Southern California with all her great possibilities and her great riches, *has absolutely nothing of this sort,** and what little comes from outside support *is utterly inadequate and ineffectual* in the face of the great work to be done! Southern California could have as splendid a service along all these lines as any other part of the world, by any one of five different means:

1. Our county service, now installed, but utterly ineffectual, could be reorganized and placed on an efficient basis, manned by trained men, and amplified to fully meet the requirements. Great results would be possible with what we are already squandering in it. If the larger part of our growers *stood* for this thing it could be done immediately under existing laws.

2. By the employment of scientific men, and somewhat of addition to equipment and working force by assistance from the county or from growers' associations, our public parks could easily give up ground to experimental work and laboratories that would be among their greatest attractions, and yield to the whole commonwealth some of the great benefits that can come from such work.

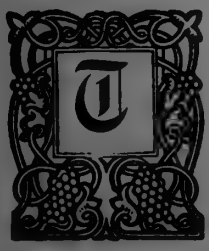
3. The Federal Government or the State could establish here a garden similar to the one already established at Chico, and by properly manning it, amplify it into the needed institution. This would, however, involve an act of Congress or of the State Legislature.

4. A levy of a few cents per box on the citrus fruits sent out of Southern California *would build and support a magnificent institution* which should be the property of and controlled by the citrus growers and which should serve their interests in the most direct and effective way. It would be a paying investment and in the end a great practical economy.

5. There are single men of wealth, and many groups of such men now in Southern California, who could amply afford to found and endow a great institution of this sort which should be built upon a broader and better plan—*to serve all the agricultural and horticultural interests of the whole community,* and which should be a blessing and a source of strength to the whole region through all the coming years of great development!

Surely out of all these possibilities something must soon come!

*Exception must be taken to this generality in the case of the valuable bulletins published by the Claremont Pomological Club, and also the Pomona Journal of Entomology and this Journal, the two latter supported by certain ambitious groups and individuals among the citrus growers. None of these projects, unfortunately, although of the greatest possibilities in public service, are yet permanent projects with assured support. In so far as they have been carried they represent a highly progressive and laudable movement which should certainly not be allowed to languish.



The safest, sanest and most efficient practical work in any line, is ever that which is built upon the solid foundation of careful and thorough technical study and investigation.

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A Man

cannot most intelligently and efficiently direct others in any great industrial work, without understanding to a finish the basic scientific principles underlying that work, and

without being able to do the things himself

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