HAWAII AGRICULTURAL EXPERIMENT STATION.

J. G. SMITH, SPECIAL AGENT IN CHARGE.

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The Banana In Hawaii

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HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

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Pl. I.—Chinese Bananas (*Musa Cavendishii,*) growing in low lands near Honolulu. The soil has been thrown into ridges with water ditches between.

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THE BANANA IN HAWAII.

INTRODUCTION.

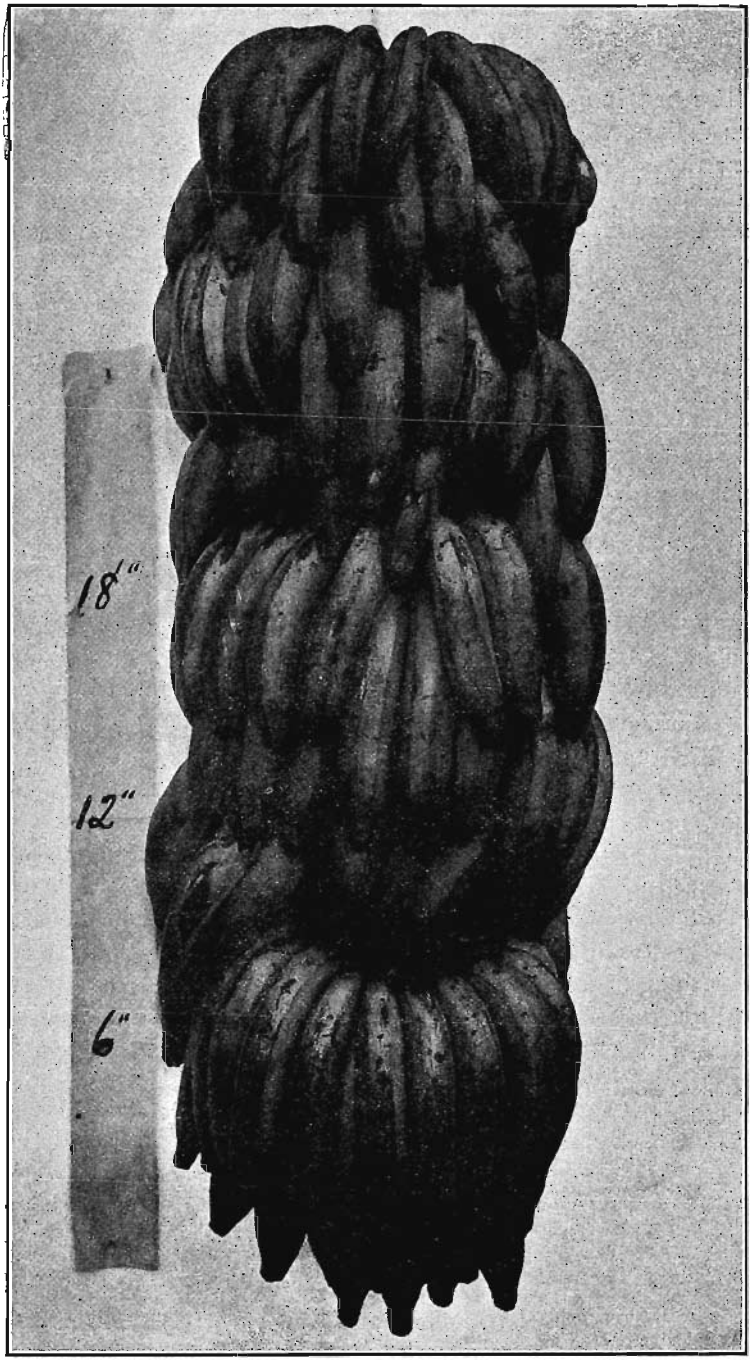
The people of the United States consumed over seven million dollars' worth of imported bananas in the year 1902. Each year the importations are increasing and at the rate of nearly a million dollars per annum in value. The West India Bulletin* states that in the height of the season, upwards of twenty steamers per week leave Jamaica alone laden chiefly with bananas for the markets of the United States. Comment is unnecessary upon what this trade has done for Jamaica, particularly since the decline in the sugar industry. Banana growing is to-day one of the most profitable industries in that island, notwithstanding the fact that tornadoes sometimes destroy whole fields. Further, the indirect influence which this trade has had upon tourist travel can not be easily estimated. The frequent passage of steamers has attracted thousands of people to the West Indies to spend the winter.

Why should not the Hawaiian Islands take some more considerable part in this large and increasing industry and commerce? This is a question worthy of careful consideration. This Territory possesses soils and climate admirably adapted to the growth of bananas. It also is free from tornadoes, the grower thus avoiding the great losses that come to planters in some other countries. A great market, on the Pacific slope of the main land of our own country, is at our doors.

Renewed activity in banana growing has already begun and the product will probably be doubled during the present year. This has given rise to a demand for information regarding the care, cultivation and management of a banana plantation. The following pages, containing the results of experience here and in other tropical countries, are given in the hope of meeting this need.[1]

*Vol. II, No. 4, P. 268.

[1]The writer would gratefully acknowledge the assistance obtained from many sources in the preparation of this Bulletin. Special mention should be made of the valuable help received through conversations with Honorable A. J. Campbell, of Honolulu, whose long experience in the banana business in these islands is well known. A paper on the subject of "The Banana Industry of Jamaica," by Hon. F. W. Fawcett has been read with deep interest and contains much information of great worth regarding the methods of cultivation in vogue in that country. In the matter of the Hawaiian varieties of bananas advantage has been taken of the knowledge of those who have long resided in the islands, especially the older of the native Hawaiians.



Pl. II.—The Jamaica Banana.

SELECTION OF SITE.

SOIL REQUIREMENTS.

There are two essential features of a good banana soil. The first is abundant moisture, the second, good drainage. It is true that the banana makes a large demand upon the fertility of the soil, especially upon the supplies of potash; but if there is a lack of plant food it may be made up in fertilizers. It is of first importance that there be a plentiful supply of moisture at all times, and quite as essential that there should be good drainage. Stagnant water is very injurious. The virgin forest loam, with its abundant humus,[1] is therefore the ideal, but a great variety of soils may be used successfully.

A Jamaica soil which has given uniformly good results to the grower has a retentive power for water of 44 per cent. It contained, by analysis,[2] .6796 per cent. soluble[3] potash.

CLIMATIC REQUIREMENTS.

TEMPERATURE.

The banana will endure quite low temperatures, but commercially it is a tropical plant and grows most rapidly and luxuriantly in high temperatures. This is an important factor in determining the location for a banana plantation in these islands. At sea level the Chinese or Cavendish banana will fruit in about twelve months from planting, but as the altitude increases and the air becomes cooler, the time required for fruiting is greater. The element of time, with its results in the number of possible bunches per year, is a factor to be reckoned with when judging of the suitableness of a given locality for this industry.

RAINFALL.

From what has already been said, it is evident that an abundant rainfall, well distributed, is necessary to the highest

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[1]Organic matter in the soil.
[2]H. H. Cousins in Bul. Bot. Dept. of Jamaica, Oct. 1901, p. 150.
[3]Hydrochloric acid test; soil passed through a 3 M.M. sieve.

success, unless it is possible to irrigate. Whatever the source, the banana should have nearly as much water as sugar-cane.

WIND.

An ordinary breeze is not prohibitive, but strong winds tear the leaves into ribbons, which impairs their usefulness, and in fruiting season the plants may be blown over.

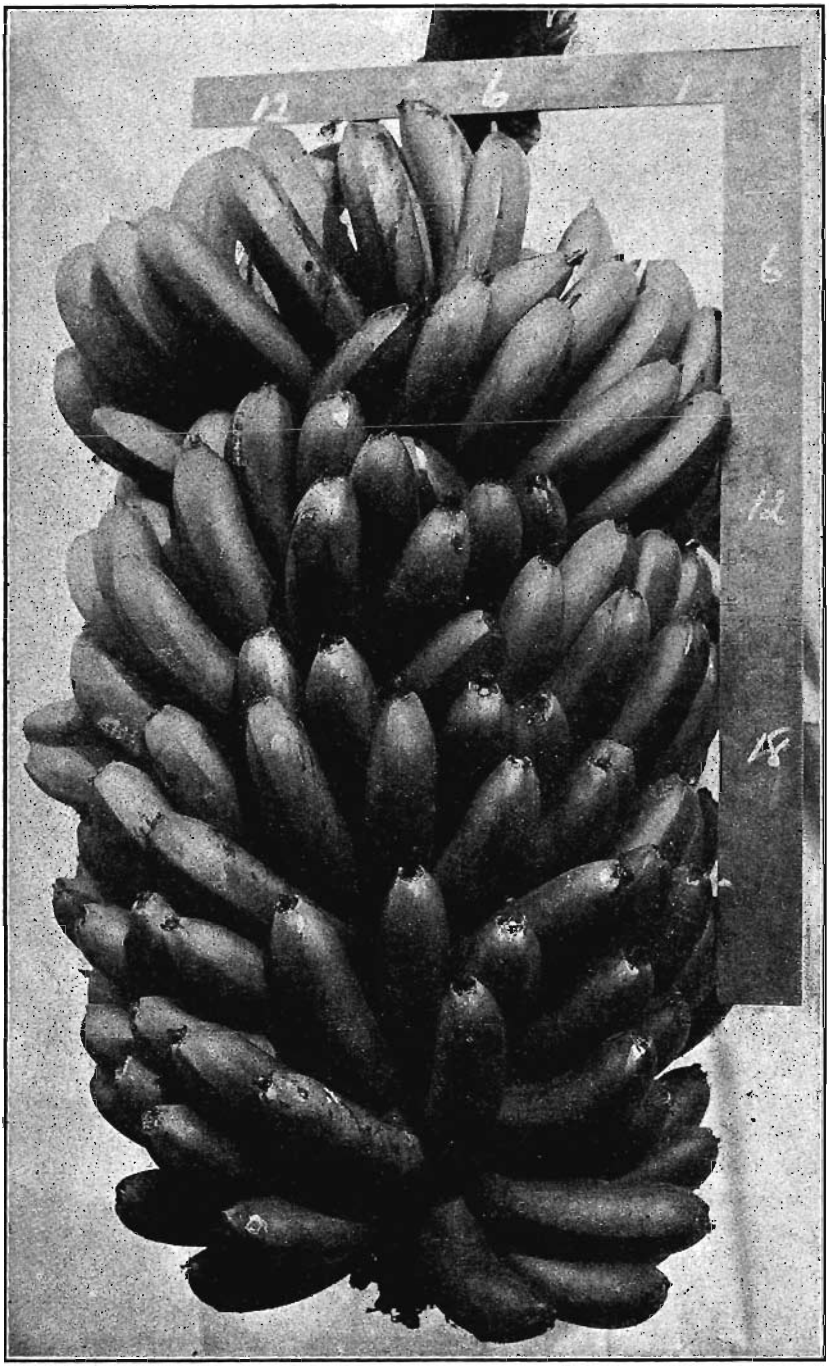
CULTURAL METHODS.

PREPARATION OF THE LAND.

If the land has been occupied by forest it is best to clear this away completely. Bananas do not require shade, as coffee, and trees are simply in the way and use up food which should go to the crop. To do this will require some expense at the beginning, but incomplete clearing is a doubtful economy and can only be regarded as a compromise to be made when capital is lacking. A cleared field means: 1st, Cheaper tillage; 2nd, Better tillage; 3rd, Larger crops of high-grade fruit; 4th, Greater facility in handling the crop. Thorough deep plowing and harrowing should follow. There are very few, if any, banana soils in these islands that do not require plowing before setting the plants, and most of our soils would be benefited by being twice plowed. If the plantation is to be upon old land, plowing will be still more necessary. The advantages of plowing and tillage in general are many, not the least important of which is the setting up of nitrification and other chemical processes which set free plant food for the crop. Again the banana roots go where there is a loose and inviting soil. If such a soil be prepared for them at a considerable depth, the result will be deeper rooting and fewer losses from wind. If it be so prepared all over the field and not simply in a small hole for each plant, the further result will be a much larger root system, still more security from wind and more feeding space for roots.

SELECTION OF PLANTS.

At least three different kinds of plants may be used to start the plantation:



Pl. III.—The Chinese Banana.

The old stumps of plants that have already produced fruit,

Large offsets or suckers from six to eight months old, with well-developed bases or corms,

Small offsets from a few weeks to two or three months old and from 8 to 30 inches high.

When the old stumps are chosen for plants they are planted whole or cut into several pieces. It is well to see that each section is provided with at least one good bud which has never been cut back. These pieces are allowed to lie in the sunlight for several days so that the cut surfaces will heal or form a callus. Otherwise there is danger of decay. It is best to take these corms from old and well-established plants since they can better afford to part with the nourishment contained in them than can plantings which have produced but one crop of fruit.

Large offsets, from six to eight months old and having well-developed corms, have found much favor in many of the best banana-growing countries. Select those whose first leaves are narrow and sword-like. It is essential with such plants that they be cut back to within about six inches of the corm. Some have failed by setting large plants without cutting them back and so have been led to believe that the very small offsets are better. These larger plants are further prepared by the removal of all the old roots. It is regarded as best to allow them to dry for at least several days before planting, and many experienced growers prefer to place them in heaps eight to ten deep, covering them lightly with trash, and allowing them to remain for a month before planting. After being set the central shoot may or may not grow. It is a matter of indifference whether it does or does not, for a bud from the side will make an excellent plant.

Small offsets, from a few weeks to two or three months old, are also used. The youngest of these can not be recommended, but the older ones make fair plants. They are usually cut back when they are dug. The old roots should also be removed. Vigorous plants should be selected with well-developed corms, with stems tapering to a point and the first leaves narrow and sword-like, (fig. 1). Avoid such forms as are represented in figure 2.

The matter of the selection of plants is of great importance. Poor plants are often the cause of the unnecessarily large number of inferior bunches in the first crop. In any case the first crop is not likely to contain as many large bunches as

later crops produced after the plantation is well established; but this very fact points to the need of setting a strong plant at the beginning.

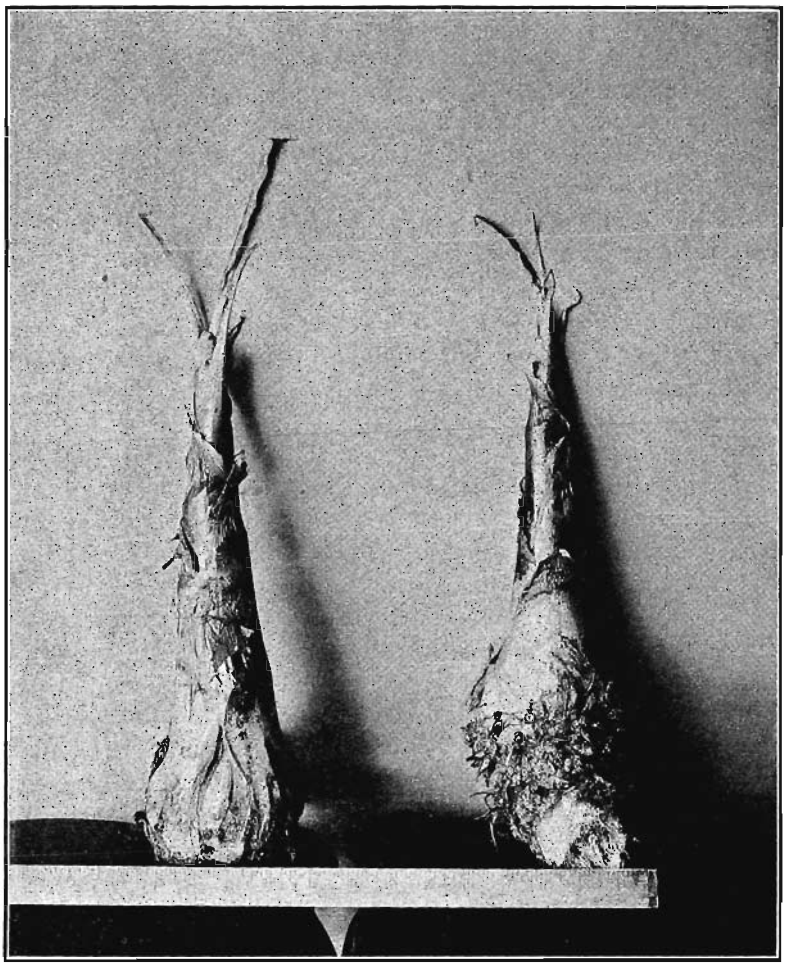


Fig. 1.—Desirable types of small suckers.

PLANTING.

Regularity. If the ground has been cleared so that it will be possible to do so, the field should be staked off with regularity. This will greatly facilitate tillage.

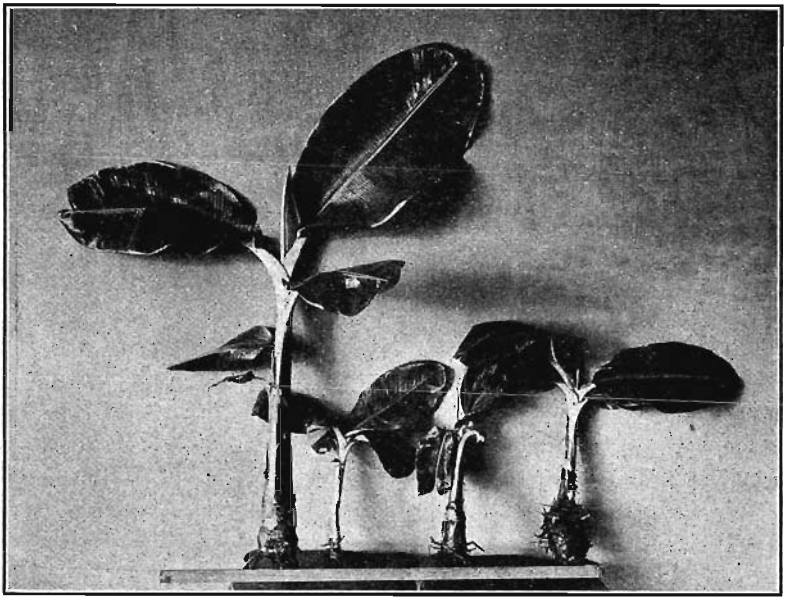


Fig. 2.—Undesirable forms of small suckers.

Distances between the plants and the rows vary with the character of the soil, the amount of moisture available, the variety of banana that is to be planted, and with the ideas of different planters. In the latter respect the banana is no exception among cultivated plants and has its ardent advocates of wide planting and those of close planting. The Chinese or Cavendish banana, which is almost the only one grown on a commercial scale in these islands, is planted at such distances as the following:—6 feet x 6 feet, 7 feet x 7 feet, 7 feet x 8 feet, 8 feet x 9 feet, 8 feet x 10 feet, and at even greater distances. They may be planted closer than 6 feet x 6 feet with a view to cutting out a large part of them after the first crop has been harvested. Such a practice, however, makes a heavy tax upon the soil and must be accompanied by thorough tillage and perhaps heavy fertilization. Further, the planter must see to it that his courage does not fail him when the time comes for the removal of half the trees.[1]

[1]The number of plants per acre at given distances is shown in the following table:

Size of hole. The size of the hole which it will be necessary to dig will depend upon the preparation which the soil has already received. If it has been poorly prepared, very large holes must be dug. They should be at least four feet square and a foot and a half or two feet deep according to the character of the subsoil. If thorough preparation has been made by plowing and harrowing, only slight hand labor will be required. If the subsoil is hard, it will be cheaper to break it with a subsoil plow than by hand labor. A subsoil plow is an implement made to run in the furrow after an ordinary plow. It goes to a depth of 18 inches or two feet, breaking the subsoil but not lifting it to the surface. This may be run through two or three furrows for each row of plants, after which the loosened soil can be rapidly thrown out to a depth of one and a half or two feet. The surface soil should be returned to the bottom of the hole. The land being thus prepared by machinery, holes of two or two and a half feet diameter will suffice.

Depth of planting. The top of the corm should not be more than a few inches below the surface of the soil of the field, on an average about three inches.

Time of planting. Bananas are planted at all seasons of the year. Naturally the spring is the time when they make the most rapid start, but if planted too late in the spring the tendency, in these islands, is for them to mature too rapidly,

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6x6	1210 plants	7x12	518 plants
6x7	1037 "	8x8	680 "
6x8	907 "	8x9	605 "
6x9	806 "	8x10	554 "
6x10	726 "	8x11	495 "
6x11	660 "	8x12	453 "
6x12	605 "	9x9	537 "
7x7	888 "	9x10	484 "
7x8	777 "	9x11	440 "
7x9	691 "	9x12	403 "
7x10	622 "	10x10	435 "
7x11	565 "	10x12	363 "

"To find the number of plants required to set an acre, multiply together the two distances in feet, at which the trees stand apart, and divide 43,560 by the product; the quotient will be the number of plants required."

L. H. Bailey, Horticulturist's Rule Book, 117-119.

producing small bunches. It is thought best by some to time the planting so as to bring in the crop during the season of high prices, when the American markets are not flooded with other fruits. Each planter must study this subject for himself, knowing how long the plant requires to mature fruit in his locality.

MANAGEMENT AFTER PLANTING.

IMPORTANCE OF FINE FRUIT.

Every effort must now be made to keep the plants growing and in a thrifty condition. The profit in fruit growing is to the man who produces fine fruit. Emphatically is this so in the banana business, for the freight charges, which constitute so large a part of the cost of production, are precisely the same on a small bunch as on a large one. When prices are such that a large bunch returns a good profit to the grower, a small bunch may only pay commissions and cost of carriage or may leave the grower in debt. Not only does this uniform freight rate work to this end, but also does the public estimate of fruit. Large fruit of all kinds sells more readily and at a higher price per pound than small fruit. A small bunch of bananas wears the appearance of inferiority and often sells at an inferior price, even though the individual fruits may be a fair size. In the West Indies buyers consider nine hands a bunch, eight hands counting for three-quarters of a bunch and seven hands for only half a bunch in the price paid.

THE FATES MAY BE DETERMINED EARLY.

The process of producing fine fruit is begun when the first steps in the preparation of the land have been taken and it continues to the harvesting of the crop, but the fate of the whole undertaking, for one season at least, may be largely determined long before the end. It is too late to try to make a large bunch of bananas after the flowers have appeared, and in fact, a good while before that. The plant grows for many months accumulating material in the corm for the de-

veloping of the fruit bud, which later pushes up through the encircling leaf bases that form the so-called "stem." At length it appears at the top and begins to open its bracts, exposing the flowers. If one will examine the flowers just as they are opening it will be apparent that there are at least two essentially different kinds.[1] Those that open first, (fig. 3), will be seen to have very long ovaries,[2] while those which open later have very short ones. The first are the female flowers, which later develop fruits, while the second are known as male flowers and possess undeveloped ovaries, incapable of *producing* fruit. Just at what time in the development of the flower bud this differentiation commences is not known, but it is probably a considerable time before the bud makes its appearance outside the plant. After this difference in the embryo flowers has become established all the care and fertilizers possible will be powerless to change the number of fruits on the coming bunch. Hence the importance of beginning early to prepare for large bunches, giving the plant every care in order that it may store up in the corm sufficient material to develop a good flower bud. The size of the future bunch is doubtless influenced by the sucker chosen—its individual vigor and hereditary characters—but there can be no doubt that the care given the plant is an important factor.

Fig. 3.—Section of banana fruit-bud showing the female and male flowers before the bracts have opened.

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[1]Strictly speaking there are three forms, male, female and hermaphrodite, but all grade into each other.

[2]That part of the flower which later becomes the fruit.

TILLAGE.

Tillage is one of the important forces making for fine fruit. It has commenced with the thorough deep plowing and harrowing of the soil and must be continued to keep the surface loose and free from grass and weeds and for the many other benefits which follow in its train. Prof. L. H. Bailey thus enumerates the advantages of tillage:[1]

"1. Tillage improves the physical condition of the land,

(a) By fining the soil and thereby presenting greater feeding surface to the roots;

(b) By increasing the depth of the soil and thereby giving a greater foraging and root-hold area to the plant;

(c) By warming and drying the soil in spring;

(d) By reducing the extremes of temperature and moisture.

"2 Tillage may save moisture,

(e) By increasing the water-holding capacity of the soil;

(f) By checking evaporation.

"3 Tillage may augment chemical activities,

(g) By aiding in setting free plant food;

(h) By promoting nitrification;

(i) By hastening the decomposition of organic matter;

(j) By extending these agencies (g. h. i.) to greater depths of soil."

All of these statements, except that in relation to the warming of the soil in spring, are as applicable to conditions existing in the tropics as to those of the temperate zones.

The implements of tillage will depend somewhat upon how the plantation has been laid out, it being possible to use quite large machines, such as disc harrows and other forms made for orchard work, where there is a wide space of ten to fourteen feet between the rows. When the rows are very close together it will be necessary to use the ordinary cultivator. Most of the time after planting, tillage of the surface soil only will be best. The subject of plowing in an established plantation is still in dispute among banana planters. Many of the roots of the plant are so near the surface that any plowing deeper than a few inches would cut off a great many of them. This may be an advantage or a disadvantage. The banana roots are not naturally branching but run out long and cord-like. Cutting off these roots causes them to send out many new ones, from the cut surfaces, which spread in sev-

[1]"The Principles of Fruit Growing." P. 139.

eral directions, thus increasing the food-gathering capacity of the plant as is claimed by some. The production of these roots, however, must make very considerable demands upon the stores of food in the corm, and therefore plowing should not be done at a time when all the supplies of stored food are required for the developing of the flower-bud or of the fruit. Basing their practice upon this reasoning, many planters in the West Indies do not plow until after the main crop for the American market has been gathered.

If the planter has made a compromise at the beginning and only partly cleared his land, he can only approach as near to perfect tillage as possible with such tools as can be used.

REMOVAL OF SUCKERS.

There is a statement somewhat current with the public, if not among planters, to the effect that offsets or suckers should not be removed before the parent plant has fully matured its fruit. This statement contains truth and error. If a very large offset be removed while the parent plant is endeavoring to mature fruit, no doubt it would be to the decided disadvantage of the latter. On the other hand, if many be allowed to grow they will rob the plant of the material it needs for fruit production and the result will be inferior bunches of fruit. But if most of the suckers be removed while yet very young, a decided advantage will be given to the main plant.

How many offsets should be left to grow will depend upon the fertility of the soil, the moisture available, the tillage given and other such factors. No fixed law to control in this matter can be laid down. In a very favored locality it is not uncommon to allow two or even three suckers to start when a corm is planted. Unless the conditions are exceptionally favorable, it would be better to leave not more than one at the beginning and to allow another to start several months later. The first will form the main plant and the second will be known as the first sucker. Still another sucker—a second—on the opposite side of the plant, may be allowed to grow some months later and before the first bunch of fruit is produced. But how often the plant may be allowed to undertake the support of a new offset will be determined by the same factors as enumerated above.

The time for allowing an offset to grow. Growers generally time their crop to meet the market demands. By choosing the right time to allow new plants to start, it is possible

Pl. IV.—A group of Brazilian Bananas. All the Suckers have been allowed to grow.

to bring in the greater part of the crop during the season of high prices.

In selecting suckers which are to be allowed to grow, choose those whose first leaves are narrow and sword-like, (fig. 1). They should also be so situated with reference to the parent plant that they will not grow up into the bunch of fruit.

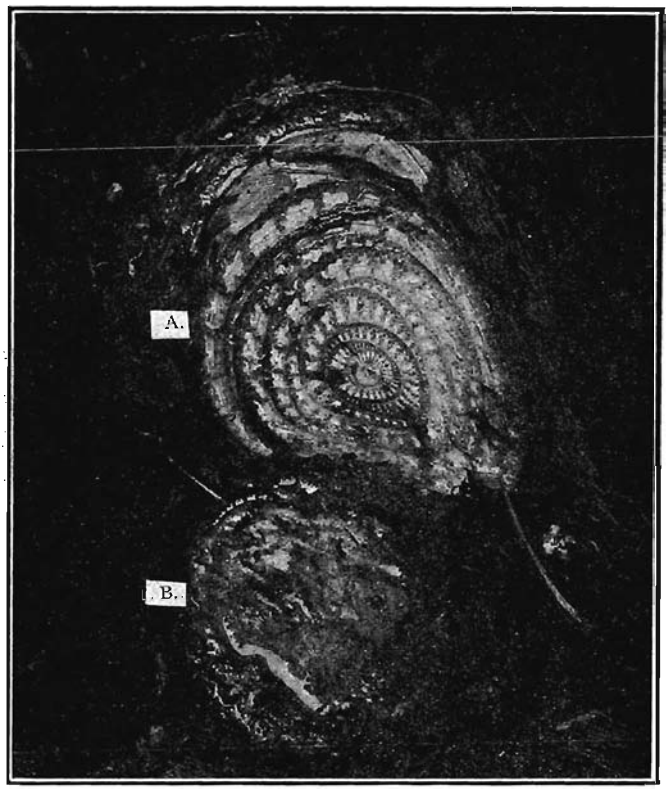

Fig. 4.—A corm from which two suckers have been removed: A, not deep enough to destroy the sucker, and, B, showing that the sucker has been destroyed.

The operation of removing suckers is performed with a sharp cutting instrument. If it is desired to use them for propagating new plants they must be cut lower than is necessary or best if it is intended simply to destroy them. But even in the latter case, it is imperative to cut into the solid part or the shoot will continue to grow. The operator soon learns to rapidly make a slanting cut (fig. 4), which removes the growing part without injury to that which remains.

It is best not to remove the suckers when they first appear, but to wait until they get several inches high. If cut too soon there will be a greater tendency for other buds to start into growth.

REMOVAL OF THE FLOWER BUD.

After the fruit has been set, the bud containing many male flowers continues to hang to the end of the bunch. In the

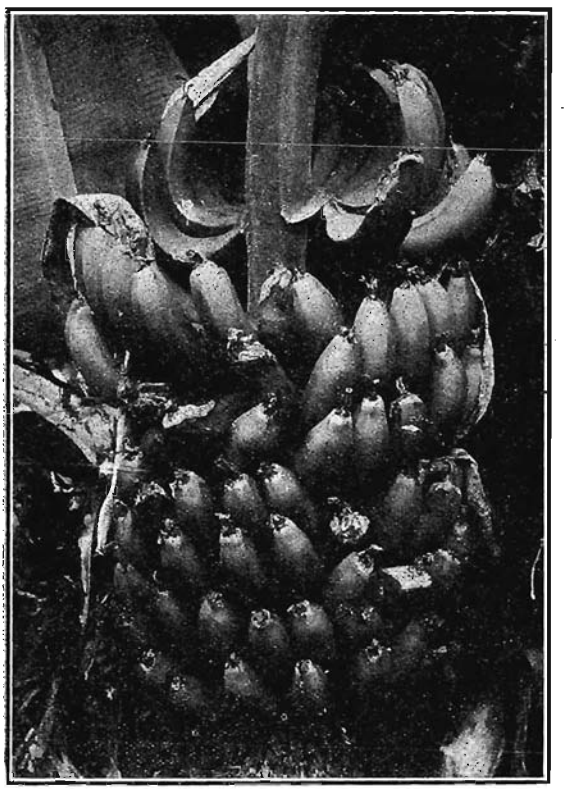

Fig. 5.—Chinese bananas from which the floral organs have not been removed. The decay which originated in the flowers has destroyed many fruits.

case of the Chinese banana it is usually thought best to cut off this bud. This is not regarded as good practice in the cultivation of the Jamica variety. With the Chinese variety, however, the bracts are more persistent.

REMOVING THE DEAD PARTS OF THE FLOWERS.

The Chinese variety retains the dead parts of the flowers at the ends of the fruits. In wet localities these often decay and carry the infection down into the fruit, (fig. 5). A few such

injured fruits in a bunch greatly detract from its market value. Where this trouble is prevalent it is necessary to remove these dead parts soon after they become darkened. They can be broken off quite rapidly by hand.

FERTILIZERS.

Fertilizing any crop may or may not be necessary. The answer to the question will depend upon the amount of available plant food in the soil and upon the requirements of the plant. The needs of the banana plant are fairly well known, but the soils in which it is planted are various. It will therefore be seen at once that it is impossible to state with certainty whether fertilizers are required or not, and if required, it will be quite as impossible to say what kinds are needed. Such questions as these can only be answered by the cultivator for himself after careful study of his plants.

It is known of the banana plant that it requires very large amounts of potash. Without this it is impossible to produce large quantities of fruit. According to Professor E. W. Hillgard,[1] Director of the California Experiment Station, the ash of the fruit of the Chinese banana is over 66% potash and that of the leaves over 27.5%. Large amounts of available potash must therefore be present in the soil.

Nitrogen must certainly be used in considerable quantities in the production of such enormous leaf growth. Most soils, however, used for banana growing are well supplied with humus, or should be for good drainage and moisture-holding capacity. Where this is the case, the humus is also a source of nitrogen supply if good tillage is practiced, and therefore the use of nitrogenous manures is not found necessary so often as potash.

Phosphoric Acid is drawn upon by the banana plant in comparatively smaller quantities.

Lime in excess of that present in the soil is sometimes necessary. It may be needed to enter into the actual composition of the plant but often when there is sufficient in the soil for this purpose it may be required as an amendment to the soil or what is known as an indirect fertilizer. As such it has an important action in connection with Potash, rendering it more available to the plant. It also aids in nitrification and corrects acidity. So

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[1]Report of Agr. Expr. Station of the University of California for the year 1892-1893 and part of 1894.

far as the banana is concerned, however, it has not been proved that an acid soil is detrimental to it. Some plants do their best in an acid soil.

OBSERVATIONS AND EXPERIMENTS.

The cultivator must determine by observation and experiment what fertilizers should be used, being guided by this general knowledge of the needs of the banana plant and such information regarding his soil as he may have been able to acquire.

If the leaves are of a yellowish green shade instead of the natural healthy color it is probable that the plants are not getting enough nitrogen or enough moisture. If the plants have a healthy vigorous appearance with dark green foliage and yet the bunches of fruit are not satisfactory, this, together with the large demands of the banana for potash, suggests that there may be a lack of this element in availabe form.

If more nitrogen seems to be needed, the deficiency may be made up temporarily by the use of nitrate of soda, sulphate of ammonia or dried blood. But the aim should be to provide nitrogen by the use of leguminous crops, for two reasons. This element in any commercial fertilizer is very expensive, while it can be secured almost free of cost by the use of legumes. These or some green crop are also necessary to maintain the humus of the soil. For this purpose Cow peas, Velvet beans or Lablab beans are useful.[1] They should be allowed to grow for a few weeks and then should be plowed under. When a field is to be replanted it would be well to let the vines grow longer.

If the conclusion is that more potash is needed it can be most economically purchased in the form of sulphate of potash or of muriate of potash.

Phosphoric Acid may be needed and if so it can be bought as a plan superphosphate which is phosphate rock treated with sulphuric acid.

Lime may have a very beneficial effect but it should be used with caution on a few plants until its results can be seen.

In fact all these experiments should be conducted on rather a small scale until they themselves have suggested the fertilizing needed.

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[1]Their use should be abandoned if nematode worms infest the plantation. See foot note page 29.

ALL ELEMENTS ARE NECESSARY.

It must be further remembered that a sufficiency of all the elements of plant-food is necessary. An abundance of one will not make up for the lack of another. All the elements of plant food usually abound in the soil, except nitrogen, potassium, phosphorus and calcium. These are spoken of by the agriculturist as nitrogen, potash, phosphoric acid and lime. Any one, two or all of these may be present, in available form, in amount too small for the use of the crop. Hence the use of fertilizers.

The following analyses[1] of bananas from the Hawaiian Islands are of interest in this connection.

1. Proximate analyses of the fruit of the banana, fresh sample procured in the San Francisco market:

	Dried at 100° C.	Fresh.
Water		82.060
Carbohydrates, etc.	90.624	16.256
Albuminoids (crude protein)[2]	3.369	.606
Ash	6.007	1.078
Totals	100.000	100.000

3. Proximate analyses of the leaves of the banana from the plantation of A. J. Campbell, Honolulu, H. I.:

	Dried at 100° C.	Air-dried.	Fresh.	Weight[4] in lbs. of ingredients of the leaves.
Water		11.443	83.953	7.842
Organic matter (not nitrogenous)	79.31	70.235	12.723	1.189
Albuminoids (crude protein)[3]	9.25	8.180	1.490	.139
Ash	11.44	10.142	1.834	.171
Total	100.00	100.000	100.000	9.341

Speaking of these and other analyses of different parts of the banana plant, Professor Hilgard says: "The analysis of the leaf ash shows that potash, lime and chorine are the ingredients chiefly drawn upon by the leaves, but the total amount of these contained in the wrapping of a bunch is only 0.17 of a pound,

[1]Report of the Agricultural Expr. Station of the University of California, for the year 1892-93 and part of 1894.

[2]Determined by the soda-lime method.

[3]Determined by the soda-lime method.

[4]Calculated upon the weight (9.34 lbs.) of fresh leaves used to wrap one bunch of bananas.

and the potash so withdrawn only amounts to half a tenth (0.05) of a pound per bunch.

"The ash of the fruit itself is very much less than that of the leaves, but it contains much more of the important elements; 63 per cent. of it is potash, which with chlorine, forms the predominant ingredient, potassic chloride. Assuming the average weight of a bunch of bananas to be 80 pounds, each bunch carries with it 0.86 of a pound of ash, of which 0.55 is potassic chloride or commercial muriate. Taking five hundred as the average number of bunches of fruit per acre (planting 9x9 feet), there will be extracted 275 pounds of potash by each crop, or, with the leaf wrappers, nearly 300. But there is another point: While the fruit is not very rich in albuminoids, the leaves contain nearly as much as average meadow hay. The wrappings of each bunch of bananas carry away, say, 0.15 of a pound of the same, each bunch of bananas about 0.25 of a pound, or over 2/5 of a pound for each bunch packed. This is quite a heavy draft per acre; when it is multitplied by the number of bunches it is over ten times as much as for a wheat crop, for example. Evidently, some nitrogenous fertilizer should be supplied."

HARVESTING THE CROP.

In regard to the time of harvesting, the banana is less exacting than most fruits. If it is to be shipped several thousand miles, it is cut from the plant earlier than is the case when intended for market within a few days run from the plantation. However, it will be generally admitted that it is best to allow the fruits to get as "full" as is safe considering the time necessary to place them upon the retail market. Of course, if too far advanced, they may ripen and decay before reaching the consumer. The exact stage of maturity which is best for certain circumstances can be determined only by experienced judgment. The terms "full," "too full," etc., are commonly used to express degree of maturity.

The bunches are cut with one and a half to two feet of stem above the fruit which serves as a convenience in handling and also is supposed to aid in keeping the fruit fresh while in transit. Sometimes a part even of the leaf sheaths adheres to the stem of the bunch.

In the case of the higher growing varieties the "trunk" should be partly cut off slightly above the middle allowing the bunch to fall slowly.

Wrapping is not commonly practiced with the Jamaica or Bluefields variety and probably for two reasons. By its shape and

the manner in which the fruits are set upon the bunch, it is peculiarly adapted to withstand transit without packing. See Plate II. But further the trade in this variety is practically controlled by two or three companies who ship their bananas in steamers specially fitted up for the work. The fruit is relieved of the great pressure and rough handling to which bananas are often subjected when shipped on consignment in boats not suited to the trade and controlled by parties who do not own the cargo of fruit.

The Chinese variety is usually wrapped. In the Canary Islands where this variety is grown for the London market, they are very carefully packed, being first wrapped in cotton wool and then with paper and finally placed in a crate with dried banana leaves packed in about them to fill all vacant spaces. In this form they appeal to the fancy trade and sell at prices one hundred per cent. above those obtained by the Jamaica bananas in the same market.

In Hawaii the Chinese variety is simply wrapped in dried leaves and bound about with cord.[1] Recently a few have been shipped in crates. The cost of wrapping is estimated at about five cents per bunch.

REPLANTING.

It is customary to replant fields after five or six years for the following reasons:

To restore regularity to the plantation which may have been quite lost by the suckers pushing out in various directions,

To make it possible to plow more thoroughly,

To facilitate control of the time of fruiting.

If the latter be the aim, replanting earlier than the fifth year would be advisable since it is easier to control the fruiting of the first plant and the first sucker than of succeeding crops. For this reason, some plant between the rows of the first rattoons, the latter being removed after bearing their fruit.

It is also advocated by some that bananas should not be grown upon the same land continuously. No doubt where it is possible to rotate this crop with some other, it would be highly advisable to do so, but if no other profitable crop is suited to the particular

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[1]A small shipment of bananas from Hilo was recently reported as having arrived at San Francisco in bad condition. The bunches were examined and were found to have been wrapped first with damp grass and outside of this with banana trash. If this grass wrapping had been omitted the fruit would have undoubtedly reached destination in good condition. The grass rotted and the bananas were soft and black when unpacked.—J. G. S.

conditions it does not seem that there is any sufficient reason for allowing the ground to lie idle for any considerable length of time. This, however, presupposes good management, the liberal use of fertilizers on most soils and the plowing in of leguminous crops when possible. It would be well to allow a leguminous vine to take full possession of a field for two or three months before plowing up for replanting.

SHIPPING.

There are several essentials to be sought after in a steamship for the banana trade, viz., good ventilation, arrangements for placing the fruit in small compartments so as to avoid too great pressure and reasonable speed in transit. Cool storage is not generally necessary, but it is used to some extent. The average banana boat carries from 10,000 to 20,000 bunches per cargo. Provision is also made for ventilation by a forced draft. Too much stress cannot be laid upon the importance of a free circulation of air. If confined in poorly ventilated quarters, in the hold of the vessel, the bananas ripen quickly.

From Honolulu and Hilo this fruit is shipped on deck and between decks on the regular steamers plying between these ports and San Francisco. They are stored so as to make the pressure upon the fruit as small as is compatible with economy of space, without any special arrangements for this class of trade.[1]

If Hawaii expects to successfully compete in the banana market she must eventually have fruit boats fitted up especially for the business.

DISEASES OF THE BANANA.

Considering the wide distribution of the banana plant in tropical countries throughout the world, it is quite remarkable that it has so very few serious enemies in the form of insects and fungi. Of these few, not more than four or five have proved of sufficient importance to be mentioned in banana literature, while only one of these has become a really alarming pest and that in only a very few instances.

There are three fungi which prey upon this plant.

Banana anthracnose. This is the result of the work of a fungus (*Gloeosporium musarum*, Cke. and Massee) which shows itself upon the ripe fruit. It is reported from Queensland and said to be characterized by a "black smut" upon the fruit. A disease

[1]Since the above writing some arrangements of this kind have been made on the boat between Hilo and San Francisco.

which is probably the same has been reported from South East Africa. It has not proved serious in either case. Diseased fruits should, of course, be destroyed.

Marasmius semiustus, Berk. and Curt. This is a fungus which affects the leaves, "stem" and immature fruits or flowers. It gradually works in towards the center of the plant and often causes the flower-bud to decay before it emerges from the "stem." Mr. George Massee[1] speaks of it as "not uncommon in Trinidad and other islands of the West Indies."

It is quite possible that this fungus was the chief cause of the disease in bananas which broke out in several of the islands of the Fiji group some fifteen years ago and in the course of a few months proved very disastrous to the industry in one or two of the islands. It was, however, checked so that "the governor was able to report in 1891 that after a period of rest the land even there was able to grow plants almost free from disease." The cause of the disease was not positively ascertained, but a fungus was found present which it is stated, caused a brownish discoloration in the rootstock. It was accompanied by at least two species of nematode worms, one upon the roots and one upon the upper part of the plant. Aphids were also present.

The remedial measures recommended for the banana disease caused by *Marasmius Semiustus* consist in the destruction of all affected plants, planting upon well drained soil only and keeping up the general vigor of the plants by every means possible. Bordeaux mixture[2] is reported[3] to have been efficient in the control of "banana Blight" in South Africa. This "blight" was probably the result of the fungus above described.

Fusarium sp. A disease due to the presence of a fungus has been noticed in several parts of the islands during the past year. It affects the central growing part of the banana plant and is first observable by the darkened color of the young leaves before they open. The decay finally results in the death of the plant though the suckers continue to grow. Specimens of the affected parts were sent to Dr. A. F. Woods, Washington, D. C., Vegetable Pathologist and Physiologist, of this Department, who reports in part as follows: "Mrs. Patterson, who made the examination, reports that a *Fusarium* is present in a state of most luxuriant growth. While this fungus has not been reported upon banana it occurs in other plant diseases similar to the one you describe."

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[1]"Text Book of Plant Disease." P. 206.

[2]See Bul. No. 3, Hawaii Exp. Station.

[3]Report of the Dept. of Agr. of Cape Colony, noted Experiment Station Record, Vol. 5, P. 354.

All plants affected with this disease should be destroyed. They are useless and are likely to prove a menace to other plants.

INSECTS AND OTHER ENEMIES.

Nematode worms. These are small worms of which there are several species known to be injurious to plants. One of the most common is the species which causes the root gall of the tomato on the mainland of the United States.[1] Several species of these have been found upon the banana plant and at least two, as mentioned above, are regarded as injurious to it. In fact these worms are mentioned either as the cause or in connection with most of the banana troubles which have been reported from time to time in different parts of the world. It is possible that their ill effects may be due to the assistance they render to the fungi in gaining an entrance to the plant. Such is the case with other root-feeding worms and insects.

The remedies recommended for this are the same as those mentioned above for the accompanying fungus disease, excepting Bordeaux mixture. Deep plowing is also recommended since the nematodes are thought to thrive best in the surface soil and if turned under many will perish.

Aphids have been found infesting banana plants but their work has not been regarded as at all serious. If it should ever prove so a remedy could be found in kerosene emulsion.[2]

Borers. The "cane borer" (*Sphenoporus obscurus*), a beetle common in Hawaii, has occasionally been found in the "stems" of banana plants. This insect was probably introduced from Tahiti. Other species of the same genus have been reported as attacking bananas in other countries.

A banana borer (*Castina licus*), a larva of a moth, has been reported from Trinidad. It has never been a serious enemy there.

A species of red-spider has done some damage to the appearance of bananas in sections of these islands, causing a "brownish smut" on the skin of the fruit. It is said to have been present in this country for a long time, but has not proved a really serious pest.

USES OF THE BANANA.

The banana plant is used in an almost infinite number of ways. Nearly every part of it is put to several uses. To describe these

[1]There is a club root disease of tobacco present in these islands due to the attacks of a species of nematode worms.

[2]See Bul. No. 3, Haw. Exp. Station.

in full would require a small publication in itself.[1] Here only brief mention can be made of some of them.

The ripe fruit is known to most Northern people simply as an article of dessert—a mere incidental to a well provided table. In tropical countries, however, it is a staple article of food, the native population frequently being quite dependent upon it. It is eaten not only raw but cooked in a great variety of ways. The unripe fruit is also cooked, some varieties being better in this way than when ripened. Some varieties are especially adapted for drying and in favorable climates may be dried by the sun without resort to artificial means. In this form, they may be used as are other dried fruits now so common in the markets.

Banana flour or meal is made by reducing the dried fruit to a powder. The following directions for its manufacture are given by Rev. J. P. Hall of Jamaica:[2]

"First—The fruit must be 'well fit' (but not on the turn) and freshly cut from the suckers.

"Secondly—The bananas should then be peeled with silver or ivory knives and thrown into large tubs containing plenty of clean water. Another person should then cut each banana into thin flakes, and spread them thinly in trays to dry.

"The quicker the fruit is handled the better will be the result as well as freedom from 'stain.'

"I use machinery and by its use I am able to barrel the flour in six hours after the fruit has been cut."

The fruit is dried by artificial means, ground to a powder and sifted to produce a uniform article.

To show the amount of flour that may be made from a given quantity of fruit, the same writer states that 87 bunches weighing 4,555 pounds yielded 452 pounds of flour. It will be seen that the fruit thus produced flour equal to about 1/10 of its own weight. Another writer states that the variety known as "Fig banana" yields very much more. The analysis of this flour varies somewhat with the variety used and with the maturity of the fruit. The following is given as its average composition by Mr. A. Petermann:[3]

	Per Cent.
Water	5.60
Protein	3.13

[1]A resume of this subject may be found in the Kew Bul., 1894, Pages 284-295. See also Musa in Watt's Dict. Economic Products of India.

[2]Journal of the Jam. Agr. Society, April, 1897.

[3]Bul. Assoc. Belge. Chim., 13, No. 3, pp. 147-148.

Fat	1.73
Nitrogen-free extract	82.39
Crude fibre	1.22
Ash	5.93

The nitrogen-free extract contained 7.19% glucose, 3.34% dextrin, 45.76% starch.

The flour is recommended as an excellent food for infants and invalids and has considerable value in cookery. Its manufacture, as an industry, has been urged repeatedly and the subject is constantly coming up in tropical agricultural journals, but it has never attained great commercial importance. This may be due to the fact that the demand for fresh fruit has been constantly increasing. It is generally true that the manufacture of secondary products from fruit does not assume great proportions until the market for fresh fruit has become overstocked. If the time comes when large interests have more bananas than can be marketed in the fresh state, the capital involved may make an outlet for some of the fruit in secondary products of which flour is probably the most promising. This is one of the things that the public will use only after being taught to do so, and to teach the public requires large expenditures in advertising. It is highly desirable, however, that this industry should be developed, thus making an outlet for the fruit of small and damaged bunches. Efforts should be continued along these lines.

Other secondary products that have been made from bananas are preserved ripe fruit, alcohol, vinegar and wine.

The fruit-bud of some varieties is cooked and eaten and is said to be very good. The flowers, fruits and corm or root-stock are said to have medicinal value. The corm is also used as food for stock as is also the part of the fruit stem inside the "trunk." The latter is also used as food by the natives of some tropical countries.

The leaves have been used as fodder for stock and, as will be seen above, Professor Hilgard states that they contain nearly as much albuminoids as average meadow hay. They are not, however, extensively used in this way. Watt states that in India they are used as cool bandages for burns, scalds, etc. The fresh white leaves within the "stem" are eaten as a vegetable. The sap or juice, the stain of which every one in the tropics is familiar with, is a source of dyeing material.

The fibre of the leaves of the ordinary bananas has long attracted attention and continues to do so. That of the so-called fibre banana (*Musa Textilis*), as is well known, is the souce of the Manila hemp of commerce and is one of the most valuable fibres

Pl. V.—Lele.

in the market. For a short treatise concerning this, see Press Bulletin No. 5, of this Station. Many and repeated attempts have been made to establish a profitable industry by extracting the fibre of the varieties of bananas grown for their edible fruits. When the plant bears its fruit it is of no further use and dies, being replaced by the suckers that have sprung up about it. Millions of plants containing thousands of tons of fibre thus decay upon the ground each year and serve no purpose except as fertilizing material. Hence the many efforts to make some commercial use of what now seems to be waste. It should be remembered, however, that the fertilizing value of this vegetable matter is very considerable. Up to the present time no marked success has followed this line of work. The reasons are probably the inferior quality of the fibre and the low percentage of fibre in the total weight of stem.

The banana fibre while of fair quality and adapted to some uses is so inferior to that of *Musa textilis* that the former does not find a ready market except when the latter is scarce and the price very high. It then brings only about half the price of Manila hemp. It is inferior both in strength and lustre.

It is claimed that the bananas contain less than two per cent. fibre. This represents a tremendous weight of material to be cut, carried to the machine and worked over to obtain a small amount of fibre. If some machine can be invented which will be effective in extracting the fibre economically and which, at the same time will be light and portable so as to avoid the expense of transporting so much crude material, there may then be an opportunity for a banana fibre industry.

The ashes of the banana plant are used in India in dyeing and tanning processes, in the making of curries and by the poorer classes as a substitute for common salt.

THE BANANA TRADE.

The banana trade is a creation of recent years. In America it commenced about a generation ago with the shipment of a few bunches from Jamaica or Panama to the United States. From this as a beginning it has continued to grow until in the year 1902 the value of the bananas imported into the United States was over $7,300,000. The rate of development during the past twenty-four years exclusive of 1903,[1] is shown by the following table of imports of bananas into the United States:[2]

[1]Statistics for 1903 not yet available.

[2]Statistics furnished by Mr. W. A. Taylor, U. S. Dept. of Agriculture. Taken from U. S. Treasury publications.

Year.	Value.
1878	$ 539,534.96
1879	510,639.20
1880	682,755.08
1885	2,095,225.00
1890	4,653,779.00
1895	4,674,861.00
1900	5,877,835.00
1901	6,550,186.00
1902	7,307,437.00

Almost all of this large importation comes from the West Indies and Central America.

While this wonderful development in industry and commerce has been taking place in America and its neighboring islands, a similar expansion has been progressing in the trade between the Canary Islands and Great Britain. The Canary banana trade "employes something like twenty-five steamers per month." During the last few years efforts have been made to build up a banana trade between the West Indies and Great Britain. These bananas, though shipped several thousand miles and though sold at a price far below that of the Canary product, still bring a profit to the shipper. The cities of the continent of Europe seem not to consume bananas in as large numbers as those of the British Isles, the United States and Canada.

In recent years an important banana trade has been developed between the Fiji Islands and the British Colonies to the South. The northern part of Australia, however, is itself a banana-growing country.

The Hawaiian banana trade had its beginning between forty and fifty years ago. As early as the year 1864, according to Thrum's Hawaiian Annual, there were 121 bunches of bananas exported from these islands. Probably these were the first of the Chinese variety to be shipped from here, since Hillebrand records that this species of *Musa* was first brought to us from Tahiti about the year 1855. In the year 1863 only sixty bunches were exported, but from this time onward the trade increased slowly until it reached its maximum in the year 1896. In this year the export amounted to 126,413 bunches. The next three years show a considerable decrease in this export. From that date to the present time there are no figures to show the size of the shipments, for since annexation our Custom House authorities have made no specific classification of bananas sent to the mainland. It is probable, however, that the shipments were

Pl. VI.—Kaualau.

light until last year when they increased again. This drop in the Hawaiian trade was no doubt due to the diligence of those interested in the Central American and West Indian fruit trade in extending their trade westward.

The Hawaiian product suffered in the market not because of inferiority, for the Chinese variety is considered superior in flavor to the Jamaican. The latter, however, can be handled more cheaply because of its hardiness.

The Hilo banana shipping business has begun only recently, since that town has had direct steamship communication with the mainland. It amounted to between 3,000 and 4,000 bunches per month at the beginning of this year, and men of conservative judgment estimate the output at 15,000 bunches per month, by the close of the year.

The low prices of the past few years may result in great good to Hawaii in several ways. They doubtless did much to cultivate a taste for bananas, thus increasing the capacity of the markets. They have also impressed it upon the grower to some extent, it is hoped, that only large bunches of first-class fruit should be shipped. They should have also taught Hawaii that to succeed the best possible article must be produced at the smallest possible cost.

The future development of the banana trade of course cannot be foreseen, but there is no reason to suppose that the limit of capacity has yet been reached. The figures above show a steady increase in consumption in America. In the future more of the bananas from the British West Indies will probably find an outlet in the markets of the Mother Country. It is possible that the public taste may become more discriminating, thus giving a stimulus to the trade in the finer varieties.

There seems no good reason why the Hawaiian Islands should not now assume a very much larger share in the trade. The soil, the climate and proximity to market are all in their favor.

THE BANANA FROM A BOTANICAL STANDPOINT.

The banana in the widest use of that word constitutes the genus *Musa*, being named after Musa, the physician of Augustus. It belongs to the natural order *Scitaminaceae*, of which there are several well-known genera. Perhaps its relatives most familiar to the public are the *Canna* or Indian Shot, the *Ravenala madagascariensis* or traveller's palm and *Strelitzia reginae* or Bird of Paradise flower. The last two of these especially bear striking resemblance to the banana which must have been noticed by all who have seen these species.

Pl. VII.—Koae or Ae-ae.

The genus *Musa* contains many species. Quite a large proportion of these do not produce edible fruit. *Musa sapientum* is the commonest species prized for its fruits and embraces very many varieties, among others the Jamaica or Martinique and the Red Spanish.

Musa cavendishii is the Chinese or dwarf banana which is usually spoken of as being of only one type. It, however, varies somewhat in different environments and it is possible that there are forms sufficiently distinct and constant to merit varietal names.

The original home of the banana is thought to be in Southern Asia, probably in the Malay Archipelago. De Candolle, in his "Origin of Cultivated Plants," says:[1] "All this indicates great antiquity of culture, consequently a primitive existence in Asia, and a diffusion contemporary with or even anterior to that of the human races." From this early home it has spread in all directions and may now be found wild or cultivated in every tropical region. Very early it made its way westward into India and eastward among the islands of the Pacific. In both of these regions it may be found wild in very many forms. Even so far north as the Hawaiian group, the wild varieties are numerous. It is difficult or impossible to state to what extent it has spread by natural means and in what instances it has been aided by man. It must have been brought to the New World on shipboard.

The variability of the banana is a striking feature and has given rise to the many forms now in existence. This is the more worthy of note when it is remembered that most species do not produce fertile seeds and hence are exclusively reproduced by asexual parts. The banana is a conspicuous instance of bud-variation. Some have supposed that this variability of the plant resulted from it having become seedless. Darwin, however, collected a number of facts from which he concluded that both the sterility and the variability alike resulted from the conditions of life. He says:[2] "It would seem that changes in the conditions of life lead either to sterility or to variability, or to both; and not that sterility induces variability."

The subject of the fertilization of the flowers of bananas in Hawaii has not been worked out but it is probable that pollenation is effected through the agency of insects.

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[1]Page 307.

[2]Animals and Plants Under Domestication, Vol. II, p. 256.

SOME VARIETIES OF BANANAS IN THE HAWAIIAN ISLANDS.

There are very many varieties of bananas in this island group, both native and of recent introduction. The introduced varieties and species are scattered in gardens and yards and are perhaps even more difficult to search out than most of the forms which grow wild in the mountains. It would be a work of many months if not of years to ascertain definitely all the forms that are present. The following list does not claim to be exhaustive but is given here in the hope that it covers most of the important kinds of edible bananas to be found in these islands.

MONENCLATURE.

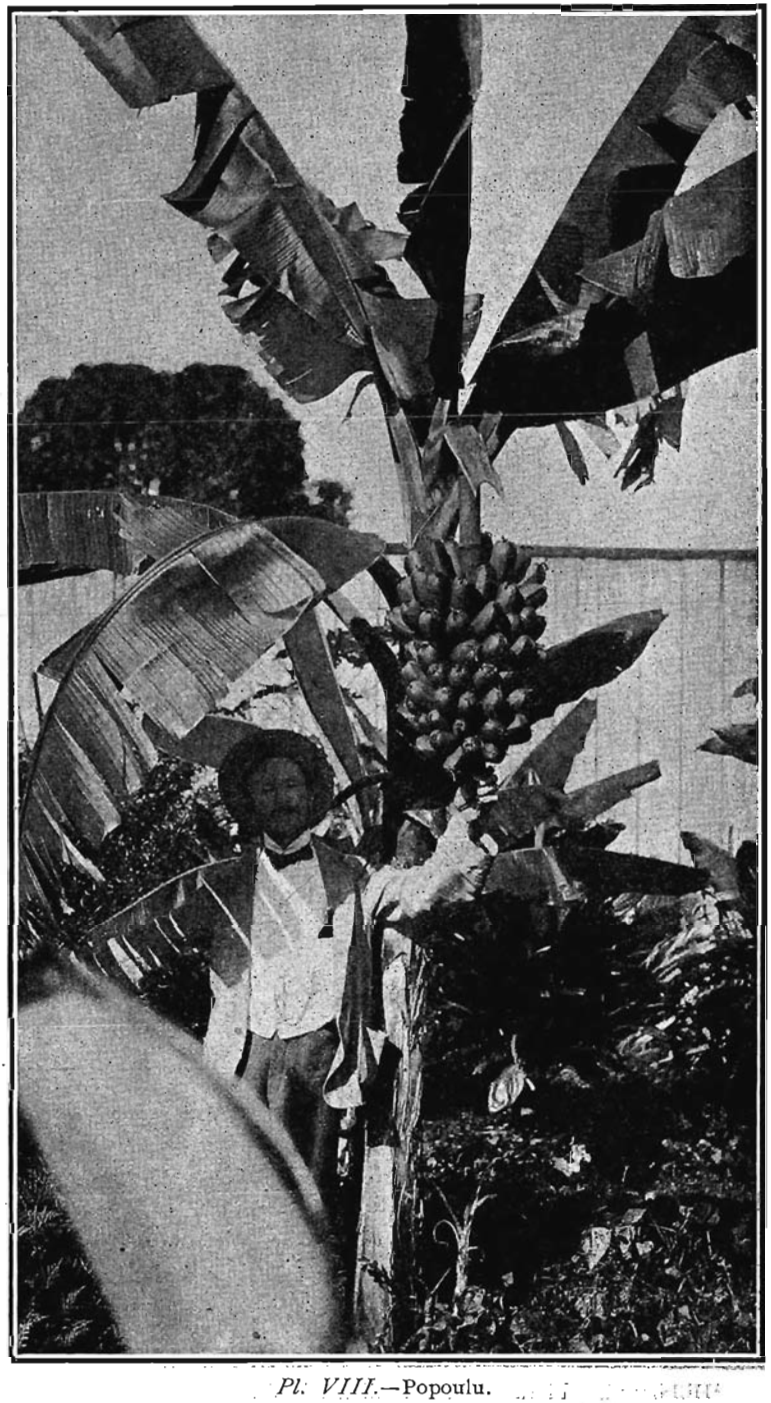
There is no uniform nomenclature for the different forms. The same variety has a different name in almost every country where it is grown. To add to the difficulty of identification, it is unfortunate that the descriptions given are usually meager and insufficient to establish identity.

Plantains and bananas. Even these terms are used with several different meanings. In some countries the name plantain is applied to almost any edible *Musa* while in other places the word banana has an equally wide meaning. Plantain sometimes has reference to fruits of a special form. It is a quite common and a better usage, however, to reserve this term for those varieties which need to be cooked before being eaten. Even in this sense it is of somewhat doubtful application since some varieties which are usually cooked are often eaten raw.

RECENTLY INTRODUCED BANANAS.

Commercial varieties. From a commercial standpoint there are but few varieties here or anywhere. The most important are the Jamaica known also as Martinique, Bluefields, etc., the Chinese or Cavendish and the Red Spanish or Jamaica Red.

The Jamaica. (Plate II.) Introduced by Mr. Philip Peck of Hilo early in 1903, and again by the Board of Agriculture and Forestry at the close of the same year. It has received many names from the places where it has been grown. It is the chief banana of the American trade; excellent for shipping; fine in appearance, flavor fair, fruits well placed on bunch for convenient handling. The plants are large. This is the banana for the millions.



Pl. VIII.—Popoulu.

The Chinese banana (*Musa cavendishii.*) (Plates I and III.) Introduced from Tahiti about 1855.[1] The plant is of very low growth, the fruit of good flavor, the bunch of large size. It is excellent for shipping but will not stand as rough handling as the Jamaica.

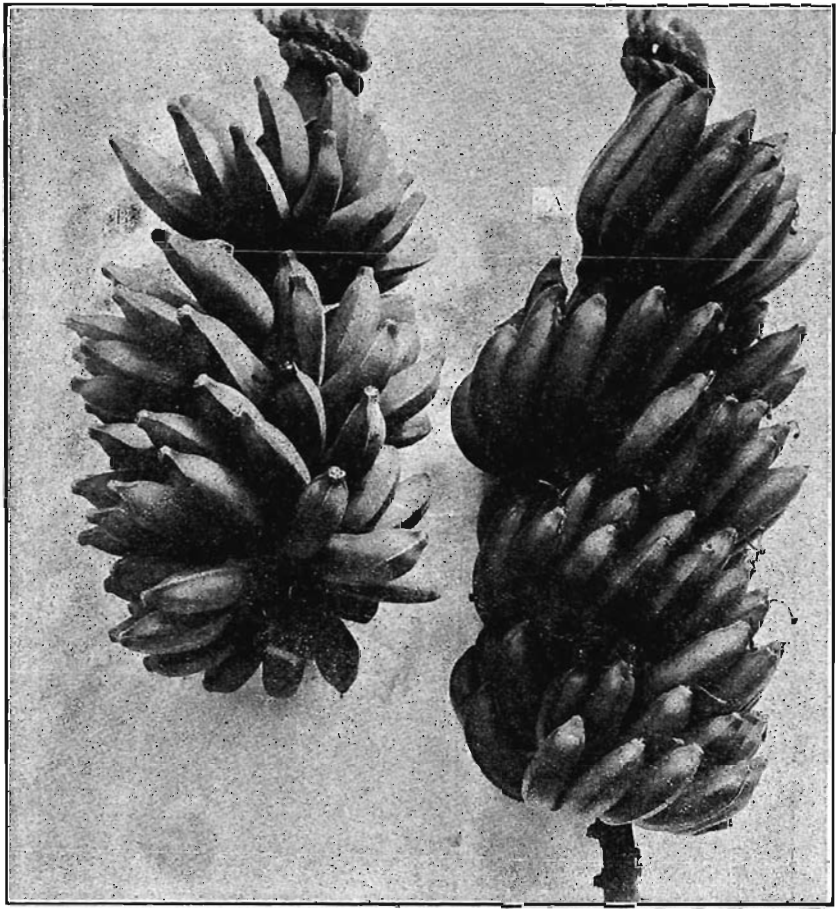


Fig. 6.—A; Apple banana; B, Brazilian.

Red Spanish. (*M. sapientum,* var. *rubra.*) Probably Ram Kela of India. The plant is 24 to 28 feet high. Trunk, petiole[2] and midrib of leaf are red. The bunch is large, with fruits large and changing through various shades of red while maturing. It is very attractive when ripe and is sold as a fancy fruit chiefly upon appearance though of good flavor.

[1]Hillebrand. Flora of the Hawaiian Islands.
[2]Stem of leaf.

The Brazilian (Plate IV) as it is locally known, is regarded by some as the finest of all in the islands for eating raw. It was introduced about 1855 from Tahiti. Probably Pisang radjah or Pisang medji, "The dessert banana" of Java. The flower end of this fruit is drawn out into a kind of beak (fig. 6). The skin is yellow, easily separating from the fruit. It has no rank as a shipping variety since the fruit falls from the bunch. The plant is a vigorous grower, 25 to 35 feet high, firmly rooted and withstands winds. It rattoons freely and is useful as a wind-break for more delicate varieties.

The Apple Banana, (fig. 6). Introduced by Mr. Afong from China about 1868. The fruit resembles the Brazilian in color but is without a distinct beak. The skin is thin, often splitting when ripe. The variety must be thoroughly ripe to be appreciated. If eaten too soon it has an astringent after-taste. The plant is of medium height (18 to 22 feet), with green trunk. The leaves are green throughout except on the edges of petiole where there is a tendency to a pinkish tint.

The Largo. Introduced with the Red Spanish from Mexico. It resembles the wild variety Lele,[1] in form of fruit and in the long scape or stem of the bunch, (Plate V). The flesh is buttery, of fair flavor and pinkish in color. The plant is of medium height.

Hamakua banana. This was seen by the writer in Hilo, Hawaii, where it is known by this name, having been brought from the district of Hamakua. Probably it was introduced from Madeira. The fruit strongly resembles the Chinese, but the plant is of enormous size.

Borabora banana. The name becomes, in Hawaiian tongue, Polapola. This in turn has been corrupted in English into Bolo Bolo by which this variety is sometimes but improperly designated. This is *Musa fehi,* which is common in the forests of Tahiti and was probably brought to Hawaii from Borabora, an island of the same group. It is not from Bolo Bolo. The Tahitians call it Fei. It now grows uncultivated in spots in the forests where it has been planted but it is not spoken of as a "native banana." The peculiarity of this variety is that the scape or stem of the bunch stands erect holding the bunch straight up instead of hanging over as most bananas. The fruit is oblong, nearly straight, sessile[2] and of fair quality when cooked.

[1]See wild varieties.—Lele.

[2]Individual fruits or fingers set close to central axis i. e. without a stem.

It is reported as producing seeds occasionally in these islands. In Tahiti it is often found to produce seeds at an elevation above 3,000 feet. The plant is a tall, vigorous grower, the base of the trunk black but the upper part green. The petiole is short and stout compared with the length of blade.[1] The trunk is full of highly colored juice.

Kusaie banana. (fig. 7.) Introduced from the Island of Kusaie by Mr. F. G. Snow about fifteen years ago. This is probably *M. sapientum var. troglodytarum* which is often mistaken for *M. fehi* because it bears its fruit in a similar upright position.

Fig. 7.—Kusaie Variety.

The fruit, however, is more rounded, of greater diameter and a redish-yellow color when ripe. It is of fair quality when cooked.

HAWAIIAN BANANAS.

By this name it is not intended to imply that the varieties mentioned below are indigenous in the strict application of that term. The original stock probably came to these islands with the early migrations of the Polynesian races from the

[1]The main part of the leaf.

south. Certain it is that the banana did not originate here, though perhaps no one can say positively that a chance introduction has never been made by natural means. Some of the varieties may have been developed here from the introduced forms. They are, however, found uncultivated in the gulches,

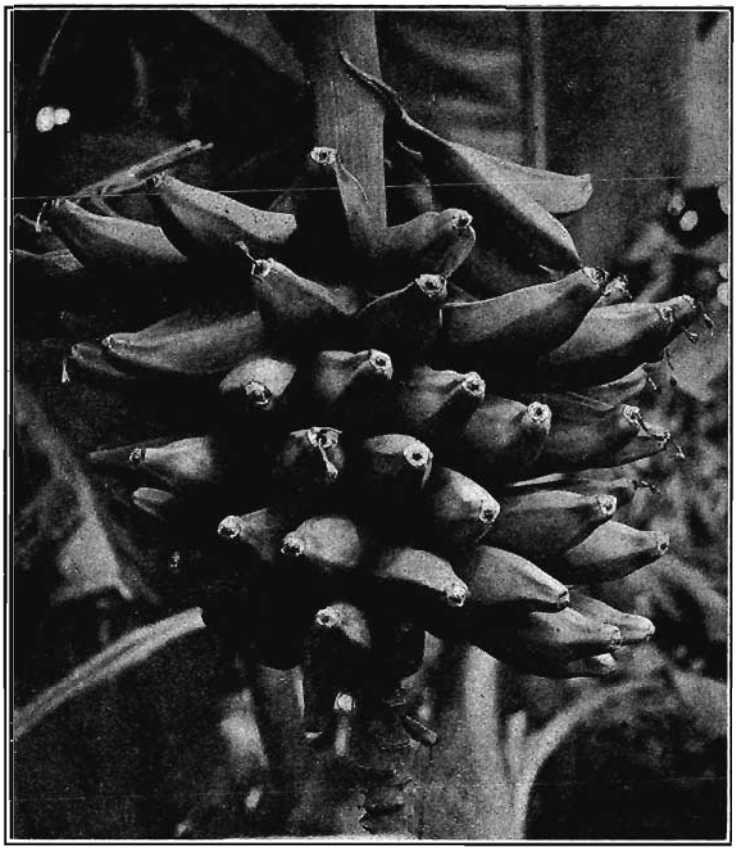


Fig. 8.—Iholena.

the valleys and the sheltered places in the mountain forests, and are spoken of as "Native bananas" or "wild bananas." Some of these are doubtless where they were placed by the early Hawaiian cultivators, but nature has also done her part in the distribution as she continues to do. For example a heavy rain uproots a banana plant or an old corm and

washes it down to the stream by which it is carried down the gulch and lodged in some new locality. As it grows it sends up new shoots and the progeny gradually spreads over the side of the gulch.

The number of these so-called native varieties is variously estimated between 25 and 50. There may be as many as 50 different names and possibly more, but it is well known that the same variety often has several different names. The Hawaiians of Kauai or Oahu may give it a name quite different from that by which it is designated on the island of Hawaii. Many names, therefore, are synonyms, but there are, nevertheless, many distinct forms. The differences in some cases are small, but sufficiently marked and constant to justify the different names.

Most of the Hawaiian bananas may be classed in three general groups. These are the Iholena, the Maoli and the Popoulu.

The *Iholena* group includes: Iholena, Lele, Haa, Puapuanui, Kapua, Hilahila and Ihou. In this group the fingers are usually of greatest diameter near the center and more or less pointed at either end. The color of the immature fruits is a light green, turning to yellow while still hard and unripe.

Iholena. (Fig. 8). This variety gives its name to the group. The plant is of low growth, perhaps about 9 feet to the top of the leaves as an average. The petioles are rather stout, light green with pink on the edges; leaves slightly bronze colored on the under surface when new. The bunch is rather small. The fruits are arranged loosely and stand out almost at right angles from the axis of the bunch. The skin of immature fruits is light green, turning to yellow before ripening. The form of the fruit is angular. When thoroughly ripe, beginning to turn black, it is regarded as one of the best of the native bananas for eating raw. It is also good for cooking. The flesh is pink.

Lele. (Plate V.) This plant is of much larger size, 18 to 22 feet. Petioles and leaf sheaths at upper part of trunk are of a very light green color. The leaf blades, when fresh, show some tendency to bronze tints on under surface, but less than Iholena. The bunch is hung on a very long scape or stem. The fruits, which very closely resemble Iholena, are placed upon the bunch in the same way. The flesh is pink as in Iohlena.

Haa. This is characterized by the dwarf habit of the plant, which is even smaller than Iholena. It fruits quickly. Otherwise these two varieties closely resemble each other.

Fig. 9.—Puapuanui.

Puapuanui. This has the largest "tree" of the group. The fruit, (Fig. 9), differs from the rest of this group in being less angular and much less pointed at the ends.

Kapua. This name seems to be a synonym of Puapuanui. It is the term commonly used in Kona and other parts of Hawaii, but on Oahu is seldom heard. It may, however, be the older name.

Hilahila. This is a synonym of Iholena.

Ihou. A plant claimed to be of this variety, and just flowering, was pointed out to the writer in Kona, Hawaii. At this stage of development it was not distinguishable from Lele. It is said, however, to have fruits of much greater diameter.

MAOLI GROUP.

Among those usually classed in the Maoli group are: Maoli or Maiamaoli, Puhi, Malai-ula, Kaualau, Hai, Koae or Ae-ae, Elele, Poni, Loha and Hinupuaa.

Maimaoli. This is the commonest variety of the group to which it gives its name. Most of the other members are simply slight modifications of this type. The trunk is light green in color when young, with faint tints of pink. The characteristics of this variety and of the group in general, are roundness of form in fruit, which is usually turned more or less upwards, bluntness at the flower end, and length much greater than thickness. Together with a few of the modified

forms it furnishes most of the cooking bananas sold in Honolulu. In flavor and texture all the Maolis very closely resemble each other. They are usually cooked, but are much enjoyed raw by some.

Puhi. The distinguishing character of this variety is the great length of the fruit, which is small in diameter, as compared with most others of the group, and is often slightly bent or twisted. These peculiarities give it its name, which is the Hawaiian for eel.

Malai-ula. (Written also Malaiula and Manaiula). The upper part of the "trunk" has a decidedly redish color, which extends out more or less on the midribs. The most striking peculiarity, however, is the very dark red color of the immature fruits or pistils of the flowers when they first appear. As they increase in size this color gradually passes away and they take on the shade of green characteristic of the Maoli group.

Kaualaau. (Plate VI.) This is the shortest "tree" of the Maoli group, being on an average about fourteen feet. It may also be distinguished from its relatives by its dark green foliage resembling in color the leaves of the Chinese variety. It will stand more wind than the others of this group.

The bunch is rather small among the Moalis but the variety can hardly be distinguished by the characters of bunch.

The fruit is of good flavor, but not regarded by some as equal to Malaiula.

Hai. This forms the largest plant of any of the native bananas and produces the largest bunch of fruit. The individual fruits also are very large. It is not so hardy, however, as some other kinds and neglected often fails to produce vigorous suckers and therefore dies out.

Koae. (Plate VII.) Also written Ae Ae or simply Ae. This is probably *M. sapientum var. vittata.* Koae is the white striped banana somewhat common in Honolulu but more so in Hilo and other moist parts of the islands. The leaves are striped with white on petiole and there are blotches of white on the blade. The fruit also is striped longitudinally with white. It is claimed by some to be of more recent introduction than the other varieties, but is said to be growing uncultivated in places in the forests. The fruit is of fair quality when cooked.

Eleele. The "stem," petiole and midrib of leaf are all very dark—in fact almost black. The fruit when it first appears is also so dark that at a distance it looks black. The black leaf

sheaths, petioles and midribs furnish material used in the manufacture of native hats.

Poni. Probably a synonym of Eleele.

Loha. Not seen by the writer. Described by Mrs. E. M. Nakuina as follows: In general characters between the Maoli class and the Iholena. The plant is of tall growth. The leaves resemble Lele. It is peculiar among all the Hawaiian bananas in that the fingers or individual fruits hang downward toward the ground. It has been seen by Mrs. Nakuina only on the Island of Molokai. The fruit, if not bruised, is very good but slight brusing even while green destroys its texture.

Hinupuaa. This is a black-stemmed variety resembling Eleele if not identical with it.

THE POPOULU GROUP.

This is characterized by short thick fruit set almost at right angles to the stem of the bunch. Here are classed: Popoulu, Kaio, Hua Moa, Moa, Nou and Lahi.

Popoulu. (Plate VIII) The plant is of medium to low growth, the stem green with slight tendency to pinkish tints on petioles. The bunch is of medium size, the scape (or stem of bunch) rather slender. There are eight to ten fingers per hand. They are short, thick and rounded, and blunt at the end. This is rather a common variety, and of good quality when baked.

Kaio. This is similar to Popoulu but grows on a somewhat taller "tree" and is not so fine in flavor. It is sometimes called a tall growing Popoulu.

Hua Moa. (Hen's Egg.) (See Plate IX.) The plant is of medium height, the petioles long and slender. There are rather more leaves in the rosette than most other varieties have. Once seen it may always be distinguished by these characters. The scape is very slender. The fruit is nearly as great in diameter as in length. There are often only two or three fruits per bunch. The fruit has a tendency to crack open before ripening—hence it must be gathered early. It is of very superior flavor.

Moa. This is claimed by some to be distinct from Hua Moa, never producing in one bunch more than two or three fruits, these, however, being of enormous size. It is probable, however, that the varieties are not distinct, the differences which have given rise to the two names being due to the immediate effects of soil and cultivation.

Pl. IX.—Hua Moa.

Nou. This variety has not been seen by the writer. It is described by Mrs. E. M. Nakuina as a very dwarf variety—three to four feet high. It does well in windy places.

OTHER VARIETIES.

There are a few varieties that cannot well be placed in the above classes.

Maia Hua Alua sometimes called *Mahoe.* The peculiarity of this variety is that it produces two bunches of fruit from the same stem.

Maia Hapai. This is one of the most curious forms in the islands; probably Lubang or eel plantain of Java. It ripens its fruit within the stem.

Oa. An ornamental variety. The leaves are blotched with redish-brown color.