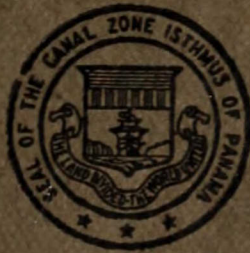


ANNUAL REPORT
OF THE
CANAL ZONE
Plant Introduction
Gardens*

For the Fiscal Year
1929



* Since the writing of this Report, announcement has been made of
the change in name to
"CANAL ZONE EXPERIMENT GARDENS"

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For additional copies of this publication address The Panama Canal, Washington, D. C.,
or Balboa Heights, Canal Zone.

LETTER OF TRANSMITTAL.

CANAL ZONE PLANT INTRODUCTION GARDENS,
SUMMIT, C. Z., *July 31, 1929.*

SIR: I have the honor to present herewith and to recommend for publication, a condensed statement of the Annual Report of the Canal Zone Plant Introduction Gardens, for the year ending June 30, 1929.

Respectfully,

J. E. HIGGINS,
Agronomist in Charge.

Mr. ROY R. WATSON,
Chief Quartermaster,
Balboa Heights, Canal Zone.
Through Mr. J. H. K. HUMPHREY,
Assistant Chief Quartermaster.

REPORT OF THE

COMMISSIONER OF THE
LAND OFFICE

FOR THE YEAR 1881

ALBANY:

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ANNUAL REPORT

OF THE

CANAL ZONE PLANT INTRODUCTION GARDENS FOR 1929

BY

J. EDGAR HIGGINS, *Agronomist in Charge.*

INTRODUCTION.

The work of the Canal Zone Plant Introduction Gardens has been continued throughout the year along the same general lines as outlined in the Annual Report for 1928. The aims and objectives of the work were quite fully set forth in that report. Increasing emphasis is being laid upon such effort in plant introduction and experimentation as may prove to be of permanent value, not only to the Canal Zone, but to Panama in general, and ultimately to the entire surrounding region. This is understood to be the definite purpose of the Administration in maintaining this work. As an illustration, mention may be made of the introduction, propagation, and dissemination of the varieties of sugar cane. The sugar industry in Panama is at present suffering much from the Mosaic disease and other pests. There is need of varieties of cane resistant to this disease and also of higher sugar-yielding capacity. The Gardens have introduced many varieties, including a number that have proved satisfactory in other countries. This year sample lots for testing under plantation conditions have been distributed without charge to the Government of Panama and to private growers of cane in the Republic. This work is being still further pursued by the introduction of other varieties and by the increasing of the plantings at the Gardens so that the dissemination of any selected varieties may be extended.

Panama imports large quantities of rice, a commodity which it would seem, should be produced more abundantly in the Republic. The Gardens have introduced many varieties from the Philippines and elsewhere, especially of upland rices, and this year are offering these to the Government of Panama and to individuals for trial.

While the emphasis is thus placed upon those things which give most promise of presenting economic results, the fact is never overlooked that it is impossible to foresee fully the future, and plants which may have been introduced for their general interest or for their ornamental value may become of economic importance also. The African Oil Palm, *Elaeis guineensis*, was probably introduced chiefly as an ornamental, yet with the increasing devastation of disease among the coconuts of this region, it is not impossible that this palm may become of large economic significance as a source of vegetable oil. Other examples of the same character might be cited. Also the importance of purely ornamental plants can not be overlooked. They are of educational value, add to the general interest of life for those who reside here, and are an attraction to travelers. The opportunities for making the Canal Zone a garden spot at the Crossroads of the World are unlimited. Therefore, many plants of general interest are being added constantly to the Garden accessions.

PLANT COLLECTING IN HAWAII AND CALIFORNIA.

During the year just closed, the Agronomist made an extended trip to Hawaii to collect seeds and plants, and a brief side trip to Southern California, the chief purpose of the latter being the acquiring of new varieties of avocado and the establishing of exchange relations with organizations interested in plant life. The record of this trip, because of its importance, may constitute a considerable part of the present Annual Report. This travel was performed in compliance with the letter of authorization of the Governor of the Panama Canal, issued September 10, 1928, in accordance with the recommendation of the Chief Quartermaster. The general purposes of the trip were those which the Government of the Canal, with much foresight, designed in the establishment of the Plant Introduction Gardens, namely the introduction of useful and ornamental plants for the improvement of the Canal Zone and, through it, of this entire region. The specific objects of this trip will be brought out a little later in a discussion of the work performed in the two countries mentioned.

THE ITINERARY.

The embarkation was from Balboa, on September 13, 1928, on the U. S. A. T. *U. S. Grant*, which arrived at San Francisco, September 24. I remained in California until October 31, a period of 37 days, during which 20 days of accrued leave were taken, awaiting the sailing from San Francisco of the next Army Transport, from the Canal en route to

Hawaii. This transport, the *Chateau Thierry*, which brought a small shipment of Canal Zone plants for Honolulu and also Wardian cases for use on the return shipment of plants, left San Francisco on October 31 and arrived at Honolulu in the evening of November 6. By the schedule which had been arranged, it was intended to make the return trip by the U. S. A. T. *Cambrai*. As this ship was unavoidably removed from her regular schedule, I embraced the first opportunity to return with the plants from Hawaii on a through boat, which opportunity was afforded by the sailing of the U. S. A. T. *Somme* from Honolulu on January 11, 1929. The *Somme* remained in San Francisco from January 18 to January 25, and arrived in Cristobal on February 4, 1929.

IN CALIFORNIA.

AVOCADO VARIETIES.

In immediate plant collecting in California, the chief objective was the securing of bud-wood of certain varieties of avocado. Although California has been engaged in avocado culture for a comparatively short time, there probably is no other place in the world where there has been so much activity in recent years in the improvement of the culture of this crop. Large commercial orchards have been planted and the growing and marketing of the fruit are being established upon a strong basis. Hundreds of varieties have been under test, including those introduced from tropical countries and those that have originated within the state. It was desired to get the latest information as to the behavior of these and to introduce such as might be of promise for Canal Zone conditions, and also any that may do well in the higher altitudes of the Republic of Panama. By all of these means, it is expected that a continuous supply of choice avocados can be made available throughout the year. At present the markets are flooded, for a brief period, with fruit, most of which is of very poor quality, and this is followed by a period of scarcity which lasts the greater part of the year. Already we have varieties which are demonstrating their adaptability to fill a part of this gap in the seasons.

There were collected in California, and shipped by mail to the Canal Zone Gardens, bud-sticks of avocados of the following varieties: Ishim, Murrieta Green, Linda, Sharpless, McArthur, Genesta, Cantel, Dickey, Northrop, Nabal, Benik, Cabnal, Fuerte Seedling, Lyon Seedling, Ishim Seedling, Spinks, Murrieta Two pounds.

These varieties are all new to the Zone or the propagating material collected represents a strain which was considered worthy of trial.

The method of packing this bud-wood for shipment may be worthy of record as the material arrived in excellent condition. The method is essentially the same as that which was successfully used by the writer in an experimental shipment of avocado buds from California to Manila in the year 1926. Strong and fairly mature bud-wood was selected. With the least exposure possible, it was cut into suitable lengths and the ends of each piece were dipped in warm paraffin. Each piece was then wrapped separately in a very thin wax paper of the weight usually sold as sandwich paper. This appears to be of considerable value for the long distance shipment of avocado bud sticks, which are essentially green, tender, and subject to bruising and decay. These separate sticks were then combined into bundles of four to six with a wrapping of a slightly heavier grade of wax paper. The packing moss was prepared by soaking a quantity of sphagnum in water, wringing out all the water possible and adding a sufficient bulk of perfectly dry, finely divided moss to give the proper moisture content. The great damage arises out of having too much moisture in the mixture. The right proportions can be approximated by dividing the entire bulk of moss into two equal parts, wetting one-half and leaving the other half dry to be thoroughly mixed with the moist half after the latter has been made as dry as possible by wringing in burlap sacking. A heavy paper box, a few inches longer than the bud-stick packages, was provided and lined with heavy wax paper which could be folded over the top when the box was filled. A layer of the moss was placed in the bottom of the box on the wax-paper lining. Over this moss a layer of bud-stick packages, prepared as indicated above, was placed and covered with more moss. More bud-stick packages were then put in and thus the packing was continued until the box was filled. The contents were pressed down slightly but not too tight, the heavy wax-paper lining was drawn over the top so as to make the package as nearly air-tight as possible and the box was closed, wrapped with another heavy wax paper and finally with a manila wrapper and was tied securely. It was then ready for mailing. The purpose of all of this is to retain the natural moisture in the bud sticks without bringing additional moisture in contact with them, and without permitting them to become bruised by rubbing together. By the use of these methods the avocado buds arrived at the Isthmus in excellent condition.

ESTABLISHING EXCHANGE RELATIONS.

A further objective of the work in California was the establishing of exchange relations with the California Botanic Gardens, now being organized, and with other institutions or individuals interested in plant exchange.

The site for these gardens is a magnificent one, located in a valley near Santa Monica. Over 1,000 acres of land have been set aside for the use of the Gardens in this unusually warm and well-protected valley. Very large endowments are being arranged and those in charge of the project are expecting to develop one of the largest botanic gardens in the world. Botanists and horticulturists representing the organization are collecting plants and seeds in various parts of the tropics and subtropics. This institution and the Canal Zone Plant Introduction Gardens seem particularly able to be of mutual assistance through cooperation. The California Botanic Gardens will introduce from tropical countries many species and varieties of plants. In many instances there may be a greater quantity of seed than will be required for the first planting. Some of the tropical plants may require several attempts to establish them in California and the first plants grown may fail, while young, from an occasional brief period of cold weather. In such cases, if the species have become established in the Canal Zone Gardens, where there is no cold-weather hazard, it would be a comparatively easy matter to send to California new propagating material for a second or a third attempt to adapt it to California conditions. The unusual opportunities for mutual assistance and cooperation which are thus opened up by the relationships of these two Gardens are now well recognized by both institutions and some exchanges have been begun. In this way, as well as in the transmitting of seed and plants native to Panama, or received from our numerous exchanges throughout the tropics, the Canal Gardens may render a helpful service. At the same time, the benefits accruing to the Canal Zone Gardens will be equally great, or greater.

Several visits were made to the California Botanic Gardens to become familiar with the work, now just beginning, and it was our privilege to have several conferences with the officials representing the organization.

Commercial gardens which have specialized in rare and unusual plants were visited. Many things of interest were seen in these, some of which will be introduced later for trial at the Isthmus.

IN HAWAII.

In Hawaii a varied collection of plants was secured. This island group has been in plant introduction work for many years and also in the work of breeding new varieties of plants. The bringing in of new plants was begun by private citizens in the early years, and has since been carried on by the Government and by privately-controlled experiment

stations. Hawaii is well equipped with experiment stations and similar agricultural institutions. These include the Hawaii Agricultural Experiment Station under the control of the Federal Department of Agriculture, the Territorial Board of Agriculture and Forestry, the Agricultural Experiment Station of the University of Hawaii, the Experiment Station of the Hawaiian Sugar Planters Association, and the Experiment Station of the Association of Hawaiian Pineapple Cannerys. All of these and other institutions have engaged in plant introduction or plant breeding, or both.

SUGAR CANE.

Hawaii is first a sugar-producing country, the little group of islands now producing over 800,000 tons of sugar per year, and rapidly approaching the one million mark. (Plate I, Figures 1 and 2.) It probably leads the world in the yield of sugar per acre, the average in 1928 for all plantations, including unirrigated as well as irrigated, being 6.67 tons per acre, while yields of 15 tons of sugar per acre and above are frequently recorded. These phenomenal yields are largely due to the application of science and engineering skill to the many problems that enter into the industry, from the breeding of new varieties of cane, the liberal, but well measured use of fertilizers and water, the increased efficiency in the application of water, and all other agricultural aspects of production to the last step in the manufacture and the marketing of the sugar. When their older canes have not proved equal to new conditions the Hawaiian Sugar Planters, through their Experiment Station, have developed new varieties to meet the situation. The now famous variety H-109, is doubtless to be credited with a very large part of increased yields of the last decade.

One of the purposes of the trip to Hawaii was to secure a collection of the most promising canes for trial in Panama where new and disease-resistant varieties are greatly needed. As the season was not opportune for the getting of these canes at that time and was likewise most inopportune for the planting of the same at the Canal Zone Gardens, arrangements were made, through the cooperation of the Experiment Station of the Hawaiian Sugar Planters' Association, and particularly through the courtesy of Dr. Harold L. Lyon, for the shipment of such a collection of canes, to arrive here at the beginning of the rainy season. This shipment, which was prepared and packed with the utmost care by the Agricultural Department of the Experiment Station, received every attention possible to insure the exclusion of all insects and diseases and to maintain the cuttings in perfect health en route. All the canes

PLATE I.



FIG. 1.—A cane plantation in Hawaii.



FIG. 2.—A near view of cane as it grows in Hawaii.

PLATE II.



FIG. 1.—A pineapple plant breeding station in Hawaii.



FIG. 2.—A plant selection field, operated by one of the large pineapple companies.

ERRATUM.

The two illustrations composing Plate II have been reversed. That shown at the top of the page is "A plant selection field" and the other is "A pineapple plant breeding station."

arrived at Balboa on May 31, 1929, in perfect condition and were immediately planted. The shipment included varieties as follows:

Stripe Mexican.	Yellow Calidonia.	H-8965.	Stripe Tip.
Lahaina.	Badila.	H-109.	26 C 250.
U. D. 1.	Hawaiian Uba	P. O. J. 36	P. O. J. 213.
D-1135.			

THE PINEAPPLE.

But the pineapple, in Hawaii, has become second only to sugar cane in importance and, in a little more than 25 years from humble beginnings, has attained an annual production approaching 9,000,000 cases of canned fruit. This industry also has been fostered by the liberal expenditure of funds in the investigation of every phase of pineapple production, packing, and marketing. While selected strains of the Cayenne variety continue to be the basis of the industry, many other introduced varieties are under close observation, and thousands of new seedling and hybrid varieties have been produced in the effort to be prepared for all emergencies and to take advantage of any superior forms that may appear. (Plate II, Figures 1 and 2.)

All of this has its bearing upon Panama and Tropical America in general, as possible pineapple producing countries of the future; and this, without competing with Hawaiian producers, who frankly admit they must look outside of the limits of Hawaii for lands upon which to expand the industry, and who would gladly enter the Americas if these regions prove to be best adapted to their business. As pineapple packers buy large quantities of fruit from private growers, the presence of a cannery would make a market for all the fruit that the native growers might produce and would bring large sums of money into the country.

Therefore, another of the principal objects of the trip to Hawaii was to arrange for the securing of a liberal supply of plants of the Cayenne variety and small amounts of planting material of a number of other varieties. The best time to secure pineapple plants in Hawaii is about midsummer, and, as this fits in satisfactorily with the planting season for the Canal Zone, it was arranged to have the shipments come forward about August. Several thousand plants of Cayenne are being purchased for the shipment. We are indebted to Dr. Frederic G. Krauss, head of the Extension Division of the University of Hawaii and Geneticist of the Experiment Station of the Association of Hawaiian Pineapple Canners, for his offer to complete arrangements for this shipment.

THE AVOCADO.

In Hawaii, the avocado was again one of the important objects of search. A decade or two ago Hawaii was almost as poorly supplied with Fall and Winter avocados as Panama is to-day, but the introduction or the breeding of new varieties, chiefly of the Guatemalan race, and the production of the hybrids of the West Indian and Guatemalan races, are rapidly changing this situation. Now, some of the best avocados of the year are available during these seasons. Buds of many of these varieties and also choice varieties of summer avocados were secured and were forwarded by mail to the Canal Zone. These varieties include the following: Lahi, Esbank, Cooper, Kanola, Gulick Green, Gulick Red, Bountiful, Kinau, Beardslee, Inezholt x Wilder, Haley, Wilder, Aubrey, Hulumanu, Itzamna, Enoi, Bon, Prize Lahaina, Sexton, Bromley, and Seyde.

HIBISCUS VARIETIES.

In the breeding of ornamental plants, Hawaii has specialized in the Hibiscus, and from about a dozen varieties has bred a bewildering assortment running into the thousands of varied forms and colors. Many of these are of exquisite beauty, and among them are included, not only singles, but all degrees of double flowers. There are single and double pure white flowers of large size, single and double yellows, reds, and pinks in innumerable varied combinations. Many of these have never been adequately described and recorded and hence have no established and recognized names. Several hundreds of cuttings of many varieties were collected and mailed to the Canal Zone. The new sorts will add greatly to the variety of form and color in hibiscus on the Isthmus.

GENERAL SHIPMENTS OF PLANTS.

Several shipments of seeds or other propagating material of many different species were despatched by mail from Honolulu. On the return trip of the U. S. A. T. *Somme* were brought four Wardian cases¹ of growing plants (Plate III, Figure 2), and 10 crates and boxes of cuttings, seeds, corms, or other propagating material, in a quiescent condition, and which thus could be carried below decks. Brief mention will be made of a few of the kinds of plants in these shipments.

¹ A Wardian case is a device for shipping plants long distances. It is essentially a closed box or case, with a roof-shaped top, covered with glass which is protected by wooden slats. It is ventilated by only a small opening in each end of the case. The device affords protection from salt spray and strong winds, and obviates the necessity of frequent watering as the water has but little opportunity to escape, and that which is transpired by the plants is condensed and again used by the plants. Moist moss placed about the pots also aids in maintaining the moisture supply.

PLATE III.

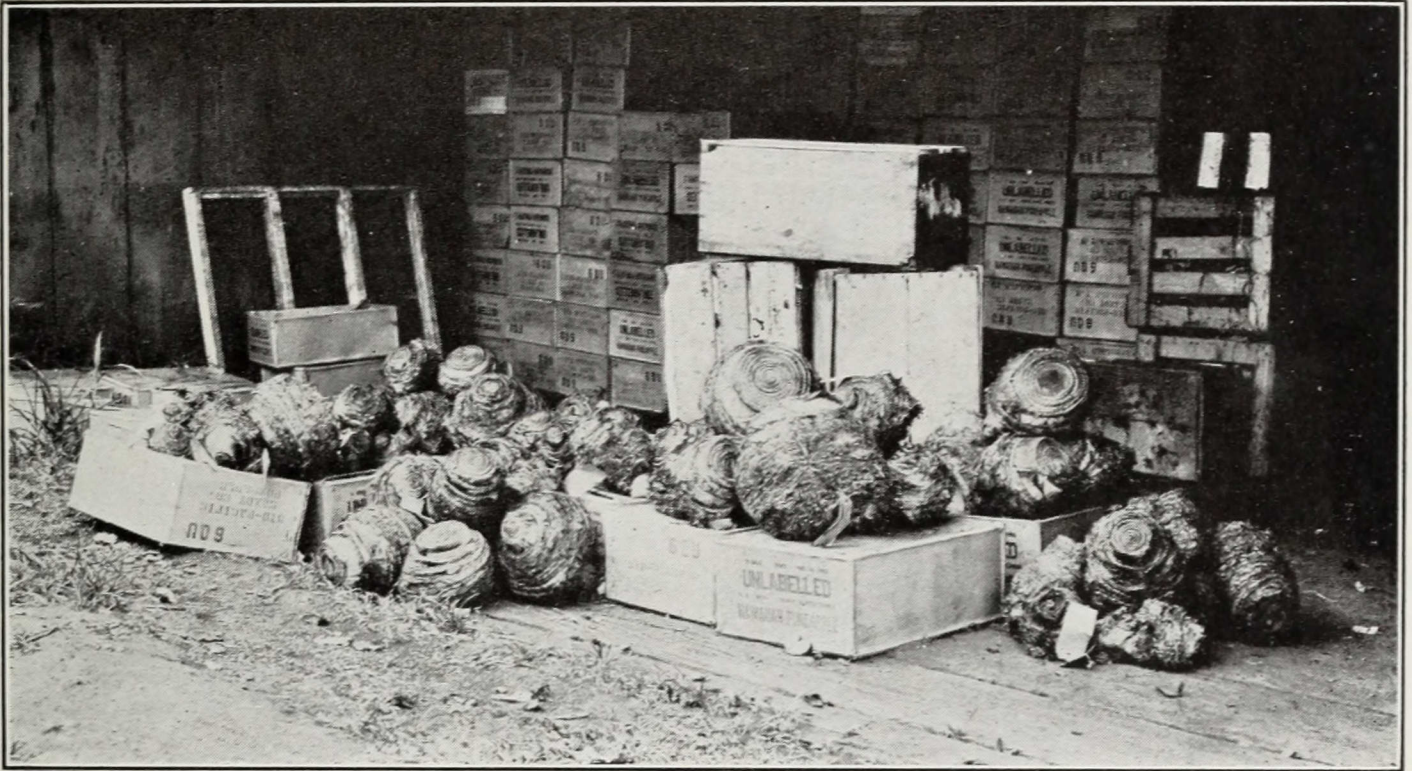


FIG. 1.—Banana corms for shipment, after being pruned and dried for a period of several weeks.

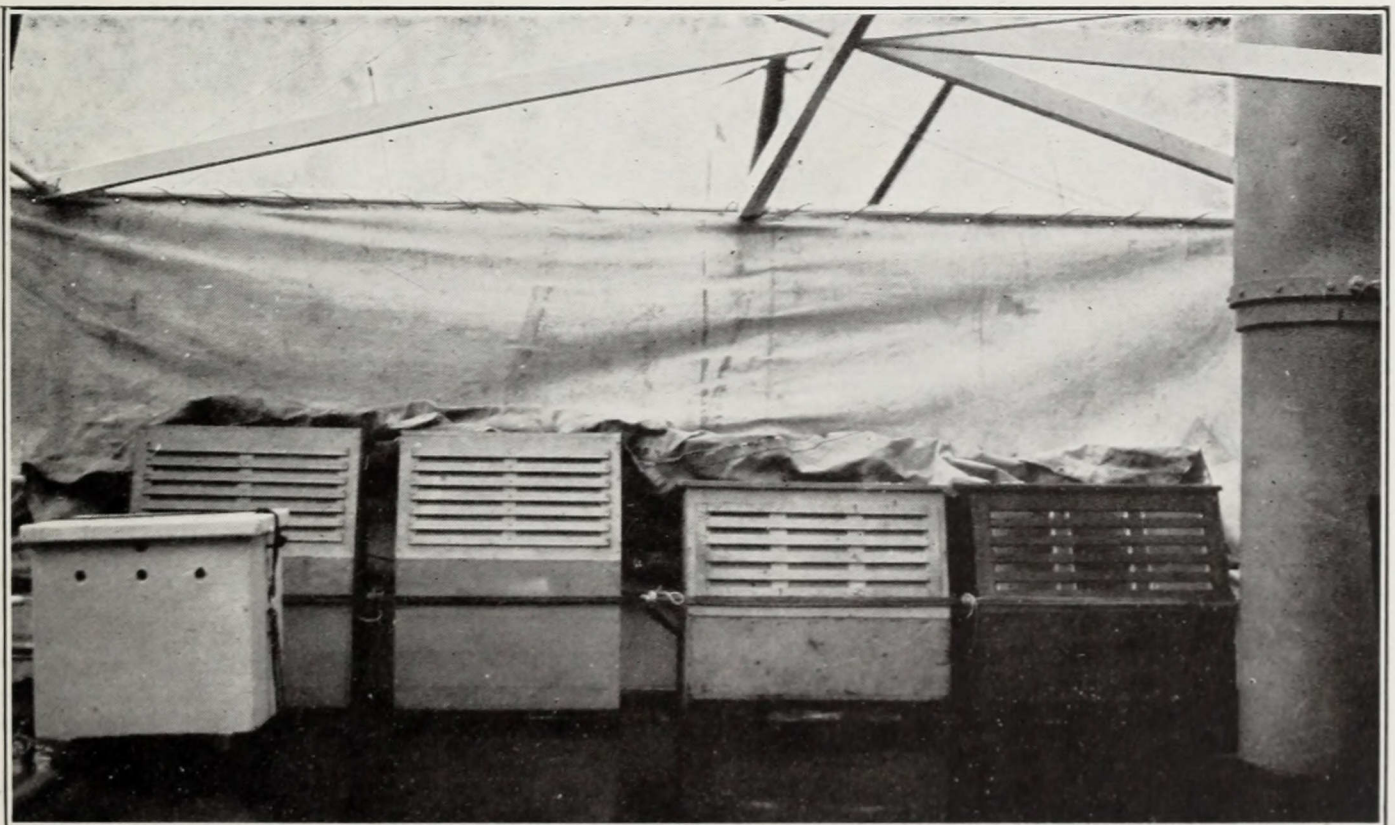


FIG. 2.—Four Wardian cases of plants on the top deck of the U. S. A. T. Somme.

BANANAS.

The banana varieties in this shipment may prove to be of much importance. The Hawaiian cooking banana is of very superior quality, surpassing most if not all of the plantains of the West Indies and Central America. The shape of the bunch and the toughness of the skin also make it a good fruit for shipping. There are several varieties of this group known as the Maoli or native banana. They are all characterized by thick and rather blunt or rounded ends of the individual fruits or "fingers" which also tend to lie rather close to the stem of the bunch. Of this group there are being introduced, in this shipment, the following varieties: Maoli, which gives the name to the group, Kaualau, Manaiula, and Ae-ae. Other Hawaiian bananas in the present introductions are the Iholena, Lele, Puapuanui, Koae, Mahoe, Popoulu, Manaikea, Iho-u, and the Maia Huaalua. Although these latter are not usually regarded as well adapted to commercial culture, they are highly prized as specialties for the home garden or banana collection.

The method of shipping the propagating material of these bananas may be of interest. In the shipment which was brought on the transport *Somme*, large corms, nearly ready to "shoot," were used. The entire top of the plant was cut off about six to eight inches above the corm and all roots were cut close to the corm. All soil, and all decaying material were removed, and the remaining parts were placed under the edge of a shed where they were exposed to direct sunlight during a part of each day for a period of about three weeks. As the leaf bases decayed, or became dry, they were removed close to the solid tissue of the corm. Plate III, Figure 1 shows this shipment ready for crating. There was thus as little as possible left to invite decay. These thoroughly dried corms were wrapped in dry excelsior, and packed in crates provided with slats about one and one-half inches apart, thus permitting free ventilation. The crates were placed in the hold of the ship, and remained there continuously, except in the port of San Francisco, where they were removed to the dock with all other plant shipments except those in Wardian cases, and were covered with tarpaulin while the ship was being fumigated.

The weather in San Francisco at the time was unusually cold, and even with the heavy tarpaulin covers it was feared that the bananas and other delicate plants would be injured by the low temperatures. The Wardian cases, by the special courtesy of the Army transport authorities, had been placed on the hospital deck and protected by awnings and tarpaulins when necessary. In San Francisco these cases were wrapped

at night in several thicknesses of woolen blankets and of tarpaulins, and in the daytime were exposed to the light. By these precautions, it was possible to avoid any injury by cold weather.

On arrival at the Isthmus, the large well-developed corms of bananas that had been prepared, as indicated above, were found to be in excellent condition. A later shipment of smaller corms, and slightly less dried, showed more losses.

OTHER PLANTS OF SPECIAL INTEREST.

The Hawaiian Fig.—A variety of fig, producing a very fine quality of fruit, has been grown in Hawaii for many years, and yields well, even at sea level. As this fig seems to be well adapted to the tropical conditions, under which most figs do not prosper, several of these plants were included in the shipment for trial in the Canal Zone, and also in Panama.

Casuarina torulosa.—One of the so-called "Australian Oaks," is another of the introductions from Hawaii that may be of value on the Isthmus. It resembles *C. equisetifolia*, the species with which many residents of the Canal Zone are familiar, under the name "Australian Oak" or "Pine" tree, although it is neither a pine nor an oak. A considerable quantity of seed of *Casuarina torulosa* was brought in and has grown well. Plate IV, Figure 1, shows one of the species of casuarina, heavily pruned, and used as a windbreak close to the sea, and exposed to the wind.

Grape.—A strain of the Isabella grape, which was probably brought to Hawaii from the Madeira Islands many years ago, is another temperate zone or subtropical fruit which has long prospered under the tropical conditions of Hawaii, and often produces two crops per year. Plants and cuttings were brought from Hawaii, and are being tried at the Gardens, and in Panama. Some of these are being sent to the higher altitudes of the Province of Chiriqui.

Queensland Nut.—Several pounds of seed of the Australian or Queensland Nut, *Macadamia ternifolia*, were included, and have germinated well. This, which is recognized to be one of the best nuts grown in the tropics, is now being planted commercially in Hawaii. It is well worthy of trial in the Isthmus at all altitudes from sea level to 5,000 feet.

The Solo Papaya.—The Solo variety of papaya, although small, is perhaps the best in flavor of all the papayas. It also acquires a good yellow color while still firm, and thus makes an attractive appearance. The flesh is also of attractive yellow color, and unsurpassed in texture. It may be spooned out to the skin without waste. The placenta to which the seeds are attached is easily removed, leaving the flesh clean and unim-

PLATE IV.

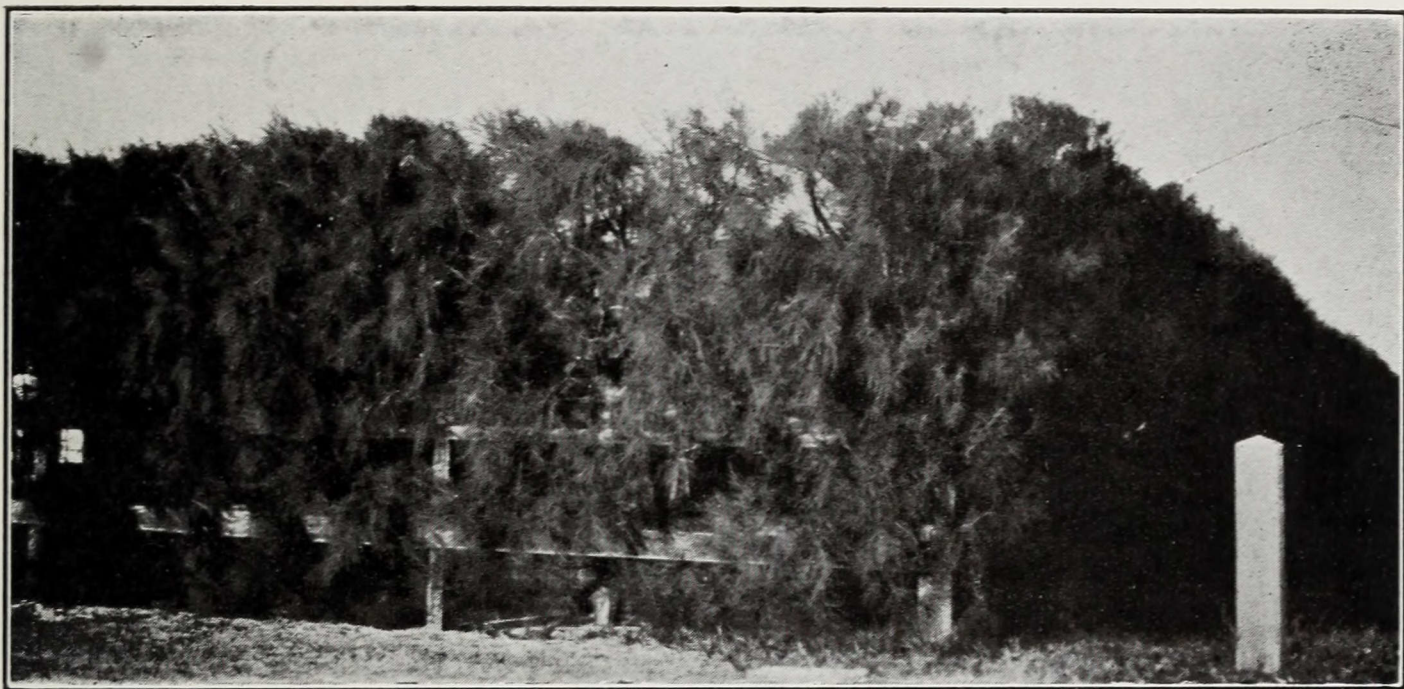


FIG. 1.—“Australian Oak,” *Causuarina*, *Sp.*, heavily pruned and effectively used as a windbreak.

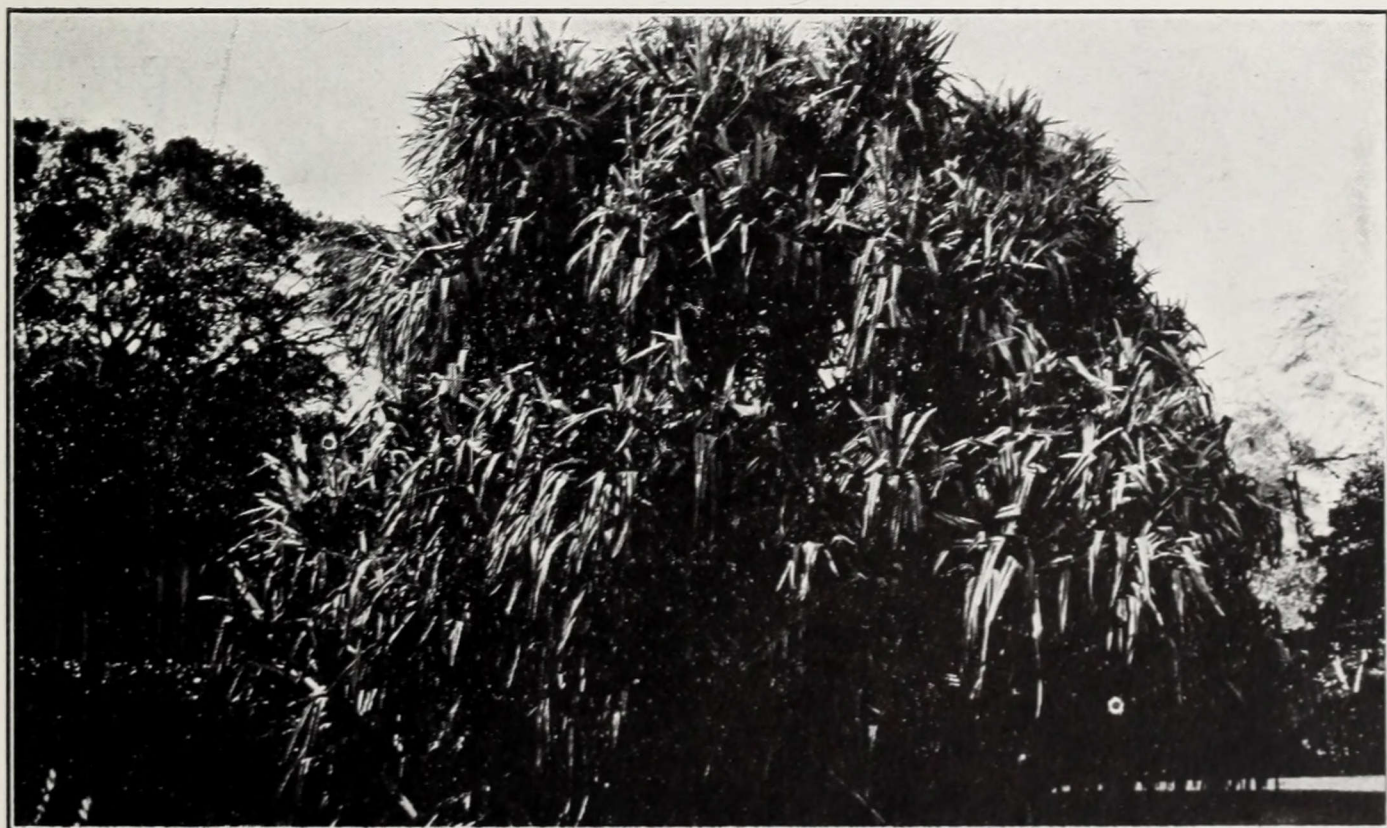


FIG. 2.—A fine specimen of Hala, *Pandanus tectorius*, from which Hawaiian mats are made.

PLATE V.

p. 16—b.

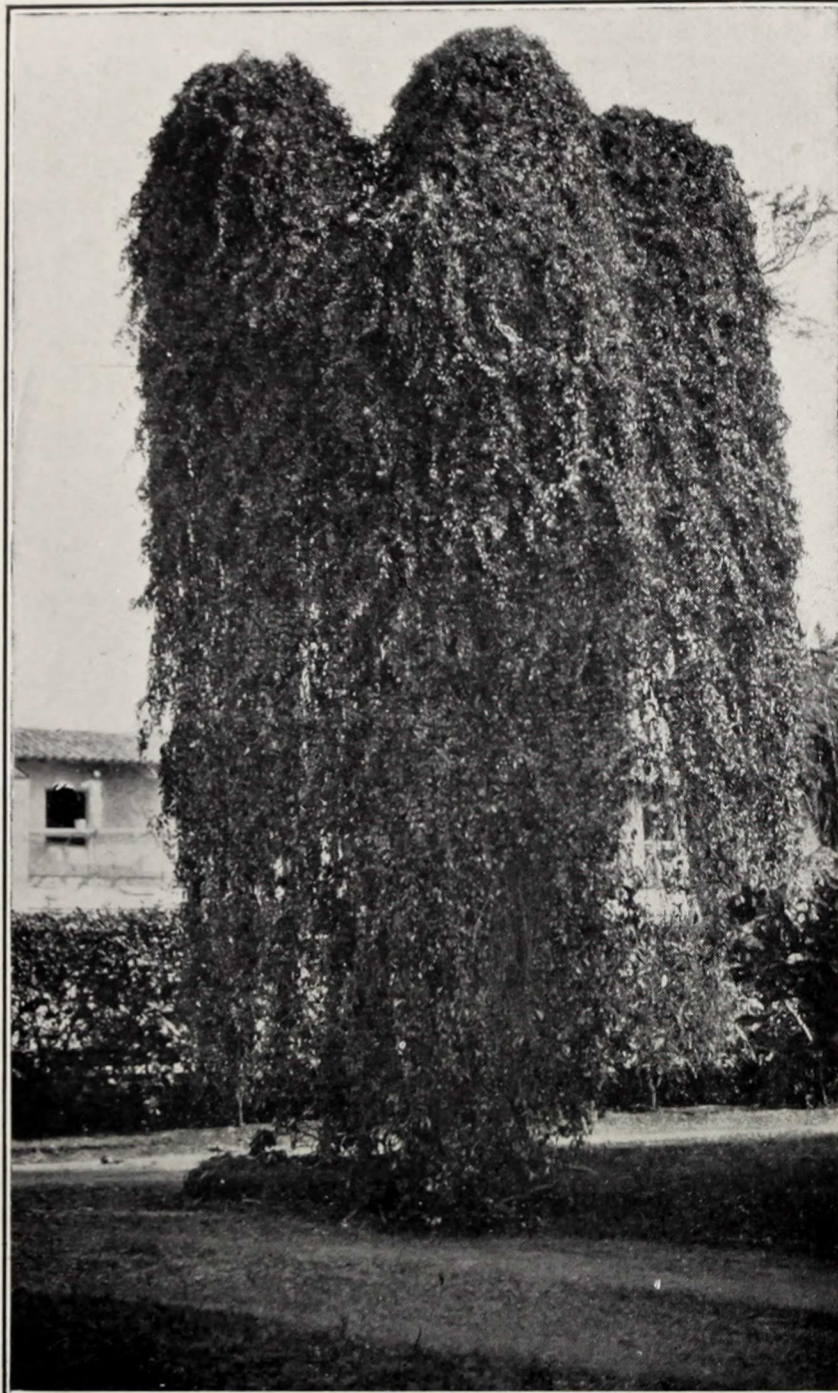


FIG. 1.—*Bignonia Unguis-cati*, a magnificent vine which becomes a veritable cloth of gold, when in flower.



FIG. 2.—Two species of *Araucaria*.

paired. These characters appear to be reproduced quite accurately by seed although the shape of the fruits is somewhat varied. The Solo has been cultivated in Hawaii for about 15 years, and retains its high quality. It is now being grown commercially for special markets, and is frequently shipped in corrugated paper boxes with individual compartments. Several hundreds of the plants, from the seed brought from Hawaii, already have been disseminated, and others are being planted at the Gardens.

Oleanders.—Mention should be made of a collection of varieties of oleanders. These included a large dark red, small dark red, pale cream, single pink, semidouble pink, semidouble white, and others. These should add much to the variety of flowering shrubs in the Isthmus, as the oleander thrives under the conditions here, and if well cared for and properly pruned makes a handsome appearance. At present the oleanders are but little used here and the varieties are few.

Bignay, *Antidesma bunius*, is a fruit tree of the Orient well worthy of a place in Central America. The tree is of medium size and rather dense growth, with dark-green foliage. It yields profusely small clusters of dark-red fruits much used in the Philippines for the making of fruit punch and jelly, both of which are very attractive in appearance and in flavor.

Among other ornamental plants worthy of special notice may be mentioned the very large flowered *Allamanda cathartica* var. *Hendersonii*, with its thick shiny-green leaves and yellow flowers, about twice as large as those of the variety now common in this country.

Another interesting and beautiful vine is *Holmskioldia sanguinea*, the so-called Parasol-Flower. This is a rather vigorous climber bearing a profusion of small flowers, resembling miniature parasols. In the distance the color effect resembles that of the brick-red Bougainvillea.

Solandra guttata, the Golden Cup, is of striking and unusual appearance. It is a strong climber with heavy dark-green leaves, and large yellow goblet-shaped flowers of delicate perfume.

Nymphaea.—The Gardens' collection of *Nymphaeas* or water lilies was augmented by a pink variety, and by a blue.

Plumeria.—Several varieties of Plumeria or Frangipanni were included in the new introductions.

Bignonia unguis-cati (B. Tweediana, Lindl.) the Cat's-Claw climber (Plate V, Figure 1) is well adapted to the covering of concrete or stone walls, and in Hawaii is much used on buildings of concrete or stone. It also is allowed to climb on some kinds of trees and on dead tree trunks.

Similar descriptive notes might be recorded in relation to many of the other species on the list of introductions. Plates IV, V, and VI show some of the interesting useful and ornamental plants of Hawaii.

ACKNOWLEDGMENTS.

Our indebtedness to the Experiment Stations of the Hawaiian Sugar Planters' Association, and of the Association of Hawaiian Pineapple Packers in connection with the cane and pineapple introductions, already has been mentioned. Equally helpful was the assistance rendered by the Federal Agricultural Experiment Station, the University of Hawaii, and the Territorial Board of Agriculture and Forestry. Thanks are due personally to Dr. Harold L. Lyon and Mr. J. E. Wist, of the Hawaiian Sugar Planters' Station, to Director James M. Westgate and Dr. Willis T. Pope, of the Federal Station, to Mr. David T. Fullaway and Mr. H. A. Whitney, representatives of the Federal Horticultural Board, to Mr. Charles S. Judd and Mr. David Haughs, of the Territorial Board of Agriculture and Forestry, whose close cooperation very greatly assisted the work, to Mrs. John Walker, for a collection of rare varieties of hibiscus, and to Mr. and Mrs. William J. Cooper, who donated a large collection of propagating material of avocado and of selected hibiscus varieties, including several originated by Mrs. Cooper.

Special thanks are due to Major General Malin Craig, commanding the Panama Canal Department, to Major General Fox Conner, commanding the Hawaiian Department, and to numerous others of the Army in Hawaii and the Canal Zone, as well as to the officers of the several U. S. Army transports concerned in these shipments. The transportation problem was very greatly simplified by the complete cooperation of all of these gentlemen, and the special care which was given to the plants which by this means it was possible to ship through on one boat from Honolulu to Cristobal without transfer.

OTHER IMPORTANT PLANT INTRODUCTIONS OF THE YEAR.

The Gardens were again fortunate in receiving, on March 29th, a large contribution of plants from the yacht *Utawana*. Mr. Allison Vincent Armour, who has done much to further the interests of plant introduction in America by expeditions with his yacht, and Dr. Thomas Barbour, made a winter trip, circuiting the Caribbean region. Calls were made at many ports and several important botanic gardens were visited. The collection of plants thus brought to the Canal Zone Gardens included the following:

PLATE VI.

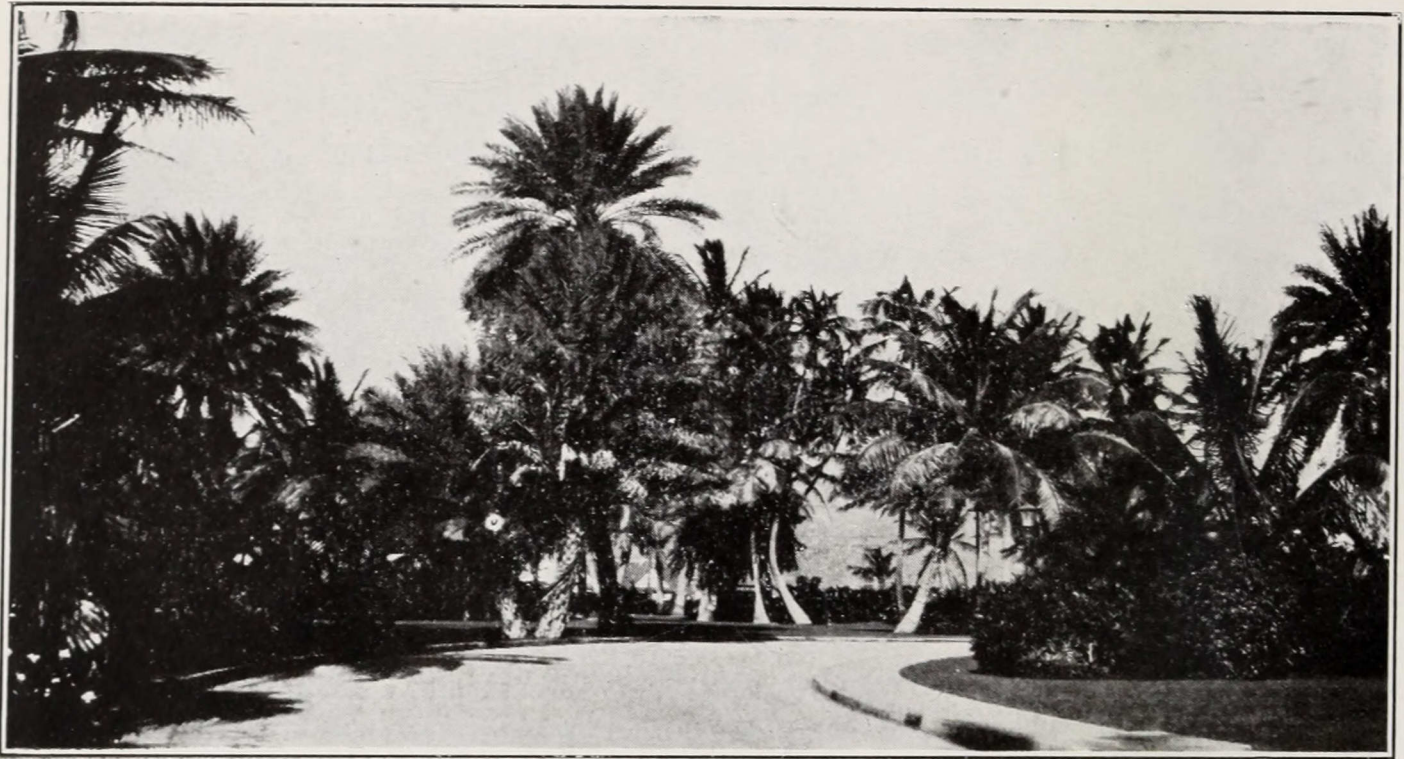


FIG. 1.—An effective piece of landscape gardening in Honolulu.



FIG. 2.—Another tropical effect in the grounds of the Royal Hawaiian Hotel.

Species or variety.

Schwartzia grandiflora.....	12 plants.
Marcgravia Hartii.....	25 cuttings.
Amherstia nobilis.....	1 plant.
Congea tomentosa.....	1 plant.
Congea sp.....	1 plant.
Eugenia caryophyllata.....	5 plants.
Copernicia cerifera.....	1 plant.
Eperua falcata.....	1 plant.
Adhatoda.....	1 plant.
Unidentified.....	1 plant.
Stevensonia grandiflora.....	1 plant.
Thevetia nereifolia.....	1 plant.
Corypha umbraculiferae.....	6 plants.
Hyophorbe verschaffeltia.....	1 plant.
Areca madagascariensis.....	1 plant.
Bertholletia excelsa.....	2 plants.
Caryocar nuciferum.....	2 plants.
Monodora ternifolia.....	1 plant.
Pongamia glabra.....	1 plant.
Putranjiva roxburghiana.....	2 plants.
Bentinckia nicobarica.....	2 plants.
Ptychoraphis augusta.....	2 plants.
Garcinia mangostana.....	6 plants.
Orchid from Tobago.....	2 plants.
Monodora grandiflora.....	1 plant.
Dypsis madagascariensis.....	1 plant.
Cyrtostachys lakka.....	1 plant.
Artocarpus incisa.....	1 plant.
Mauritzia palm.....	1 sack seed.
Borassus flabellifer.....	2 seeds.
Sweet Lime.....	12 seeds.
Portlandia grandiflora.....	6 seeds.
Barringtonia speciosa.....	2 seeds.

Species or variety.

Cocos amara.....	1 seed.
Ptychorhaphis augusta.....	8 seeds.
Strychnos nux vomica.....	1 pound seeds.
Kentia Macarthurii.....	6 seeds.
Brosimum calactodendron.....	6 seeds.
Acanthoriza aculeata.....	6 seeds.
Ormosia dasycarpa.....	$\frac{1}{2}$ pound seeds.
Saraca taipingensis.....	3 seeds.
Attalea spectabilis.....	2 seeds.
Caryota mitis.....	$\frac{1}{2}$ pound seeds.
Lagerstroemia Flos-Reginae.....	12 seeds.
Kleinhovia Hospita.....	1 ounce seeds.
Cassia emarginata.....	1 pod seeds.
Dombeya masteriana.....	$\frac{1}{2}$ ounce seeds.
Dialium guineensis.....	2 ounce seeds.
Thrinax Morrissii.....	2 ounce seeds.
Chrysalidocarpus lutescens.....	6 seeds.
Hyophorbe verschaffeltia.....	12 seeds.
Dalbergia lanceolaria.....	2 ounce seeds.
Euterpe edulis.....	4 ounce seeds.
Myristica fragrans.....	12 seeds.
Berrya ammonilla.....	2 ounce seeds.
Colvillea racemosa.....	1 ounce seeds.
Pongamia glabra.....	6 pods seeds.
Thrinax parviflora.....	12 seeds.
Carica papaya from Mar-	
tinique.....	1 ounce seeds.
Carica papaya from San	
Domingo.....	1 ounce seeds.
Sabal umbraculifera.....	$\frac{1}{2}$ ounce seeds.
Latania Commersonii.....	3 seeds.
Bertholletia excelsa.....	2 fruits.
Persea americana.....	6 fruits.

(Early Martinique)

In addition to these larger lots of plants, many important introductions have been made from widely separated parts of the tropics and from the United States Department of Agriculture, which maintains a staff of explorers who travel in the interests of plant introduction. Close cooperation exists between the Department and the Canal Zone Gardens.

PLANT DISSEMINATION.

The dissemination of plants that have been found to be of value for economic or for ornamental purposes, must be considered as the complement and counterpart of the work of plant introduction. This applies also to plants that have not yet proven their worth but which

must be tried, in various conditions, before their merits can be known. Therefore, it becomes necessary to maintain nurseries for the propagation of plants in numbers sufficient to be sent out to the different parts of the Isthmus. In fact the plants from the nurseries at the Gardens are being sent to several of the neighboring republics. For distribution purposes, these plants and seed stocks divide themselves into two general classes, including first those that have been more or less tried out, for which there is a popular demand, such as the varieties of oranges, grapefruit, mangoes, avocados, and some other fruits, as well as very many ornamentals. The second class includes quite new things on which it is desired to get data from a wide range of conditions. These are represented at present by such things as abaca, Hevea rubber trees, and the recently introduced figs, grapes, and rices. Plants or seeds of this class are usually placed, in small quantities, free of charge, in localities and with parties where the chances seem best for the acquiring of the desired data.

Plants of the first group also were formerly given away without cost but there are so many of these called for in this country, where there are no commercial nurseries handling such stocks, that the work became limited by the extent of the funds which it seemed justifiable to put into such work, in view of the fact that every dollar so spent out of the allotments was a dollar taken out of the permanent development of the Gardens. Early in the history of the Gardens, it was found necessary to make a small charge for plants, and during the year just closed an arrangement was made for the establishment of this phase of the nursery work of the Gardens on a self-supporting basis. This was done by the setting up of a revolving fund; the charging of such prices for nursery stock as are believed to cover the cost of production; and the return to the revolving fund of all income from sales, which thus becomes available for use in producing further nursery stocks.

The plan, as outlined, appears to have been working out quite satisfactorily. The demand for the nursery products is constantly increasing and comes from an ever-widening circle. The quality of the nursery stock is becoming better each year and every effort is being made to send out only clean and healthy stock. For nearby points, the trees removed from the nursery row with a ball of soil, are shipped in open boxes. For long distance shipment of citrus trees, a nurseryman's crate is used.

THE MANGO.

Some of the experiments in the control of the flowering season of the Mango which were recorded in the Annual Report of these Gardens for

the year 1928, have been continued. During the year just closed, the girdling process was applied to one or more branches of each of several young Sandersha mango trees that had been producing some fruit for about two years. The purpose, again, was to determine whether such treatment would result in flowering earlier in the season and thus in the maturing of fruits before the beginning of the rains. The girdling was done in October, 1928, by the removal of a complete ring of bark about one inch wide, the wound being covered with paint. Practically every branch so treated, flowered early and held partly matured fruits at the regular flowering season, when other trees and the other branches on these trees were beginning to flower. These results confirm those of the preceding year in which the main trunk of a large old tree was girdled and produced a heavy crop of early fruit. The same results, it will be recalled, followed the root-pruning of two other trees. No experiments in root-pruning were conducted during the year just closed.

These practices, it must again be stated, are not being recommended for general use but are merely being tried experimentally, as a part of a plan to determine whether such changes in the behavior can be brought about. The practical application of any such results must be worked out later. One of the problems in connection with any such practices, is the possible injury to the tree. In this connection it may be recorded that the very wide girdling of the trunk of tree No. 3, referred to in the Report for 1928, has been completely bridged over in nearly the entire circumference of the trunk, thus indicating the tremendous recuperative power of the mango tree. On the other hand, it must be stated that one or two of the girdled branches concerned in this year's experiments, broke off at the girdle which may have been due in part to heavy bearing. It is not thought that any girdle so wide as one inch will be necessary to bring about the early flowering which is desired; nor should such branches be permitted to carry an excessive amount of fruit. It is possible that root-pruning may prove to be a more practical process to bring about the same results.

The fruiting season, which is at its height as this is being written, is making it possible to get valuable data on many varieties, and it is already possible to begin the eliminating process which must always result from a variety collection. This is the whole purpose of a variety test, to discover those forms which are of greatest value and to eliminate those that are worthless or unadapted to local conditions. In this connection, it must be remembered that a variety of any fruit might be considered passable or even good, if there were not other varieties that so far excel it or are so much better adapted to the conditions that the less worthy must give place to the better.

On this basis, even at this early stage in the history of the orchard, it is possible to establish three lists of the varieties of mangoes in the orchard. One of these may be called the suspended list, another the present choice, and a third consisting of those that must be further studied before any judgment can be passed on them. Some of these are of great promise. The present choice, in which the results attained thus far give more confidence than in any other, is that to which we have given the name Fairchild. The following is a brief description:

Mango variety *Fairchild*.—(Plate VII.) Fruit of medium size, averaging less than three-fourths of a pound; form ovoid, sometimes pointed; skin thin, clear bright yellow; flesh light golden yellow just beneath the skin and becoming of deeper color towards the seed, entirely free from fiber and of most delicious flavor; seed small, of the same general outline as the fruit, polyembryonic. One of the most important of the characteristics of the fruit of this variety is its high degree of resistance to anthracnose to which it appears to be almost immune.

Origin and History.—The Fairchild mango is a selection from the lot of seedlings which were introduced into the United States under the S. P. I. number 11654, by Dr. David Fairchild, then Chief of the Office of Foreign Seed and Plant Introduction. The seedlings were grown under the general designation "Saigon" mango as they had been introduced from Saigon, Cochin China. At an earlier date, Dr. Fairchild had introduced seeds from Cambodia, French Indo-China, under the general group name, *Cambodiana*, expecting, in the case of both introductions, that some varieties of special merit would be found among the seedlings. Although this race of mangoes from Indo-China is polyembryonic and therefore reproduces its characters by seeds much more accurately than do the East Indian mangoes, there is nevertheless, a sufficiently marked variation to have given rise to different forms, some of which are not desirable. One of these is of green color when ripe and is quite subject to injury by anthracnose. It is unfortunate that the several forms have all passed more or less indiscriminately under the two names, *Cambodiana* and *Saigon*. One of the seedlings which originated in Florida from the first lot of seeds introduced, was given the group name *Cambodiana*, which still further complicates the matter. The present selection from the progeny of the second lot of seeds (the Saigon seedlings) has been given the name *Fairchild*, in honor of the distinguished explorer for plant introduction, to whom credit is due for the introduction of the seed from which all of these varieties have sprung, and likewise for a very long list of most valuable plant immigrants.

PLATE VII.



The Fairchild Mango.

Although the *Fairchild* does not excel all others in point of flavor, texture, and appearance, it stands very high in relation to all of these characters and excels in its resistance to mango anthracnose, producing comparatively clean fruit even in rainy weather and without the application of any fungicide. So far as can be concluded from two or three years of bearing, the trees appear to be vigorous and productive while the fruit is almost entirely free from fiber and of delicious flavor. Other varieties, such as the Pairi, may take rank with it, if sufficient and economical methods are developed for the control of anthracnose. There is need of a systematic study of the use of fungicides under local conditions, but the frequent torrential rains during the mango season, render the use of the ordinary fungicides very difficult and rather ineffective.

The suspended list includes the following:

Sandersha, Juan Mina, Ancon No. 2, Rosa, Corozal No. 546, Costa Rica No. 11.

Sandersha, although handsome in appearance, when free from disease, and also a heavy producer, has little to recommend it in point of texture or flavor, and is so extremely subject to anthracnose that since the rains began scarcely a single fruit has ripened without splitting and decaying. The disease appears to affect varieties differently, but Sandersha splits longitudinally and decays. Because it has little to recommend it, the Sandersha will not be extensively propagated at present.

Juan Mina is a fibrous mango probably of local origin, having a good flavor but too much fiber for any commercial variety. It is also subject to anthracnose. Since there are others that excel it in all respects, there appears to be no sufficient reason to propagate it.

Rosa has only its beauty to recommend it. The fruit is certainly handsome in form and color, but it is too fibrous and of indifferent flavor.

Corozal (tree No. 546) is extremely precocious and prolific and is worthy of a place in a breeder's collection for these characters, but the flavor and texture are much below par.

In the case of the so-called suspended list, which will be augmented each year as further data become available, it is intended that one or two trees of the varieties will be retained but the others will be top-grafted to better kinds. If still further observations confirm the present estimate of these fruits, most of them will be discarded.

The list of those on which no judgment can be passed need not be given here in full, as it contains all of the other mangoes at the Gardens, most of which have been mentioned in earlier reports. There are in this list some varieties of which much may be expected. Among the most promising is the Pairi (Syns. Paheri, Pirie, Pyrie). This is one of the

Bombay or Alphonse group. It is almost entirely free from fiber so that the seed usually can be slipped out of the fruit, leaving the latter in halves. The aroma is unique and enticing. If ripened in dry weather and hence free from anthracnose, the fruit is handsome, with a scarlet blush on the exposed side. Fortunately the variety is not so subject to anthracnose as are many others, and it may be possible to protect it quite satisfactorily with fungicides. In flavor, Pairi is considered by many to be the most delicious of all mangoes.

PINEAPPLES.

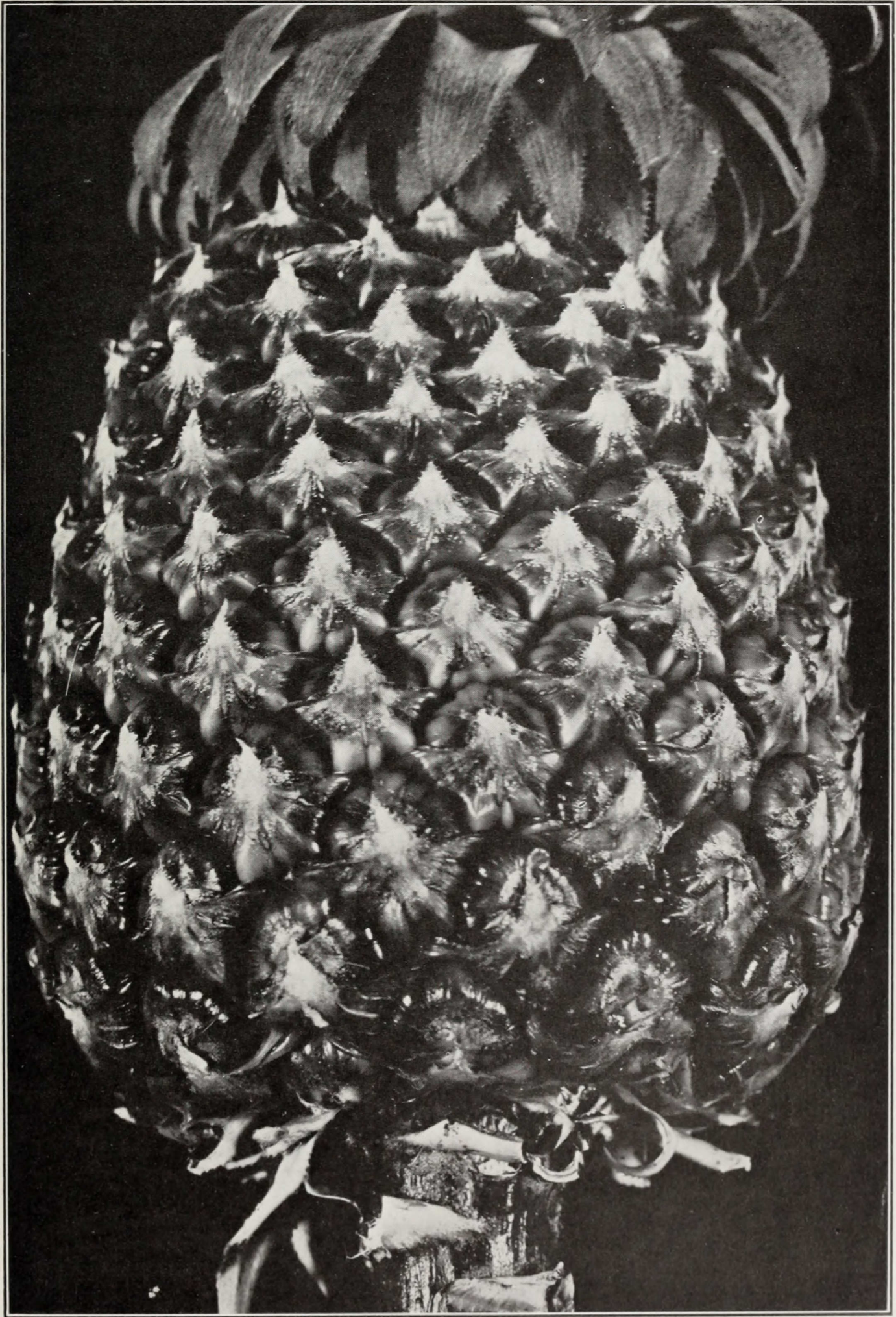
The little field of about 5,000 plants of pineapple of the Spanish (Red Spanish) variety, mentioned in the Report of 1928, has been fruiting freely. At the time of this writing, just 21 months from the date of planting, the first crop has not been completely harvested. The variety appears to have met with favor in the local market. It was introduced because of its adaptability to long distance shipment, and because it is well known in the eastern United States markets. Several thousand plants are available for distribution.

The Queen, sometimes known as Montufar (Plate VIII), has made an unusually good growth and yield for this variety. The fruits have proved to be extremely popular and nearly all those who have tried them here have pronounced the Queen the most delicious pineapple that they have ever eaten. The fruit, as grown here, has been of medium size, with rather prominent "eyes" or fruitlets, and light golden-yellow flesh, free from fiber, tender, crisp, and sufficiently juicy. It is important that the fruit be eaten before it has lost all of its green color, as fully colored fruit is likely to be over-ripe. A small supply of planting material of this variety also is available.

The variety, Milagro, introduced from Ecuador, is proving to be of much interest because of its superior flavor, abundant juice, and its freedom from spines on the leaves. Even the Cayenne, which is frequently called the "smooth" Cayenne, has some spines near the tips of the leaves but spines are rare or entirely absent on the leaves of the Milagro. Comparing this variety with Cayenne in other respects the following differences may be noted.

	<i>Cayenne.</i>	<i>Milagro.</i>
Exterior color.....	Dark golden yellow.	Straw color.
Color of flesh.....	Light golden yellow.	Cream.
"Eyes".....	Small, flattened.	Large, more elevated.

PLATE VIII.



The Queen pineapple.

The Milagro is undoubtedly worthy of very careful study and may prove to be of large commercial importance in the pineapple industry in general.

The Cayenne variety has been mentioned in the earlier part of this report, in connection with the plant introductions from Hawaii. This being the standard canning variety, arrangements have been made to get several thousand plants so that the supply for distribution can be increased more rapidly.

SUGAR CANE.

In the introduction of this report, mention has been made of the purposes of the work with sugar cane. A newly planted plot now contains the following varieties:

Badila.	Yellow Calidonia.	M 36.
Hawaiian Uba.	P. O. J. 36.	D 74.
Kavangira.	P. O. J. 213.	H 107.
Lahaina.	P. O. J. 979.	H 109.
Merthi.	P. O. J. 2714.	H 8965.
Oshima.	P. O. J. 2725.	BH. 10 (12).
Striped Mexican.	P. O. J. 2727.	D 1135.
Striped Tip.	U. D. 1.	26 C 250.
Tekcha.	EK 28.	

It is believed that a most useful service can be rendered by the introduction of varieties and by propagating them for trial under plantation conditions.

RICE.

Much the same may be said of rice as has been stated concerning sugar cane. Many varieties of rice have been introduced and have been grown for one or more seasons. Small trial lots of seed are being distributed and further plantings are being made at the Gardens to increase the available stock for next year. The varieties now under test include the following:

Canabungbong.	P. R. 315.	P. R. 402.
Dinagat.	P. R. 318.	P. R. 422.
Kinamaleg.	P. R. 327.	R. D. 234.
Kinarazon.	P. R. 343.	R. D. 239.
Kinastila.	P. R. 358.	R. D. 249.
Pinulot.	P. R. 367.	S. D. 117.
Pulupot.	P. R. 388.	S. D. 120.
Tuit hog Dalog.		

RUBBER PLANTS.

In a cooperative effort, in connection with the United States Department of Agriculture, about 1,000 trees, from selected seeds of *Hevea brasiliensis*, have been grown at the Gardens for certain experiments which the Federal Government is desirous of conducting. These have made excellent growth and are a very fine lot of seedlings.

DROUGHT RESISTANT TREES.

The severe and prolonged dry weather of the past season has called attention to the remarkable resistance to drought exhibited by some species of trees. Among those that have gone through the dry season without any irrigation and have maintained themselves in healthy appearance may be mentioned the Ohia, Mountain-apple or Malay-apple, *Eugenia malaccensis*. This tree with its thick, glossy, dark-green foliage has not even drooped or appeared in a distressed condition at any time through the dry weather. The fruit at this season was dry and pithy and new growth was not being made, but the trees remained handsome. With the coming of the rains, the Ohia bursts into new growth, presenting beautiful reddish-brown foliage over the exterior of the tree which changes to a light green and finally to the dark-green color of the fully mature leaf. The young trees at the Gardens are 18 to 20 feet high, but fully grown trees reach a height of 50 to 60 feet. The flowers which are produced on the interior of the trees are bright red and showy because of the clusters of long stamens. The interior of the tree at the flowering time has been described as "filled with a delicate scarlet haze." The fruits, although of no commercial importance, are of brilliant red color, very decorative, and quite refreshing.

The sapodilla, nispero or naseberry, *Achras sapota*, is another tree that appeared well able to adapt itself to dry conditions. It had no appearance of suffering from lack of water. Had it been in fruit, doubtless water would have been necessary to mature the crop. This tree, a source of chicle for the manufacture of chewing gum, is possibly native in this region, but does not appear to have received here the full recognition of the value of its fruits. These are about the size of a small peach, and are russet in color, containing from one to several seeds. When properly matured they are indeed delicious, resembling in flavor a sweet pear. Possibly the reason for the comparatively infrequent planting of this as a fruit tree may be the tardiness of the seedlings in coming into bearing, and also their variability in bearing habit. In the Orient, where the sapodilla is an introduced species, it is much more highly prized. In the Philip-

pinos, where the fruit is known as the chico, the tree is propagated by air-layering or Chinese layering almost exclusively, which results in fruitfulness at an early age. It is one of the most profitable fruit trees grown by the Filipino farmer. Here in Panama, the propagation of the choicest sapodillas should receive more attention while the tree also merits a place as an ornamental, especially because of its apparent resistance to drought.

Another of the outstanding drought-resistant trees, judged by its performance in several different parts of the Gardens during the past season, is the *Acacia auriculaeformis*. There appears to be little information in the available literature concerning this species of *Acacia*, which was introduced by the United States Department of Agriculture under the S. P. I. No. 59,672. It is said to be a small tree, native of Australia. The trees were received at Summit in 1925, and were planted out in August of 1926. Thus, with less than three years in their permanent position, they have attained a height of 12 to 15 feet. During the last season, without the application of any water, these trees showed no evidence of injury, remaining green and unwilted.

Among other trees in the Gardens which seem to endure well the dry weather are the mango, the beefwood or "Australian Oak," *Casuarina equisetifolia*, and the African Tulip tree, *Spathodea campanulata*. To what degree the application of water to mango trees, during heavy fruiting, may be beneficial has not been determined. It is probable that it would be necessary to use water if the trees are ready to mature fruit in dry season.

Although there are these and a few others that can maintain themselves in health without irrigation during the dry season, there are many that can not survive without applied water, and many more that are retarded seriously in their growth.

TOWN AND ROADSIDE PLANTINGS.

The Agronomist, on request, acts in an advisory capacity in the matter of the making of new plantings of trees or shrubs in the Canal Zone towns, and also in relation to the care of older plantings. The principal new plantings recommended for Balboa and Ancon during the year were on the slope above Cascadas Road, in view from the Administration Building; and also in the grounds surrounding the United States District Courthouse. A few plants have been planted in various other places as needed. On the slope above Cascadas Road, the plantings were chiefly of handsome flowering trees and shrubs. Among these are several trees of the "Pink and White" Shower, *Cassia nodosa*, which

produces about May and June, a great profusion of flowers resembling a display of apple blossoms, but unlike the apple, this tree continues in flower for many weeks. (Plate IX, Figure 1.) It is one of the most beautiful of flowering trees. Several trees of *Cassia multijuga* were also included. This is a tree of medium size producing its brilliant yellow flowers at a time when the *Cassia nodosa* is not flowering. On the point of the hill, there was planted a *Jacaranda mimosifolia*, a tree with very delicately cut foliage and loose panicles of beautiful blue flowers. It is classed among the best of the flowering trees. At the end of the slope near Heights Road, there was planted a tree of the native species "Alanza" or "Salamo," *Calycophyllum candidissimum*. This tree, which grows to a height of 50 feet or more, is familiar to most residents of the Isthmus by its profusion of white bracts at flowering time which cover the tree almost completely and persist for many weeks. Groups of the Purple Wreath, *Petrea volubilis*, were planted on the lower part of the slope. This shrub or vine, during the dry season, is clothed with elongated terminal racemes of most magnificent blue or purple color, making it one of the most striking and attractive of tropical shrubs at that time of the year. During the rest of the year it is rather inconspicuous. Other plants recommended for this locality include *Lagerstroemia flos-reginae*, *Warscewiczia coccinea*, a native tree with brilliant red bracts like those of the Poinsettia, and several others.

On the grounds surrounding the Courthouse were planted some *Triplaris americana*, a native species, with purplish red flowers on the pistillate tree, appearing in the dry season and persisting for several weeks. Here also were placed a Pride of India, *Lagerstroemia flos-reginae*, a *Calophyllum inophyllum* sometimes called Palo Maria, a *Chrysalidocarpus lutescens*, the Cuban palm and other handsome trees.

In New Cristobal the plantings have been more general because of the laying of new streets and the building of new cottages. In the case of street trees it has always been recommended to confine the plantings to one species on each street, or at least for several blocks. Exceptions to this are made where temporary, rapidly-growing trees, can be interplanted with those of slower growth but of more permanent character. The African Tulip tree, *Spathodea campanulata*, is well adapted to use in such interplantings, as it very quickly forms a shade and is handsome in appearance when young, but loses its beauty as it grows older, and can then be cut down to make room for its more permanent neighbors. A species of the "Australian Oak" or "Ironwood" tree, *Casuarina*, has been chosen for one street, as these trees appear to do well in that locality. Another street is planted with *Triplaris americana*, and another with *Warscewiczia coccinea*, two native species mentioned above. The

PLATE IX.



FIG. 1.—*Cassia nodosa* in flower.



FIG. 2.—Interior view of plant house showing type of construction.

PLATE X.

p. 28—b.



FIG. 1.—Corotu tree, *Enterolobium cyclocarpum*, showing defective branching habit.



FIG. 2.—Corotu tree, showing splitting due to defective attachment of branches.

latter two trees are more or less experimental as street trees, but are worthy of a trial because of their beauty when in flower. It has been recommended that the side of Ninth Street, next to the sea, be planted with *Ficus nitida*, a banyan-like tree of great vigor and beauty, and well known to the residents of the Isthmus because of the plantings so generally admired on Roosevelt Avenue in Balboa. This tree requires wide spacing, and there are few streets in the Canal Zone wide enough to give room for its full development. Ninth Street, on the sea side, affords a good opportunity.

Some important lessons for future planting and for the care of the street trees arise out of the observations of the year. The Corotu, or Ear-tree, *Enterolobium cyclocarpum*, is one of the most majestic of the trees that have been planted for shade in the Zone. The past year has called attention to a weakness in the construction of this tree which makes it quite vulnerable in storms. Some trees have split due to the narrow angle in the formation of the branches, at their junction with the main trunk, or the tree may be so divided that two branches are of equal size. These narrow-angled branches easily split off from the tree. Plate X shows this formation and the results. Not only are such branches likely to split off, but the cavity in the angle of attachment is often so deep as to collect water where mosquitoes breed and, in dry season, leaves and other debris collect there and harbor ants and termites. These difficulties may be overcome in very young trees by judicious pruning, removing all such narrow-angled branches and, if necessary, cutting back the main trunk at the desired height and then forcing out branches at wider angles.

A new difficulty, with the Corotu trees, appeared during the dry season when the trees were out of foliage. An insect appeared and multiplied in such numbers as to completely cover 10 or 15 feet of the outer ends of the branches. This insect, which does not seem to have been observed here to any appreciable extent in earlier years, was submitted for identification to Mr. James Zetek, Associate Entomologist of the Federal Bureau of Entomology, stationed at Balboa. Mr. Zetek identified the insect as *Poeciloptera phalaenoides* of the family *Flatidae*. Not only did these insects injure the trees, but the excessive exudations of honey-dew or similar substance and its dropping on clothing and automobiles caused annoyance to residents. Several applications of an oil spray were made by the District Quartermaster before the attack subsided.

In the selection of street trees, their habits of defoliation should be kept in mind. Some trees, as the Corotu, or Ear-tree, and *Dillenia indica* shed their leaves during the dry season and thus afford very little

shade at a time of year when shade is most needed. It is to be remembered however, that the shedding of the leaves is an adaptation to dry conditions and a tree should not be eliminated from the desirable list for this cause alone.

SYNTHETIC MANURES.

The Canal Zone towns are models of cleanliness and sanitation. A constant warfare is kept up against flies as a part of the necessary sanitary measures. The use of stable manures in vegetable gardens, flower gardens, or about trees in the lawns, always introduces the hazard of providing a place for flies to breed. All manures so used are first stored in concrete pits long enough to insure the destruction of any eggs or larvae, but the material is often subject to reinfestation when again exposed, thus making objectionable the use of stable manure in the towns. But the gardens, without some organic manures would soon fail. To meet this situation, it was recommended that a trial be made of synthetic manure, prepared by causing the rapid decomposition of grass, weeds, and leaves. Of these there is always an abundance which must be gathered up and hauled away from the towns. If placed in piles and kept wet they would in time decompose, but more rapid breaking down may be brought about by the use of a small amount of material, containing large numbers of nitrifying bacteria, and well mixed with the trash, as it is built into a long compost heap. In the case in question, a proprietary preparation was used by the District Quartermaster of Balboa and Ancon, who carried out the suggestion. The results were reported to be satisfactory. The break down was rapid, the decomposed material served well as a fertilizer, and is reported to have been free from infestation by flies. It is not impossible, however, that this material may be more or less subject to infestations.

BUILDINGS.

Both ranges of plant houses at the lower end of the Gardens have now been rebuilt. The Annual Report for 1928 mentions chiefly the south range, including potting shed, concrete soil bins, soil sterilizer, a glass house, and permanent shade houses of pipe construction. During the year just closed, the north range has been rebuilt, consisting of two small sheds or work rooms, and several part-shade houses of slat construction, with grooved slat roof so as to reduce to a minimum the dripping of water upon the plants. Although this type of construction is less permanent than that in which galvanized pipe is used, it is also very

much less expensive and regulates more accurately the amount of shade. It remains to be determined, how long the wood will last and whether it will prove to be an economical construction. For bench supports in all of these slat houses, slightly damaged vitrified pipe has been used, this being more permanent than wood, resisting water and termite attacks. It also costs only the hauling as these pieces of new pipe with slightly chipped shoulders that can not be made water-tight are useless in sewer construction and must be condemned. Being of uniform size, new and clean, the appearance is quite satisfactory. Plate IX, Figure 2, shows the general type of construction of these shade houses.

THE NEEDED IRRIGATION SYSTEM.

In the Annual Report for 1928, the need of an adequate irrigation system was presented. The dry season just passed was long and severe, resulting in much damage to some of the plants. The avocado orchard serves as an illustration in point. This orchard, which ought to have been bearing fruit for the past two years, has not yet produced a basket of fruit, and has none worth mentioning this year. Thus two or three years of fruitfulness and of valuable experimental data have been lost, all of the trees have been seriously retarded in their growth and some have died, as a result of insufficient water, although such water as it was possible to get to them was applied. As this condition is typical of many parts of the Gardens, it is gratifying to be able to state that plans for establishing an adequate irrigation system are now receiving consideration. Several plans have been presented by the engineers, and it is hoped that funds will be made available to relieve the situation before the next dry season.

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