ANNUAL REPORTS

OF THE

Canal Zone Experiment Gardens

For the Fiscal Years 1933 and 1934

THE PANAMA CANAL PRESS
MOUNT HOPE, C. Z.
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LETTER OF TRANSMITTAL

CANAL ZONE EXPERIMENT GARDENS,
Summit, C. Z., *July 17, 1933.*

SIR: I have the honor to transmit herewith a Report of the Canal Zone Experiment Gardens for the year ending June 30, 1933. Publication is recommended when funds become available.*

Respectfully,

J. EDGAR HIGGINS,
Director.

Mr. ROY R. WATSON,
Chief Quartermaster,
Balboa Heights, Canal Zone.

Through Mr. J. H. K. HUMPHREY,
Assistant Chief Quartermaster.

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* Publication authorized February 19, 1938.

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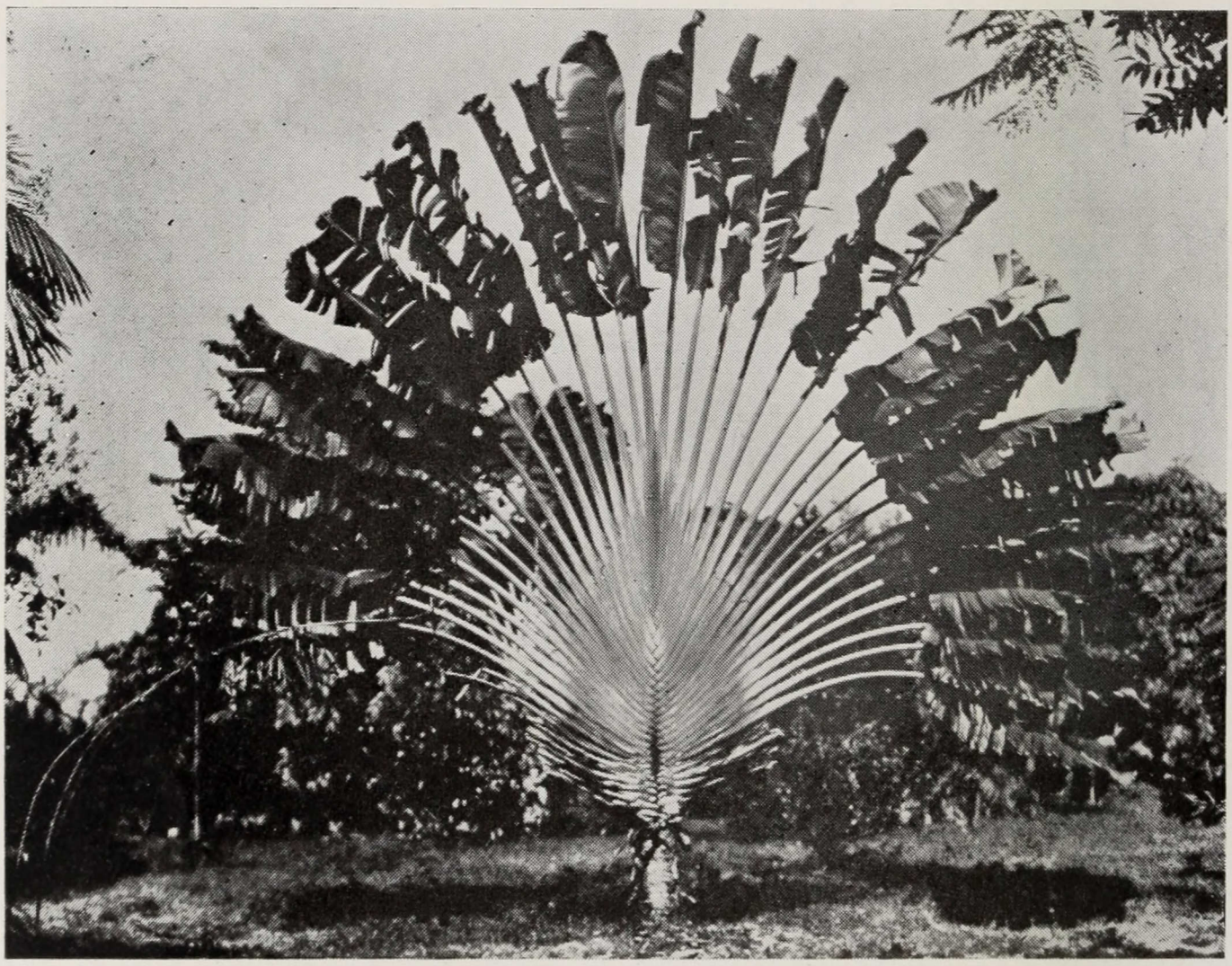


Ravenala madagascariensis.—Traveler's Tree

Annual Report

OF THE

CANAL ZONE EXPERIMENT GARDENS FOR 1933

BY

J. Edgar Higgins, *Director*

General Statement

During the fiscal year 1933, the Canal Zone Experiment Gardens have been operating under great difficulties because of shortage of funds, as has been the case not alone with other branches of the Canal organization but with nearly all public and private institutions. It was necessary to cut the budget from $24,000 to about $14,700. This necessitated the reduction of expense for labor by nearly fifty percent, after allowing for certain fixed overhead and after cutting all other items to a minimum. As it was impossible for the laborers with one exception, to secure employment elsewhere, because of the general depression, it was considered best to place the men on half-time administrative furlough instead of discharging half of them. This resulted in some additional inconvenience but the laborers and their families were at least able to buy food. One man who had been trained at the Gardens in plant propagation secured private employment because trained men in this line of work are extremely few in Panama. As further plans in the economy program, the eight-acre plantation of Chaulmugra oil trees (*Taraktogenos kurzii*) at Flat Rock on the Chagres river had to be neglected; practically all annual cultures were eliminated except such as were necessary to retain propagating material; no travel was performed in the interests of plant introduction and new accessions were confined almost entirely to exchanges. It has not been possible to publish any annual report since that for 1930. No expansion in the planted area has been attempted and only a few minor and much needed improvements have been made. A small dam has been put in, making a new pond for the care of aquatic plants, the old pond being fully occupied. The big ditch in front of the building which formerly was occupied as an office, was washing away with landslides and has been

filled, after laying a large pipe to carry off storm water. The labor on both of these jobs was performed by the prison labor gang.

To meet the conditions requiring strictest economy and to do so with the least possible sacrifice of the Gardens, some trees of species that have been represented by a considerable number of specimens have been cut down to make place for the planting of other kinds of trees that are new in this country. In all cases, however, the best specimens have been left. In this way recent introductions can be given a place. It is hoped that with the restoration of normal conditions in Government operations, funds may be appropriated to carry on the work of the Gardens with the expansion that is necessary to success.

Review of Plants

Each year some plants present new features or new developments in their maturity. A brief statement will be made concerning some of the plants which have called for special attention during the year just closed.

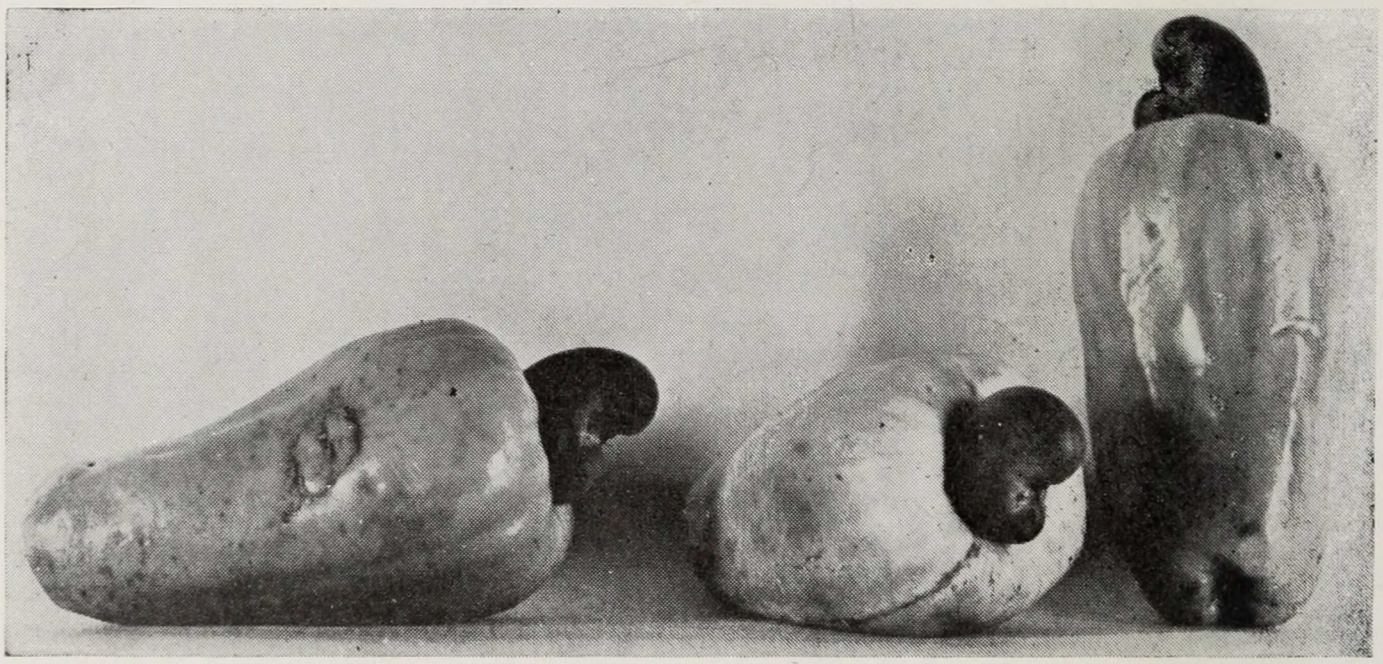
The Mangosteen (*Garcinia mangostana*)

Of all the new varieties and species of tropical fruits that have been introduced at the Gardens, none appears to be more contented with the conditions on the Isthmus than the mangosteen, that famous fruit of the Oriental tropics which Fairchild, the great explorer for plants, considers as perhaps the most delicious of all the varied fruits of warm countries.

Young trees of mangosteen, probably the first ever introduced into this country, were brought to the Canal Zone by Fairchild after first establishing them in hot houses in the Department of Agriculture in Washington, D. C., whither they had been brought as very perishable seeds from the East Indies. A tree of the original introduction has been fruiting at Frijoles, but the first planting of any considerable size was made at these Gardens less than ten years ago from plants received from the United States Department of Agriculture. These which now constitute an orchard of fifty to sixty trees and some minor scattered plantings, are among the most thrifty growths to be seen in the Gardens. Two years ago a few trees began producing a little fruit but this year at the time of this writing the first real crop is maturing which will afford an apportunity for some eager plant enthusiasts to experience a long deferred satisfaction in the tasting of this new and exotic product.

In the matter of cultural requirements, it has frequently been stated that the mangosteen tree requires shade and it is probably correct that in its early stages of development shade is beneficial and perhaps important. Based upon this accepted belief the trees at Summit were provided with artificial shade during the first few years in the orchard

PLATE II



Cashew fruit.—*Anacardium occidentale* of a variety introduced from Trinidad

but for four or five years past they appear to have outgrown the need of shade. Few fruit trees are able to adapt themselves to so wide a range of moisture conditions as are the mangosteens. While retarding of growth has been observed in spots where stagnant water accumulates, practically all of the plantings at the Gardens are on soils that remain, during the entire rainy season, too wet for most cultivated fruit trees. Although the mangosteen for successful fruit production appears to require irrigation during the dry season, the tree appears to have the power to resist considerable drought by going into a period of rest during which no new growth is made but the foliage retains its form and color.

Every cultivated plant has its natural enemies but up to the present time about the only pest that has attacked the mangosteen in the Canal Zone is the stingless black bee, *Trigona sp.*, the same insect which cuts the young foliage of citrus and some other trees. In the case of the mangosteen the bee does not trouble the foliage but causes real damage to the fruits in all the early stages of development. This disfigurement is so great as to spoil the fruit for market purposes if the insect is not controlled. Fortunately it has been found possible at the Gardens to reduce this injury to very minor proportions by the systematic destruction of the nests of the bees in the Gardens and the surrounding fields.

In the early years after introduction, the propagation of the mangosteen at Summit met with considerable difficulties. The first difficulty was the lack of seed because mangosteen seed is extremely perishable and only by the working out of most careful methods of packing was it found possible to get a reasonable percentage of viable seed after the long journey from the countries where this species has long been in established cultivations. It is a soft seed which quickly dries out and dies if exposed to the air, as is true of the litchi and many other tropical tree seeds. On the other hand, in the presence of excess moisture it either decays or quickly germinates and perishes in the package. It has been found necessary to carefully adjust the moisture to the needs so as to prevent drying out and also to avoid germination in transit. Some shipments of seed were received at the Gardens from the Orient via Europe and gave a fair percentage of germination after planting. By the methods for shipping soft seeds that have been worked out by tropical horticulturists in various parts of the world, this difficulty of introducing seed has been overcome to a large degree. In the meantime, however, as indicated above, our own trees have now come into bearing so that the need of importing new seed will probably not again arise.

The second great difficulty in the early attempts at propagation was found in the fact that carefully nursed seedlings in pots and cans in the propagation houses seemed to lose vigor and made most unsatisfactory

growth. Apparently they suffered from too much nursing and the confinement of their root systems. By placing them out in the open nursery row, in deeply trenched and well-manured soil, and providing slight shade, a vigorous growth has been produced which is in every way satisfactory. The trees are taken up with a good ball of soil and may be transplanted without difficulty while young.

Much interest has been manifested by tropical horticulturists and plantsmen in the problems of the asexual propagation of the mangosteen and some work has been done in budding and grafting, notably by the late Peter J. Wester of the Philippine Bureau of Agriculture. This interest has been based in part upon the desire to propagate rapidly and accurately any specially good seedlings that may be found, for it will be remembered that up to the present time practically all market fruits of mangosteen are the product of seedling trees. Without doubt, trees will be found excelling in productivity or in quality of fruit. Also because seedling trees of all kinds are more tardy in coming into bearing than are those that have been grafted, a second reason for this interest in asexual propagation is easily understood. But because most seedling mangosteens are of excellent quality, it is probably that the greatest urge was to find rootstocks that could be more easily grown than mangosteen seedlings and that might lend a wider range of adaptability to soil and climatic conditions. Hence several different species of *Garcinia*, the genus to which the mangosteen belongs, have been tried as possible rootstocks. While it is possible to establish unions between the mangosteen and some of these relatives, it is probably correct to affirm that no great success has yet been attained in the production of mangosteens on other rootstocks. Since the mangosteen root system itself appears to be well adapted to a considerable range of soil conditions and since methods have now been achieved for the successful production of strong seedlings, it would appear that the next important step in progress must lie in the application of budding and grafting methods to the propagation of the mangosteen upon mangosteen rootstocks.

It is probable that there are few if any of the recently introduced fruits plants which give larger promise of establishing for themselves an important place in tropical American horticulture for the great American markets than the mangosteen. It is not only delicious in flavor and texture but is a fruit of attractive appearance, protected by a thick tough shell, and endures well the effects of shipping long distances. The way now seems to be opening for the establishing of commercial orchards.

The Solo Papaya

Several references have been made to this variety of papaya in earlier reports. It is most unfortunate that this exquisitely flavored papaya has been found to hybridize so freely in this country by natural means with less desirable sorts that it has lost its most desirable characters and practically disappeared, although there are still many trees which have the outward appearance of the variety. The writer had an exactly similar experience with this variety in the Philippine Islands where the essential characters of flavor and aroma disappeared in a few generations. In Hawaii, where the variety originated, it appears to have more nearly maintained its identity through many years. For this reason a new introduction of seed from Hawaii has just been made. An attempt will be made to keep the variety isolated so far as possible but with many varieties in cultivation and with wild forms in the jungle and so many possible carriers of pollen, it may prove to be easier to grow all new plants from imported seed.

Another most unfortunate feature of this papaya in Panama is its susceptibility to the attack of the papaya fruit-fly because of its small size and thin flesh. Papaya fruits with thick flesh appear the more resistant. One of the many promising fields of effort in the breeding of tropical fruits would appear to lie in the hybridizing of the Solo with strong-growing and free-bearing varieties, having fruit with thick flesh in order to combine if possible the unique flavor of the Solo with the thick flesh and greater vigor of some other forms.

The Cashew (*Anacardium occidentale*)

During very recent years the cashew has been creating a new interest, chiefly because of the nut which is finding its way into commerce. This tree is native in Brazil and possibly other parts of tropical America. It certainly became widespread on this continent and the West Indies at a very early date and for centuries past it has been growing in warm regions of the Eastern hemisphere also. By the native people of all of these countries, it has been prized for the fleshy portion of its fruit and for the seed which is very curiously placed outside of the flesh or, in common parlance, the "nut" which growns on the outside of the "fruit." As a fruit, the cashew is used in many ways in the countries where it is grown, including dessert, fruit-punch and an alcoholic drink. The fruit is very perishable and cannot be shipped long distances but finds its way to local markets in considerable quantities. It is the seed or nut, however, which in recent years has been bringing the cashew into prominence. The cashew nut has always been appreciated in the

countries where the tree grows but it is only recently that it has found its way into world commerce. This new development appears to have been due largely to the discovery of processes of packing by which the nuts can be transported to any country without deterioration or insect attack. These nuts are now packed by a patented process in tight containers from which the air is exhausted and replaced by gases, said to be chiefly carbonic acid, in which they are perfectly preserved. Information received from the Bureau of Foreign and Domestic Commerce of the United States reveals the fact that 10,262,916 pounds of cashew nuts were imported into the United States in the year 1931. These were entered at a value of $2,052,240 which is intended to represent their market value in the principal markets of the country from which exported, including the cost of containers or coverings and all expenses incident to placing the merchandise in condition ready for shipment to the United States. In 1932, the imports were slightly under 9,800,000 pounds which represents a very small shrinkage compared with the general falling off in trade in that year of general business depression.

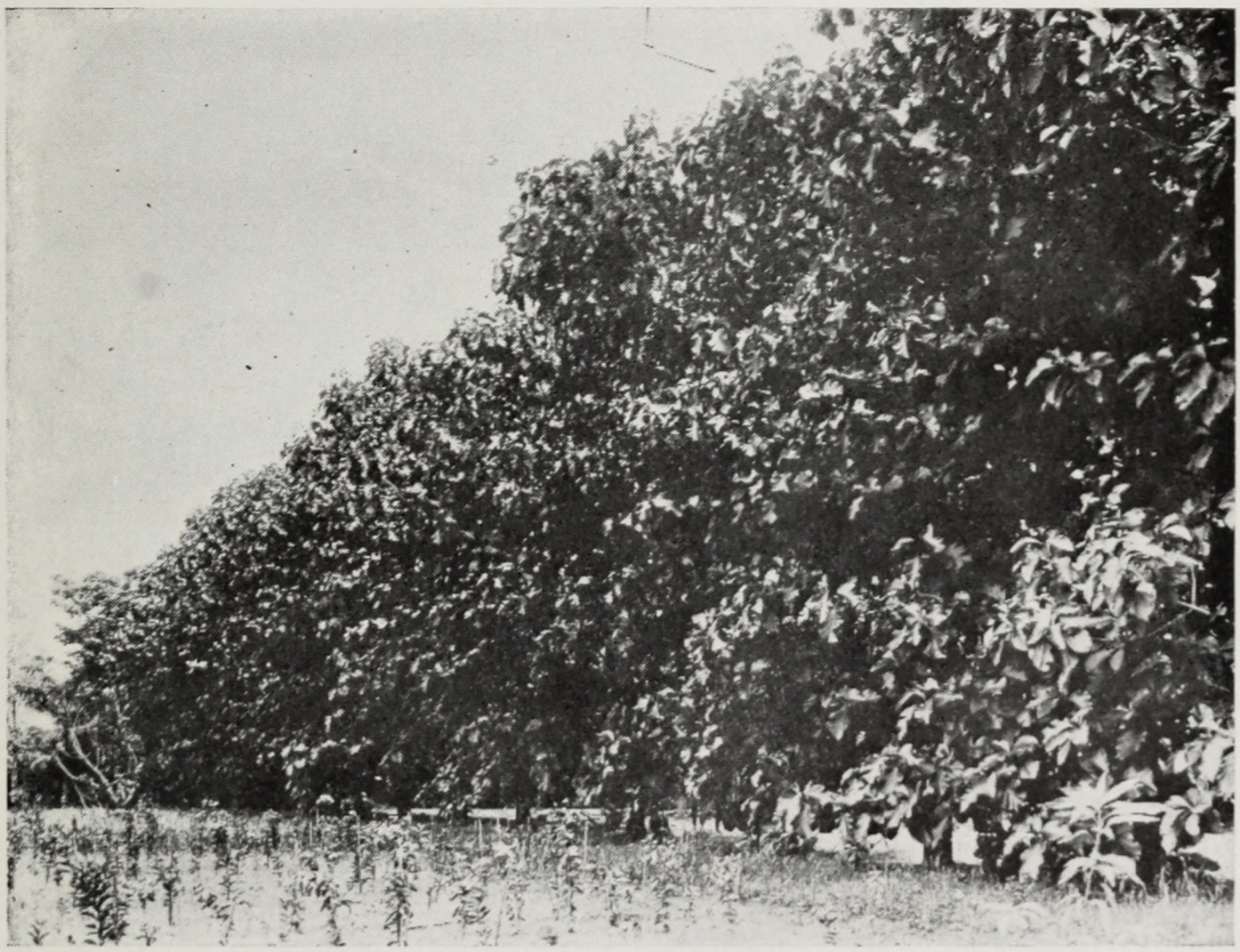
It is worthy of note that nearly the entire importation comes from British India and not from its home in tropical America. Considering the fact that the cashew grows almost as a weed in Panama and yields abundantly even in rather poor soils, it would appear that attention should be given to the possibilities of developing a cashew industry here much nearer to the market. To do this it would be necessary to interest the importing companies in stimulating trade and production here. The climate, the soil, the proximity to market and the facilities for shipping are all in favor of such an industry.

The Experiment Gardens have introduced several varieties of cashew of unusual size and appearance all of which are doing well here and yielding abundantly. Fruits of one of these varieties introduced from Trinidad is represented in Plate II. We are now in correspondence with Brazil in an effort to get some of the best varieties from that country which is believed to be the home of this fruit and which probably makes a wider use of it than any other part of the Western hemisphere.

Trees Yielding Anti-Lepric Oils

Our correspondent, Dr. P. H. Rolfs, Consultor Technico de Agricultura do E. do Minas Geraes, Brazil, presented the Experiment Gardens with seed of Sapucainha, *Carpotroche brasiliensis*. This is a new source of an anti-lepric oil which is reported to be superior to the oil produced by trees of earlier introduction, including *Taraktogenos kurzii* and the two species of *Hydnocarpus* which have been referred to several times in

PLATE III



Tectona grandis.—Teak trees, nine years old.

earlier reports. Dr. Rolfs has been making careful selections of trees of *Carpotroche* and believes that there are probably several distinct species included in the forms which tentatively have been placed under the single designation, *C. brasiliensis*. This carefully selected seed which was received by air express early in 1932 was planted promptly and germinated well. Strong plants have been set out in permanent position in the Gardens. There is said to be a wide variation in the oil content among the seedlings. The species is polygamodioecious * and produces many staminate or nonbearing trees, a condition which, in the papaya is familiar to residents of the tropics. Because of the frequent occurance of these male or nonbearing trees and also because of the variability in yield just referred to, grafting and budding with scions or buds from carefully selected, high-yielding trees has appealed to Dr. Rolfs as the most practicable means of establishing plantations which may be expected to give a satisfactory return. Hence he is establishing clones or pedigreed trees to be used as sources of budwood and the basis of uniform plantations. He has offered these Gardens budwood of his selections, if it will be possible to get it here in good condition, by air, after our seedlings are well-established. It is of course important that all kinds of trees yielding anti-lepric oils should be represented in so far as each may be adapted to conditions here.

Plant Sources of Insecticides

A great interest is now being taken in investigations concerning the insecticidal properties of certain plants, as the basis for the manufacture of effective insecticides which, as ordinarily used, are not injurious to man and domestic animals. Plants used as fish poisons are to be found in many parts of the world. Branches, bark or roots are crushed or macerated and thrown into quiet or slow-flowing water. The fish become stupified and float to the surface where they are easily caught in scoop nets or are speared. In Panama such a fish poison is known as "barbasco." Several native plants are so used, such as species of *Serjania* and *Paullinia* of the Soapberry family (Sapindaceae). In the Orient and in some parts of tropical America, a prolific source of such poisons is found in certain members of the family *Fabaceae*. Notable among these are species of *Derris*, *Lonchocarpus* and *Cracca* (Tephrosia). The principal chemical constituent of these plants which is the active poison, is believed to be rotenone but there are others frequently associated with it which also produce similar effects. Rotenone especially has been found to be an extremely effective insecticide and in recent

* Having bisexual flowers in one tree and unisexual flowers on another tree of the same species.

years it has been extracted and used in the manufacture of commercial products for the killing of various kinds of insects. It is claimed that "its use as a fruit spray would make unnecessary the present expensive machinery for washing sprayed fruit." It has also been used against cattle grubs (*Hypoderma sp.*), in the backs of cattle and is reported to have been effective in destroying these parasites, without toxic effect upon the cattle and with no injury to the skin. The growing of *Derris elliptica* especially has become an agricultural industry of some importance in certain of the East Indies and in parts of the Malay Peninsula, many thousands of acres being under cultivation.

Other related species are reported as having a much greater content of rotenone than *D. elliptica*. *D. malaccensis* is one of these and according to the Bulletin of the Imperial Institute (London), ether extract of this species showed 34.2 percent rotenone, while *D. elliptica* contained in this test only 9.7 percent. Another souce of rotenone is found in the plant called cubé (coo' bay), *Lonchocarpus nicou*. It is related to *Derris* and is found in the wild state in South America, notably in Peru. It also is reported as richer in the poison than *D. elliptica*.

Because of the prospective importance of these plants as sources of rotenone and related compounds as the basis of new insecticides which probably will replace some of those that have long been standard, and because of the possibilities of the commercial cultivation of some of these plants in this region of tropical America, some of the more important species have been introduced at the Experiment Gardens and are under test. Seed of *Derris elliptica* was obtained from Buitenzorg, Java, late in December of 1930. The plants have grown well and appear to be well adapted to conditions here. The plant is a rambling vine which spreads over the ground without support.

In September of 1932, through the kindness of Captain C. B. Fenton, of Cristobal, the Gardens received ten plants which had come from Brazil under the name of *Derris guianensis*. These are apparently some species of *Phyllanthus*. The plant is reported as occuring in the Lower Amazon region. These plants have maintained a healthy appearance since their arrival in the Canal Zone, but they have not been planted out long enough to determine their adaptability to the conditions at Summit. Two introductions of the Peruvian cubé (*Lonchocarpus nicou*) have been made from the Office of Foreign Plant Introduction of the United States Department of Agriculture. Two of these plants arrived in June 1931, and twenty-five root cuttings in April of 1932. None of these has yet made a very satisfactory growth. Although it is too soon to arrive at any conclusion concerning the adaptibility of cubé here, it may perhaps be expected to do better in the higher altitudes of the interior than at

PLATE IV

Monodora grandiflora in flower

the Experiment Gardens where the elevation at the entrance is only 254 feet above the sea. Its native habitat is understood to be in the Andes.

Another related plant introduced through the Office of Foreign Plant Introduction is *Cracca toxicaria*, F. P. I. 101,188. It is native to the highlands of Bolivia and not too much should be expected of it in Panama except in the higher altitudes. Some plants have been sent to El Volcan for test. An effort is being made to secure propagating material of other related species, that may yield rotenone or related compounds in order that we may have them for comparative study here and also that we may be able to supply material for study and analysis by the Department of Agriculture in Washington when it may be desired.

During the fiscal year just closed, the Experiment Gardens have responded to a request for cooperation in these investigations which came from the Insecticide Division, Chemical and Technological Research, Bureau of Chemistry and Soil of the United States Department of Agriculture through the Department of State and the American Consular Service. A letter dated November 7, 1932, was received from Mr. Herbert O. Williams, American Consul of Panama, reading in part as follows:

"This Consulate General is in receipt of an instruction from the Department of State, requesting that it obtain for the Department of Agriculture a sample of a plant known as *balbec*, used as a fish poison or insecticide in Panama. The following quotation from this instruction explains in detail the wishes of the Department of Agriculture:

> "In connection with investigations carried on by the Insecticide Division, Chemical and Technological Research, Bureau of Chemistry and Soils, of this Department, it is desired to enlist the aid of United States Consuls and other representatives in tropical countries in securing small quantities of certain plants used as fish poisons and as insecticides.
>
> "Samples of not less than two pounds of the carefully dried plant material are desired That portion of the plant reputed to have the greatest potency should be collected. In general, it is believed that the root of the plant will be found to be richest in toxic constituents. In case there is doubt concerning the botanical identity of the plant collected a carefully pressed flower or leaf, or the fruit of the plant should accompany the sample of root or other plant material."

Although inquiry of several well-informed gentlemen of long residence here did not result in our finding anyone familiar with the name "balbec" as applied to any plant in Panama, samples of branches and of bark of two native plants used as fish poisons were submitted. One of these was *Salmea scandens* and the other undetermined.

Teak (*Tectona grandis*)

A view of a row of teak trees at the Gardens is shown in Plate III. The trees were about nine years old. It will be seen that these trees

have made excellent growth and present a magnificent appearance. The importance of teak as a timber of world-wide use can hardly be over-emphasized because of its unique qualities and the continued and increasing demand for it notwithstanding the present tendency towards steel construction. Its durability and resistance to decay and to termite and other insect attack, as cured timber, are perhaps its most important features. In the Oriental countries where it is native, it is subject to the attack of a borer while it is growing but after seasoning the wood appears to be immune to most insects and very highly resistant to termites ("white ants"). Mr. James Zetek states that teak wood that has been in the ground at Barro Colorado Island for eight years shows no injury from termites. It is reported that ships built of teak have withstood the elements for hundreds of years. The great demand for the wood and its relative scarcity have kept prices high. The United States has no supply of teak trees of its own and none is available anywhere on this side of the world. Because of the value which such a supply would have to the Navy, it is stated: "*that consideration has been given to the possibility of establishing a Naval reservation for teak plantings." At this time when reforestation is being undertaken on a gigantic scale as a part of the Federal Government plans for rehabilitation of the economic system and the recovery of prosperity, what could be a more fitting use of a small part of these funds than the planting of a small experimental forest of teak here in the Canal Zone as an adjunct to the Experiment Gardens? Abundance of idle lands, formerly occupied as cattle pastures and practically cleared, surround the gardens on all sides. The conditions of soil and climate are the same as those at the Gardens where the teak trees are growing as shown in the illustration referred to above.

Notes on Marijuana (*Cannabis sativa*)

In cooperation with the Health Department in its study of the effects of marijuana, the Experiment Gardens conducted some investigation of the plant which yields this drug, as it is grown in this country in a very small way and on an extensive scale in India and other tropical countries. Plants were grown at the Gardens in sufficient quantity to provide the Health Department with the plant product of uniform grade and in the amount necessary for the department's investigation. The notes that were made at that time on the culture of the plant in India and also in this country are here recorded. These notes were placed at the disposal of the Health Department.

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* Navy Department, Bureau of Construction and Repair, Technical Bul. No. 1—25: "Teak, Its Habitat, Exploitation and Marketing" by Lt. Wendal P. Roop.

PLATE V

Guadua angustifolia, a giant bamboo

Marijuana is one of several common names applied to the plant *Cannabis sativa*, and more particularly to the plant and its products when used as the source of a drug which produces forms of intoxication. Because of the fact that some of these products are being clandestinely produced, sold, and used in the Canal Zone and that there are said to be some addicts here, considerable inquiry has been made during the past few years concerning the plant and the effects of the drug.

The Culture of the Plant in India *

The plant as grown in India was known for many years under the botanical name *Cannabis indica*. This was believed to be a distinct species but more recently the species *C. indica* has been reduced to *C. sativa*, as no botanical characters are found to exist upon which to establish two species. The plant varies under different climatic and soil conditions in India, and these differences are quite as marked as those found between the plants grown in India and those grown in Europe where the species has long been grown for its fiber known as hemp. In India the plant is grown to some extent for fiber but also and in some parts exclusively for its narcotic principle. The seeds are also eaten and are a source of oil.

There are three principal forms in which the narcotic is prepared, but of these there are many modifications. The first of these forms is that known as charas; the second is ganja; and the third, bhang. Charas is the resinous exudation found on the bark, the leaves, and on the pistilate or female flowers—and even on the fruits. Ganja is an agglomeration of the pistilate flowering stems with the exuded resin. Bhang consists of the dried mature leaves and to some extent the fruit also, but not the twigs.

Cannabis sativa grown as a source of the narcotic has very special treatment. The species is dioecious.† The staminate, or male plants yield little or no resin and are not allowed to remain in the field after their male characters become apparent, except as a few here and there escape the eye of the "ganja doctor" as the expert is called who passes up and down the rows to eliminate the undesirable plants. It is desired to rid the field of all staminate plants not only because they are not wanted in the harvest, but also because if allowed to remain and to cause the formation of fruits, the yield of the narcotic in the pistilate plants is reduced.

Charas, the resinous substance which exudes naturally from the bark, leaves, and pistilate flowers, is successfully produced only in the northern

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* Watt. Dictionary of the Economic Products of India.
† Having the staminate or male flowers on one plant and the pistilate or female flowers on another.

parts of India or in the higher altitudes as the plants do not appear to give this natural exudation sufficiently in the lower and warmer parts of the country. Several methods have been used for collecting this resin. One consists in sending coolies through the rows, clad in leather coats to which the resin adheres. Or these natives are treated to an oil on the skin and run through the rows nearly naked. The resin is then removed from the man's skin or his leather coat. Another, and perhaps a more common method, is to rub the pistilate flowering stems between the hands—the bruising process causing the exudation of the desired resin. The resin, however collected, is pressed into the desired shape for market purposes. Charas is smoked as a means of getting the effect of the drug.

Ganja is prepared from the pistilate flowering heads which, as already stated, must not be allowed to form fruit if the best quality of ganja is desired. For the gathering of this product the plants are cut quite low at the time of full flowering, are spread out to dry for about 6 or 8 hours, after which the flowering stems are cut off and laid upon mats in a circle with points inward, the leaves being removed. The other parts of the plant are thrown out. These flowering heads are then tramped upon by bare-footed natives until the desired resin is pressed out and the mass of agglomerated flowers and resin is pressed into the desired shape. Ganja, as charas, is used for smoking as a means of getting the narcotic effect.

Bhang consists in the dried leaves and to some degree the dried fruits of the plant. The resin, it appears, is not extracted from this product which is used directly in the preparation of the products which furnish the effect. One of these products is hashish, an intoxicating beverage. Another is a sweet-meat known in India as majun or majum. Bhang is made chiefly from the wild plants where the plant grows abundantly as an excape from cultivation.

In parts of India, *Cannabis sativa* is so abundant as to be used as bedding for animals. Bhang is reported to be much weaker than ganja or charas and is believed to be much less injurious.

The method of cultivation of *C. sativa* as s source of narcotic is somewhat as follows: A seed bed is most thoroughly prepared by often repeated tillage months in advance of the sowing of the seed. The purpose of this is in part to rid the soil of weeds. The seed is planted broadcast without shade and the plants when 6 inches to 12 inches high are transplanted to their permanent postion in thoroughly prepared soil. The distances vary from less than 1 foot to 9 or 10 feet—the widest spacing being used only when the plants are to be used for the preparation of bhang, although, as stated above, cultivated plants are not often used for this purpose.

Marijuana as Grown in This Country

I have seen *Cannabis sativa* growing in several places in this country. Apparently its cultivation on a small scale is not uncommon. Some farmers grow only a few plants to supply their own wants while others evidently have more than could be used by themselves and their families. There is probably no extensive cultivation.

Use Among the Farmers

It would appear that the use of this plant for its drug content is not infrequent among the people living in certain localities. It is used to make "tea," four or five or more dried leaves being placed in a cup with boiling water. Among the people there is great faith in the efficacy of this drink as a mild stimulant, giving a feeling of well-being and also as a preventative of malaria. The smoking of the dried leaves and flower heads seems also to be not uncommon.

Manner of Preparation

It seems very probable that the form in which they use the plant has saved these people from the most disastrous effects of the drug because the part used is often composed to a large degree of leaves and includes at times the leaves of the staminate plant as well as those of the pistilate. Also there appears to be not the same diligence that is found in other countries in the removal of the staminate plants immediately when their identity can be established by the presence of the flowers. Some growers allow these plants to remain in the fields until they become mature and show yellowing of the leaves when they are harvested, dried and used for smoking or for "tea." It is well understood among the people that these leaves are very much weaker and less effective that the preparations from the pistilate plants which include the flower clusters. It is quite possible also that these dried leaves of staminate plants may be mixed with the harvest of pistilate plants which comes on later. It has not been determined whether any of the growers are careful to remove all staminate plants immediately. If this is not done, even the pistilate plants will not yield the drug in the quantity that is yielded by nonfecundated pistilate plants. Hence it seems not improbable that the marijuana grown and sold locally is of very low grade judged by its content of the drug. In fact, most samples of dried marijuana that have come under my observation have contained a considerable quantity of seed, indicating that the staminate plants have remained in the fields at least long enough to fecundate the pistilate flowers. For the reason stated above it will be seen that marijuana purchased locally is probably

of quite variable character and tests of its physiological and mental effects in any experiments may be expected to vary likewise.

It would appear that there is no production of charas in this country. Likewise, it is probable that there is no ganja produced here, all the crop being disposed of entirely in the form of bhang or the dried leaves and flower heads which have not been treated to bring out the resin.

Other Noteworthy Plants of the Year

"The Miraculous Fruit." One of the most remarkable and interesting of the plants that have come under observation during the year is the "Miraculous" fruit, *Synsepalum dulcificum* (F. P. I. 75,283). This tropical African shrub of upright and rather narrow habit, with dark green foliage belongs to the family *Sapotaceae* and produces small red fruits, oblong to oval in shape, about three-quarters of an inch long and three-eighths of an inch in diameter. This strange fruit makes sour things taste sweet. It is rather pleasant to the taste but after it is kept in the mouth for a few minutes and is partly masticated, the most acid lemon or lime tastes as sweet and pleasant as a well-sweetened fruit punch. The cause of this remarkable reaction which has given rise to the name "miraculous" fruit is not well understood nor has it been determined how long the effect will last. No uncomfortable effects have been observed. The plant is worthy of further study and it is possible that it may be found to be of some economic importance.

The Traveller's Tree, (Plate I) *Ravenala madagascariensis*, sometimes erroneously called Traveller's "Palm," is attracting much attention because of its quite unusual and striking appearance. It is said to have acquired its common name from the well-known fact that it accumulates considerable water at the base of the leaf sheaths which can be tapped by the traveller when in need of water in the forests of Madagascar where it is native. The tree is not a palm but rather is related to the bananas.

Monodora grandiflora. The Gardens are indebted to Dr. Thomas Barbour and Mr. Allison V. Armour for the introduction of this beautiful and unique tree which was propagated from a tree in Trinidad, said to be the only mature specimen in the Western hemisphere. In March and April the young tree at the Experiment Gardens flowered profusely and presented a handsome and unusual sight with its many large brown pendant flowers which hang like orchids from the branches. Plate IV shows the tree in flower.

The Waringian banyan, *Ficus waringiana*, gives promise of being even stronger in growth and more handsome in appearance than its close relative, the Chinese banyan, or laurel de India (*F. nitida*). The latter

PLATE VI

Bignay.—*Antidesma bunius*, a fruit tree introduced from the Philippines

as seen on Roosevelt Avenue, in Balboa, is universally admired by residents and visitors. The Waringian banyan has made a tremendous growth at Summit during the few years that it has been planted out and is upright and symetrical in habit. To date it has been entirely free from thrips, the one pest which severely attacks *Ficus nitida*. Concerning this species (*F. waringiana*) Dr. David Fairchild, in his fascinating book on "Exploring for Plants" says: "Of all the strange avenue trees that I have ever seen, the Waringian is the strangest. Like the banyan but with much smaller leaves, it spreads over the ground by hanging aerial roots, until a single tree comes to look like a whole grove." The Waringian is very easily propagated by marcottage, sometimes called air-layering. A few trees have been planted on the Prado area in La Boca where it is thought there is room enough for their development and where they may be expected to afford an excellent shade beneath which children may play and older people may rest. There are not many places in Balboa and Ancon where there is sufficient open space to justify the planting of such a tree. A few have also been planted in the rear of the new residence quarters, on Colon Beach, in New Cristobal.

A *Bamboo of giant proportions* was introduced from Ecuador by Mr. Holgar Johansen, formerly in charge of these Gardens. This has now grown to great height and produces poles six inches in diameter with rather short internodes. It has been tentatively identified as *Guadua angustifolia*. This would be an especially useful bamboo for structure purposes. At the Gardens, when grown in sufficient quantity it should supply excellent plant tubes of sufficient size to hold a rather large nursery plant. Plate V shows the lower portion of a clump of this bamboo.

The *Bignay*, (*Antidesma bunius*) is a small tree of graceful form which yields great clusters of small current-like fruits in wonderful profusion and affords a magnificient sight in fruiting season. The young trees which were grown from seed, introduced from the Philippine Islands, are fruiting heavily at the time of this writing (July 1933) (See Plate VI). The fruits are very highly prized in the Philippine Islands for making a delicious fruit punch and also for jams and jellies.

Seedlings of the Brazil nut, *Bertholletia excelsa*, grown from seed introduced from Trinidad are making good growth and it is hoped that future years will see this famous nut tree well established in this country. Its relative, *Lecythis tuyrana*, which is represented by two good specimens in Balboa Heights, has come into fruiting. It is a beautiful tree, always clothed with rich green foliage. It was introduced into the Canal Zone by Dr. H. Pittier. Its economic importance has not yet been determined.

Another *Lecythis* (*L. elliptica*) introduced from Colombia, has also come into bearing at the Gardens.

Plate VIII shows one of the very handsome native orchids, *Epidendrum stamfordianum*, flowering in great profusion. It is growing upon an African Fountain Tree at the Gardens.

The Nursery and the Revolving Fund

It is fortunate that operations of the nursery have not been affected by the shortage of funds. The nursery functions as a means for the dissemination of plants of kinds that have been tested and established. It operates under a revolving fund which was established for this purpose and the receipts from all sales are returned to the fund, thus enabling the propagation and dissemination to go on independently without taxing the limited resources which are available for the maintenance of the Gardens. Some of these plants are sold to other branches of the Canal and the Panama Railroad organizations and others go to individuals and business concerns in the Canal Zone, in the Republic of Panama, and in other countries of Central America and South America, while a few go as far as the United States. Notwithstanding the financial depression during the recent years the sale of plants has gradually increased and more have been sold during the year just closed than in any other twelve months period. The sales for the year, consisting chiefly of trees, plants, propagating material and prepared soil for box and pot cultures, have approximated $5,746 in value. Although this is not a large volume of trade from a business point of view, it represents the distribution of a rather large number of plants, many of which would never have become established in this country except through this agency. While it has been stated above that the nursery is carried on without expense to the regular Gardens funds, it must be pointed out that it could not operate independently of the Gardens because it requires careful and trained supervison which the Gardens can supply at cost but the volume of business is too small to sustain the full time of a man capable of supplying this necessary supervision. The revolving fund which was initiated in 1929 with an allotment of $5,000 now shows a total credit of $6,634, the increase of $1,634 representing a fair margin of safety which also is available to aid in carrying the Gardens through any period of emergency.

The Care of Trees and Plants in Public Areas

The Agricultural Aide in the Care of Trees

During the fiscal year 1932, Mr. John Paul Keenan was appointed as Agricultural Aide, in the care of trees and plants in all parts of the Canal Zone, under the direction of the Director of the Experiment Gardens. The urgent need for the appointment of a man who could devote his entire time to such service had been frequently pointed out. Trees in all parts of the Zone, some of them grand and majestic, were in urgent need of attention, having dead and decaying branches, open wounds, impossible of healing without treatment, and in some cases suffering from insect attacks. Mr. Keenan came with training from the Syracuse University School of Forestry and with experience in the field service of the Bureau of Forestry of the United States Department of Agriculture. He entered upon the work with a keen interest in the problems peculiar to tropical conditions and with an enthusiasm which has been steadily maintained. The improvement in the appearance of the trees was manifest from the beginning and has attracted the attention of many who are interested in the trees. Those who have observed intimately have found not only improved appearance but also the healing of wounds and the arrest of decay which gives promise of the saving of many trees which otherwise would have been destroyed in a few years.

But the importance and value of the function of a tree expert lies not only in the effort to maintain the health and vigor of old trees but also in the training of trees that are young so as to adapt them to the special purposes and situations for which they are desired and to encourage a formation that will be strong and enduring. Many young trees have been planted in towns of the Zone in recent years and it is a part of the tree expert's duties to train these.

Mr. Keenan has been an employee of the Experiment Gardens, operating under the Director, but his time has been devoted exclusively to public areas and his services have been charged out to the accounts of the District Quartermasters where the work has been done. It is deeply regretted that it was found necessary to discontinue this service on June 30 because the general shortage of funds in public areas, as in other branches of the Canal organization, makes it impossible to pay even this modest salary. It is hoped that with the return of normal conditions, it may be possible to reestablish this position on a permanent basis for without it valuable and handsome trees that have required many years for their growth will be neglected and suffer deterioration, and in many cases destruction.

Landscape Planting and the Supervision of Trees and Plants in Public Areas

A large share of the time of the Director of the Gardens, during the year, has been devoted to problems concerning the new plantings for landscape effect in public areas and in the supervision of established plantings. The latter requires frequent inspections in the towns on the Pacific and on the Atlantic sides of the Zone. The new and the supplementary planting plans for landscape effect include those of Lion Hill Road, some officials quarters on Balboa Heights, the Prado area including the slope from the Administration Building, the Balboa High School site and the patio, the triangular park facing the Balboa Post Office, the new residence section near the Quarantine area and the Amador Road section, all in the Gold quarters areas of the South or Pacific side of the Isthmus. On the Atlantic side, the new residence section facing Colon Beach, in New Cristobal, has received considerable attention. Because of the strong and continuous winds of the dry season most plants which prosper elsewhere are a failure on Colon Beach and efforts are now being made to test certain plants which may endure the wind and the salt spray. Among those that are now being tried are the "shore-grape" (*Cocoloba uvifera*), icaco, (*Chrysobolanus icaco*), *Tecoma stans*, mangrove, lilies (*Hymenocallis americana* and *Crinum longiflorum*) *Furcraea*, *Barleria involucrata*, *Wormia burbidgei*, *Calophyllum calaba*, *Casuarina glauca*, and *Casuarina equisitifolia*.

Blue prints covering most of these projects have been submitted, and are now on file. In the new planting near residence quarters the aim has been to cloth the buildings with group plantings, afford some privacy in the open basements and preserve as much as possible of the very limited space for lawn. No hedges have been used except where necessary to screen out clothes lines or other unsightly features. I would again strongly urge that the regular clipping and shearing of shrubbery be discontinued, except under supervision, first for the sake of the beauty of the plants and their free-flowering and second to avoid unnecessary expense. A limited amount of pruning is necessary and at times a severe but judicious pruning may be found beneficial, but regular shearing and clipping to maintain an exact shape is objectionable in these informal plantings. There are of course exceptions to this general statement and in some situations in the Zone towns plants formally trained seem to be in place.

One of the recently introduced flowering trees, being used in these new plantings, is the Queen crapemyrtle, *Lagerstroemia flos-reginae* (Plate VII).

PLATE VII

Lagerstroemia flos-reginae.—Queen crapemyrtle

The rapid effect which it is possible to get in landscape plantings in this country is quite astonishing to those who are familiar with such work only in the temperate zone. Here where there is a twelve-months growing season it is possible to produce in a few years such results as would require a decade in the North. Plate IX shows two years growth from bare lands in the Gavilan town site. Much of the credit for such excellent results is due to interest which has been taken by nearly all of the occupants of the residences. The training of the trees has been done by Mr. Keenan.

In connection with this brief reference to landscape plantings, I would urge that future town sites be planned with a deeper frontage between the sidwwalks and the houses so as to provide sufficient space to arrange a landscape and especially to allow the planting of graceful shade trees which will neither interfere with the sidewalks nor the houses. If lawns of liberal size are allowed and are not cut up by the scattered and spotty planting of shrubbery, the cost of mowing them with a power mower will not be greater than that of cutting the grass and trimming around the many single shrubs in a much smaller yard. Most shrubbery should be kept in well-placed groups where they require less attention and produce more picturesque effects.

In accordance with instructions of the Chief Quartermaster, trees and some shrubs have been planted in the residence towns occupied by laborers of the Silver Roll. Fruit trees, chiefly mangoes, have been chosen for this purpose and have been arranged along the streets where there is sufficient room and also in open spaces between houses. The West Indians who occupy these quarters are especially fond of mangoes and other tropical fruits and the few trees that have been planted near some of these quarters appear to have been protected and cared for. In some places a little shrubbery of such hardy but beautiful kinds as hibiscus and crotons has been planted. If it is found that these prosper, under the existing conditions, more planting will be recommended for a later date. All of the Silver towns have been included in the planting plans.

In the laying out of all of these planting plans for the Canal Zone towns and in the recording of them in permanent drawings, the assistance of Mr. Keenan has been of great value, as also in the supervision of much of the planting work.

Outside of the Canal organization, the Director of the Gardens has acted in an advisory capacity in assisting officers of the United States Army and Navy in connection with planting plans and the care of established plants.

Seed and Plant Accessions

Although the acquisition of new kinds of plants has not been pursued as actively as in normal years, because of the insufficiency of funds, nevertheless many valuable accessions have been added. Among these is a collection of several new varieties of sugar cane known as Mayaguez seedlings. The originating of new varities and their testing is a work of outstanding importance in the sugar industry in these days and the Puerto Rico Station at Mayaguez has developed several varieties of much promise. The major portion of the sugar industry of today is based upon varieties that were not in existence until quite recent years. This collection of Mayaguez seedling varieties of sugar cane was received from Dr. E. W. Brandes, in charge of the Office of Sugar Plant Investigations of the United States Department of Agriculture. They will be disseminated for trial under varying field conditions when propagating material becomes available. These varieties are as follows: Mayaguez Nos. 3, 7, 42, and 151.

Pineapple varieties have been acquired by exchange with the Experiment Station of the Hawaiian Pineapple Packers Association and with the Department of Agriculture of the Federated Malay States. Some of these represent new varieties which may be of value here. The complete list of the varieties introduced is as follows:

From Hawaii:

Accession No.	Variety
9581	Natal
9582	Wild Kailua
9583	Ruby
9584	Sarawak
9585	Wild Brazil
9586	Hilo Cayenne
9587	Congo
9588	Pernambuco

From Federated Malay States:

Accession No.	Variety
9772	Ruby
9773	Sarawak
9774	Mauritius
9775	Smooth Cayenne
9776	Canning
9777	Comte de Paris

Other Important Accessions of the Year

A list of the other more important plant accessions of the year is presented as a separate report for official records.

Visitors at the Gardens

The number and the interest of visitors to the Gardens increases each year. In March of 1933, it was a special pleasure to welcome the distinguished veteran and pioneer in plant introduction, Dr. David Fairchild with Mr. Allison V. Armour and Dr. Thomas Barbour to

PLATE VIII

An orchid-clad tree at the Experiment Gardens, showing *Epidendrum stamfordianum* in full flower

whom these Gardens are indebted for many important plants, brought on Mr. Armour's yacht the *Utowana*. Dr. Fairchild spent several days in intensive examination of many plants resulting from the introductions made on his tours of exploration in the tropics. The mangosteen was an especial delight to him in its luxuriance of growth and just bursting into flowering, for much effort and limitless enthusiasm had been expended by him in making introductions of seeds and plants by laying a foundation for establishing in America this remarkable fruit of the Orient.

The Gardens were also honored with a brief visit from Dr. C. L. Marlatt, chief of the Bureau of Entomology of the United States Department of Agriculture.

Congressman Edward T. Taylor made a passing visit in June, being a passenger on the U. S. A. T. *Republic*. Congressman Taylor expressed a deep interest in several features of the Gardens and was especially surprised at the excellence of the mangoes of the Cambodiana and the Fairchild varieties.

The Canal Zone College Club, on February 23, held a special session at the Gardens at which their guest of honor was Mrs. J. Julian Southerland, President of the "International Tropical Flower Show." Mrs. Southerland was on a tour by air to various points in tropical America and the West Indies in the interests of that exhibition.

Dr. J. Horace McFarland, distinguished lecturer, author, publisher, and expert in the art of photographing flowers and trees, spent about a half-day in the Gardens while his ship was in port and manifested a deep and enthusiastic interest in the treasures of tropical plant life.

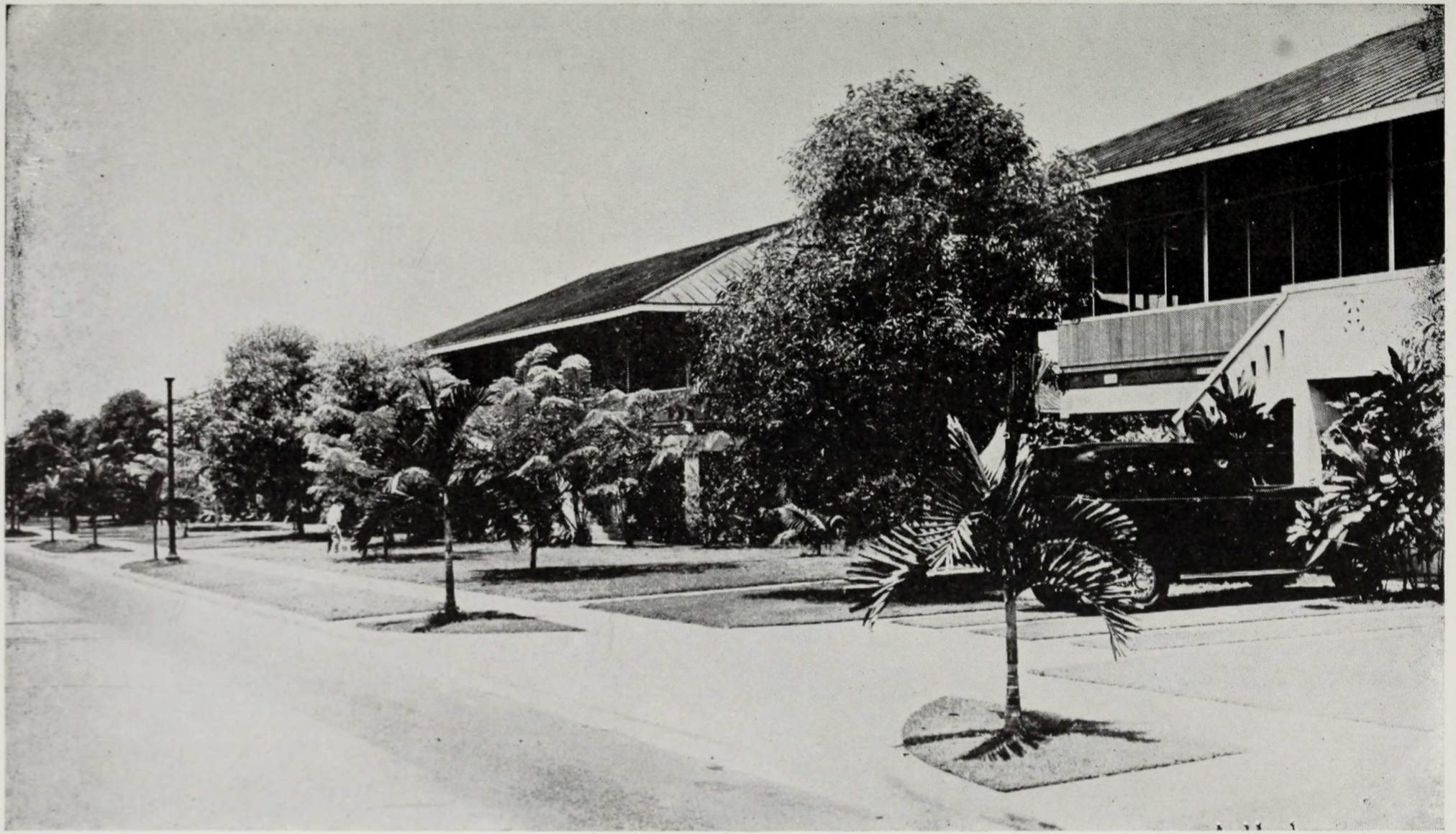
The increasing number of visitors from the neighboring Republics is especially indicative of a new interest in the cultivation of tropical plants and many of these visitors are eager to secure planting stock of trees, shrubs, sugar cane varieties and other economic and ornamental plants.

The Future of the Gardens

In the past these Gardens have been supported by funds received from the rentals of Canal Zone agricultural lands. As is well known, the present policy of the Administration, based upon health considerations and the expense of controlling malaria in the Canal Zone, is to issue no new agricultural leases or land licenses and to renew or transfer none that expire by the death or withdrawal of the lessee. Hence the income from land licences is steadily falling off and the resources for the support of the Experiment Gradens are as steadily shrinking. Through the efforts of the late Governor Harry Burgess and Governor Julian L. Schley, an item of $5,000 which was inserted in the Panama Canal Bill

as an aid to the work of the Gardens, was passed by Congress and will be available during the current fiscal year to supplement the diminishing returns from land rentals. It will be necessary to increase this amount in each year's appropriations or to obtain money from other sources if the Gardens are to be maintained on a basis of efficient operation. It is recommended and urged that an item be inserted in the Supply Department budget for 1935, providing for a sufficient increase in the appropriation to bring up the total amount available for the Gardens to $24,000. The amount that would be necessary to insert in the budget would depend upon the Auditor's estimate of the prospective net return from land leases. In consideration of the large amount of money that has already gone into the Gardens to bring together and establish so valuable a collection of plants; and in further consideration of the growing interest and importance of the work which has attracted wide attention of scientists and other visitors, it is hoped that adequate support will be forthcoming. Neglect would mean ruin to most of this collection.

PLATE IX



Landscape effects attained in two years growth

Annual Report of the
Canal Zone Experiment Gardens

FOR THE FISCAL YEAR

1934

LETTER OF TRANSMITTAL

CANAL ZONE EXPERIMENT GARDENS,
Summit, Canal Zone, *July 17, 1934.*

SIR: I have the honor to transmit herewith a Report of the Canal Zone Experiment Gardens for the year ending June 30, 1934. Publication is recommended when funds become available.*

Respectfully,

J. EDGAR HIGGINS,
Director.

Mr. ROY R. WATSON,
Chief Quartermaster,
Balboa Heights, Canal Zone.

Through Mr. J. H. K. HUMPHREY,
Assistant Chief Quartermaster.

* Publication authorized February 19, 1938.

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ANNUAL REPORT OF THE CANAL ZONE EXPERIMENT GARDENS FOR 1934

By J. Edgar Higgins, *Director*

Introduction

For another depression year, the work of the Canal Zone Experiment Gardens has been conserving rather than expanding. With shrinking resources, it has not been possible to pursue plant introductions with the same activity which has been attempted in the predepression years. Nevertheless, some progress has been made even in the introduction of new species; and the natural progress of the established trees and other plants has brought to attention some things of interest and importance. Also such improvements in appearance and accessibility as could be carried on with the limited resources have been in progress.

Plant Introductions

Through the medium of seed and plant exchanges some valuable accessions have been made during the year. The United States Department of Agriculture has been the largest contributor. Sixteen species of orchids were received from the Bureau of Science, Manila, Philippine Islands, in exchange for a shipment of Panama orchids from the Gardens. Exchanges received from the Royal Botanic Gardens, Trinidad, B. W. I., included about 24 different species and varieties. A half-dozen or more items came from Mr. W. P. Phillips of Orlando, Fla. Scions of seven Hawaiian varities of mango were received from the Hawaii Agricultural Experiment Station, Honolulu, T. H. From the Atkins Institution of the Arnold Arboretum at Solidad, Cienfuegos, Cuba, seeds or plants of upwards of 40 kinds were received. Dr. E. B. Stilz, of Lusambo, Belgian Congo, Africa, contributed a number of interesting items, including selected seed of the African Oil Palm *Elaeis guineensis*. Seed of several cover crops was received from the Department of Agriculture, Rabual, New Guinea. Mango scions of five varieties were contributed by Dr. Wilson Popenoe from the Lancetilla Experiment Station of the United Fruit Company in Tela, Honduras. *Ceratonia siliqua* seed was sent by Dr. Thomas W. Brown of the Agricultural Department, Giza, Egypt. Exchanges were received also from Mr. Holger Johansen of

Puerto Rico, formerly Agronomist in charge of these Gardens; from the Director of Forestry, Manila, Philippine Islands; from the Puerto Rico Agricultural Experiment Station; and one or more species from each of many other contributors. It is desired to express the thanks of the Canal Zone Experiment Gardens to all of these who have continued to cooperate freely in seed and plant exchanges.

A few explanatory notes regarding some of these introductions may be of interest. The longan, *Dimocarpus longan*, was received through the United States Department of Agriculture. It is a relative of the litchi and is a fruit-bearing tree of the Orient where it is highly prized although not equal in importance to the litchi. Trees of the litchi are well established in these Gardens but never have flowered. However, seedling litchi trees are very erratic in their bearing habits and usually very tardy in coming into bearing. Even where litchi trees bear abundantly, the seedlings may produce no fruit until they are over 25 years of age. Hence it is the custom to propagate them by air-layering or what is known as the gootee method and thus to produce bearing trees in only a few years. By this method a branch from a fully mature bearing tree of known quality is made to produce roots and later is removed to form a new tree. Up to the present time it has not been known whether the entire lack of fruit on the litchi trees at Summit has been attributable to their seedling character or to the tropical conditions under which they are growing. The native habitat of the species is not strictly tropical. It has produced well in Hawaii and Cuba and we are advised by Dr. Wilson Popenoe that the trees of the United Fruit Company in Honduras have come into production.

Hence it is hoped that even in the tropical climate of the Canal Zone the litchi trees may be expected to produce in due time. Girdling may aid in bringing about fruit-bearing, as was described in the case of mango trees in the Annual Report of these Gardens for the year 1928. As the longan is native of the same regions as the litchi it is also hoped that this species will yield fruit here.

Lonchocarpus domingensis, as its relative, "Cubé," *L. nicou*, is under trial as a possible commercial source of rotenone, now attracting much attention as an ingredient in the manufacture of effective insecticides that are comparatively innocuous to man and domestic animals.

Awa, *Piper methysticum*, is a narcotic plant formerly much used by the ancient Hawaiians and probably other Polynesian races. It is now under investigation as a medicinal plant.

A variety of sugar cane designated as Mayaguez No. 28 is one of the new seedling varieties originated at the United States Agricultural Experiment Station at Mayaguez, Puerto Rico. It is a variety of out-

standing promise in Puerto Rico and may prove to be of importance, among the other varieties introduced by the Gardens, in aiding the Panama sugar cane industry.

The nutmeg, *Myristica fragrans*, is represented at the Gardens by mature specimens, but only of the pistillate or female tree. Without staminate trees there can be no fruit production. Some of the seedlings from this introduction, if they mature, should be staminate trees.

Aegle marmelos is a relative of citrus, which is of some possible value as root-stock. It is one of the collection of citrus relatives being cared for here, primarily for the investigations of the citrus specialists of the United States Department of Agriculture.

The African violet, *Saintpaulia ionantha* is a very beautiful little house plant that was introduced by Mr. L. E. Burdge who presented the Gardens with several plants. The foliage is handsome and the flowers resemble violets in form and color. It is becoming very popular.

Acacia koa is the Koa tree of Hawaii which produces a very valuable lumber, often sold under the name of "Hawaiian mahogany." It is much used for fine cabinet work.

The sweet corn variety, Maypuertotres, is a new hybrid produced at the Puerto Rico Agricultural Experiment Station at Mayaguez, Puerto Rico, under the United States Department of Agriculture. It represents an attempt to breed a variety having the characters of sweet corn, but adapted to growth under tropical conditions. None of the standard varieties of sweet corn appear to be suited to the lowland tropics.

Ceratonia siliqua, the Carob or St. John's Bread, is valued as a stock feed and is of considerable economic importance in the Mediterranean region. This strictly tropical climate may be unsuited to it but it should be given a trial.

Teak, *Tectona grandis*

Reference has been made in earlier reports to the progress of the teak trees in the Gardens. This year measurements of growth have been recorded and one tree was cut down as a test of the timber.

Thirty-nine trees of this species in various parts of the Gardens are apparently the product of about one ounce of seed received from Dr. David Fairchild and Mr. Dorsett when in Ceylon. It came through the Office Seed and Plant Introduction and is S. P. I. Number 66,242. These are recorded as having been received April 8, 1926. As this is the only record of the planting of teak seed at the Gardens prior to 1927, all of the large trees of teak now on the place must have come from this introduction. Later plantings of teak trees have been from seed of these older trees. These trees therefore were eight years old in April of this year (1934).

Cutting and testing. One of these trees was cut down for a timber test on February 21, 1934. It was the second tree from the south end of the row west of the propagating house. When the trees were later marked with permanent numbers this stump was inadvertantly omitted from the series and hence has been designated as tree No. 1-A. The tree marked No. 3 was girdled in accordance with the Burma method of harvesting and will be allowed to stand until dead and partly seasoned.

The measurements of the tree that was cut down (tree No. 1-A) under the supervision of the Garden staff and of Mr. F. W. Braddy, timber expert for the Panama Canal, were as follows:

Height, 54-feet, 7-inches; mean diameter 1-foot above ground, where cut, 14 inches; mean diameter of heart-wood at the same point, $12\frac{1}{3}$ inches. It cut a 13-foot bole of 14 inches diameter at the base and $10\frac{1}{2}$ inches at the top. It was quite unexpected that so large a part of the trunk of this very young tree would be found to be heart-wood.

Rings. It is interesting to note that the bole of this tree showed rings corresponding to the annual rings of temperate zone trees and that the number of distinct rings appears to be nine, or one more than the number of years that the tree has been growing.

The 13-foot log was delivered at the Mechanical Division of the Panama Canal, on Friday, February 23, for seasoning, for observation, and for sawing. The remaining portion of the tree trunk and main branches are being kept at the Gardens where they will be exposed to weather and to termites for future observation.

Remaining trees. The height of all of these trees in the row referred to is approximately uniform as was shown in Plate IV of the Report for 1933. The circumference of 16 of the trees, 18 inches above the ground surface, on June 11, 1934, taken in consecutive order and measured in inches, were as follows: 62.5, 52, 55, 59.5, 44.5, 60, 64.5, 61, 62.5, 59, 51.5, 62.5, 45.25, 52, 65.5, 70.5. The mean circumference was thus 57.9 inches.

The above trees have all received considerable water in dry season during recent years due to their proximity to nurseries from which they doubtless appropriated also some fertilizing elements. It will be interesting to compare the above measurements of circumferences with those of other trees of the same introduction but located in other parts of the Gardens where conditions were different.

Trees numbered 17 to 34 inclusive, are located in comparatively dry places and where irrigation water is not usually applied. It is possible that they may have received some irrigation in dry season during their first year or two. There are no records of such. The circumference measurements of these trees at 18 inches above ground expressed in

inches were as follows: 44, 43, 43, 42, 36, 71.5, 55, 49.25, 58.5, 57, 41, 39, 34.75, 37, 43, 38, 30, 42.5. This represents a mean circumference of 44.69 inches.

Trees numbered 35 to 39 inclusive are located in soil that is naturally more moist and in rainy season is inclined to be wet and not well drained. The circumference measurements of these trees at 18 inches above ground and expressed in inches were as follows: 54.5, 62.5, 46, 57, 38. The mean circumference of this group was 51.6 inches.

To summarize, it will be noted that the 16 trees which in the last few years have had access to some water and fertilizer, applied to adjacent nurseries, show a mean circumference measurement of 57.9 inches. The group of 18 trees in the drier location without irrigation or fertilizers present a mean circumference measurement of 44.69 inches, or 13.3 inches less than the first group. The group of five trees in a more moist location without irrigation or fertilizer have a mean circumference measurement of 51.6 inches or only 6.3 inches less than the favored group. It would appear therefore, that even on the dry hillside a very satisfactory growth has been made while on the more moist places the growth has been better.

Mangosteen Demonstrations

The small mangosteen orchard continued to prosper and produced about fifteen hundred fruits in July and August. This made possible the giving of several mangosteen demonstrations at the Gardens at which some of the residents of the Canal Zone and of the Republic of Panama were given the opportunity to try this fruit, as yet quite new and rare in the Western hemisphere. By this means also it was possible to save the seed for planting. There is a limited supply of very excellent seedlings resulting from earlier plantings now ready for planting out and the younger stock from the 1934 plantings is making good progress. Mr. Walter R. Lindsay has conducted experiments in grafting mangosteens on mangosteen roots for the purpose of devising means for the multiplication of any especially good clones which may appear and also with a view to bringing trees into bearing earlier in their development.

Another good crop of fruit is about to mature at the date of this writing.

A New Guava Variety

A new guava, *Psidium guajava* var., from the Experiment Gardens introductions, fruited for the first time in June, in the gardens at Albrook Field under the care of Mr. J. B. Shropshire. This is apparently the progeny of F. P. I. No. 81,849 which was introduced from Peru by the United States Department of Agriculture through Dr. Wilson Popenoe.

The fruit is shown in the accompanying illustration (Plate I, Figure 1). It is of outstanding interest first because of its unusually large size but more particularly because of its very thick pericarp which may offer resistance to the fruit fly (*Anastrepha sp.*). This insect is found in almost every ripening guava fruit in this country. Of the several fruits of this variety that have been gathered none has contained any larvae.

An Experiment in Apprenticeship

In the first half of the fiscal year, the suggestion was offered by the Executive Secretary of the Panama Canal that a mutual advantage might be attained if the Experiment Gardens would offer the opportunity to a group of young Panamanians to come to Summit in the capacity of student laborers. The Department of Agriculture of the Republic of Panama expressed interest in the proposal and after several conferences between Director H. D. Sosa and the representatives of the Canal, a plan was worked out under which a group of about 10 boys and young men varying in age from perhaps 17 to 23 years, began work at the Gardens on December 11, 1933. The group has varied in size by the dropping out of a few who did not seem adapted to the work and by the coming in of others. They were given subsistence and experience in many different kinds of horticultural operations and in turn they performed any kind of labor that needed to be done. They remained at the Gardens for about six months when most of them were needed by the Government of Panama and were given positions as assistants in connection with the extension service carried on by the Department of Agriculture. Even with this very brief period of training they appeared to the Department to be the best material available for the work to be done.

During their stay at the Gardens these young men gained some experience in such operations as collecting, preparation, and planting of seed, establishing of seedling nurseries, budding, grafting, training of nursery stock, balling trees, transplanting, pruning of nursery and orchard trees, preparation and application of sprays, operation of spray-pumps, propagation by layering and air-layering, collecting and preparation of banana propagating material, harvesting grass seed, potting and handling of greenhouse plants, operation of gasoline lawn-mowers, laying small water pipe-lines, grading and many other operations incident to the work of the gardens. They also have had opportunity to make observations upon and to become more or less familiar with several varieties of oranges, grapefruit, lemons, limes, mangoes, and other fruits. The amount of information acquired under such circumstances depends chiefly upon the students eagerness to learn. If the period of residence could be increased such would be advantageous for the students.

PLATE I

FIGURE 1.—A Guava variety (*Psidium guajava* var.)

FIGURE 2.—Breadfruit tree twenty months after planting

After this first group was called to service in Panama, a new group of somewhat larger size was placed at the Gardens. The number at the date of this writing is 14. They appear to be interested and desirous of acquiring information and experience.

Finances

Until the recent inclusion of an item of $5,000 for the Experiment Gardens in the Congressional appropriations, the Gardens have been dependent entirely upon the net revenues from agricultural leases or land licenses. At the beginning of the fiscal year 1934 it was estimated by the Land Agent and the Accouting Department that the net revenues of that office, above expenses, would be approximately $9,922. This, with the $5,000 above mentioned, would make a total of $14,922 available for the Gardens operations for 1934. This is about $9,000 short of the normal needs. At the date of this writing the accounting for the entire 12-month period is not available but the expenses from these funds for the 11 months ending May 31 have amounted to $13,779. If the 12th month is at the same rate the total operating costs will be $15,031. However, the land revenues, although much less than those of any preceding year, appear to have exceeded the estimates and it is believed that there will be a small surplus which should be obligated to meet the needs of 1935 when it is expected that there will be a further shrinkage in revenues. It has been possible to keep the expenditures within the income only by neglecting many things that ought to have been done and by further suspending the publication of annual reports. It will be necessary to have increased allotments from Congressional appropriations each year or to have funds from other sources to meet the shrinkage in land revenues, in order to meet the needs of maintenance alone, without reference to the natural growth which should be made.

The nurseries carried on by the Gardens for the dissemination of valuable plants have continued to operate upon a self-supporting basis under the revolving fund. The sales for the 11 months ending May 31 have amounted to $3,879.45. June is usually the month of largest sales, amounting to $1,603 in 1933. It is thus estimated that the 1934 total sales will approximate $5,000. There remained a balance of about $8,247 in this fund on May 31, representing an increment of approximately $3,250 over the $5,000 originally set up for these operations.

In the Equipment Replacement account which is maintained by a monthly charge against the operating funds there was a balance of about $1,823 on May 31. This will be reduced in the immediate future by approximately $300 by the installation of much needed grinding equipment.

Report of a Trip to Chiriqui Province

In January 1934, the Director of the Gardens made an official trip to the Province of Chiriqui. A copy of the report of this trip, which has already been submitted, is incorporated herewith as a part of the year's activities. It is as follows:

REPORT OF TRIP TO THE PROVINCE OF CHIRIQUI

Chief Quartermaster,

Balboa Heights, C. Z. (Through the Assistant Chief Quartermaster).

Sir: In accordance with the letter of authorization of the Governor, on recommendation of the Chief Quartermaster, I visited the Province of Chiriqui, leaving Balboa on Sunday, January 14, and returning to the Canal Zone on Thursday, Feburary 1.

The purposes of this trip were as follows:

Inspecting the condition of plants which the Gardens have placed in Chiriqui for experimental purposes; selecting suitable locations and cultivators for the placing of other plants requiring higher elevations than those at Summit; familiarizing the people of the region with the facilities which the Experiment Gardens are offering in the matter of plant introduction and distribution; and attaining familiarity with the conditions of the Chiriqui region and other matters in the interests of the Canal Zone Experiment Gardens.

Inspection of Earlier Distributions

The trees of avocado from the Gardens, now growing in the very deep, rich soil in the banana district, a few miles inland from Puerto Armuelles, have made a remarkable growth and have begun to bear fruit. (Plate II, Figure 1.) Some were in flower at the time of my visit to the orchards and gave promise of producing quite heavily this year. The soil of that region appears to be ideal for avocado culture and this may be said of extensive areas in the Chiriqui Province. I saw none of the failure of avocado trees which is so prevalent in the heavy and tenacious soils of the Canal Zone towns. With the further dissemination of grafted and budded trees of these choice, selected varieties, this most fertile province should take an important part in supplying the markets of Panama City, Colon, and the interior towns with avocados that will compare favorably with those of any part of the world and should entirely replace the non-descript lot of seedlings which are so frequently seen in the markets. Doubtless there are also choice seedlings of Panama origin which also should be multiplied by budding or grafting. Even with the present facilities for shipping there is no reason why avocados from Chiriqui should not be safely placed in the markets of Colon and Panama.

In the higher altitudes of the Province had been placed some of the varieities of the race of avocados which is found in the highlands of

Guatemala and is known as the Guatemalan race. These were seen in different localities at 4,000 to 5,000 feet elevation and were reported to have begun to produce fruit. Some were in flower at 5,000 feet at the time of my visit and looked very promising. Avocados of these varieties may be expected to supply fruit at seasons when the lowland varieties of the so-called West Indian race are out of the market.

Mangoes

The mango trees seen at Blanco, near to sea-level, are making a very vigorous growth and are in a healthy condition. It is yet too soon to determine what these may do in the matter of fruit production. They were planted about the middle of October in 1929 and thus were a little more than four years in the orchard. Some were in flower in January of 1934 which indicates rapid maturing. In this rich, deep soil, abundantly supplied with moisture during a long rainy season, I was rather surprised to see flowers while the trees were so young. Mangoes are naturally strongly vegetative until the trees become quite old, and I should not be surprised if it be found necessary to adopt some such measures as girdling of some of the branches to arrest growth and encourage production of fruit.

Citrus Fruits

Observations of citrus fruit trees both on the lowlands and also in the coffee districts, indicate that a large assortment of varieties of oranges, grapefruits, lemons, limes, and others may be expected to prosper in the Chiriqui Province. The observations covered not only the citrus trees sent out from the Experiment Gardens, but also the old seedling sweet oranges that have been in the country for a very long period, and the Bahia or Washington Navel orange introduced many years ago from California. Mr. W. J. Wright is authority for the statement that this introduction was made in 1896 by Mr. Frank Tedman of Alto Lino. Mr. Wright has a small orchard budded from the Tedman tree and this is one of the special attractions of the town of Boquete. These Navel oranges, in flavor, texture, and appearance, would do credit to any market. These and other trees of the variety scattered through the district bear strong testimony to the fact that Panama should produce all its own oranges and also become an exporter of this high quality fruit. The Bahia (Washington Navel) orange in the tropics has so far appeared to be strictly a highland variety and its production on a commercial scale should not be attempted on the lowlands as the fruit in these localities tends to be of poor quality. It is possible that special clones may be found that will be adapted to these conditions. The Canal Zone Experiment Gar-

dens have introduced budwood of one of the best strains of Bahia grown in California. This budwood was from trees whose production records have been kept for many years past. This is propagated at the Gardens and the trees are shipped to the high elevations, but are not yet on our recommended list for the lowlands.

Grapefruit in several varieties also prosper in Chiriqui on the lowlands and at altitudes up to at least 4,000 feet. The fruit, whenever found, was of good quality.

Breadfruit

Breadfruit thrives like a weed in the rich, moist soils of the lowlands of Chiriqui. Plate I, Figure 2, shows a breadfruit tree which was received from the Experiment Gardens about May of 1932 and was planted out by the Chiriqui Land Company at Blanco. The photograph taken in January of 1934, shows the tree when it had been planted for less than two years. The breadfruit furnishes a staple food supply for thousands of the inhabitants of the Pacific Islands and should be planted by every farmer on the lowlands of Chiriqui and in many other parts of Panama. The trees yield abundantly a most nourishing food and require almost no attention in the conditions to which they are adapted. Under such conditions, it also is one of the most handsome shade trees that can be found anywhere, with its huge, deeply lobed leaves which present a magnificent tropical effect. A few trees would keep a family supplied with the necessary starchy food throughout the entire fruiting season.

Locating Homes For New Plants

I took with me to Chiriqui 145 plants for the purpose of placing them for trial in locations where the environmental conditions are quite different from those prevailing at the Experiment Gardens or anywhere else in the Canal Zone. Some of the plants are not suited to the comparatively low elevations on the Canal Zone and others will probably benefit by the rich and more friable soils of some parts of the Chiriqui lowlands. These plants were as follows:

25 Grape cuttings, Isabella variety
2 Lonchocarpus nicou
20 Derris elliptica
3 Cracca toxicaria S. P. I. 101,188
3 Macadamia ternifolia
24 Eugenia floribunda
30 Asparagus officinalis
2 Sasa variegata pygmaea F. P. I. 52,614
2 Sasa pumila F. P. I. 52,673

12 Bambusa tulda (suckers)
3 Bertholletia excelsa
3 Lecythis sapucaya
2 Lecythis tuyrana
3 Lecythis elliptica
3 Ficus waringiana
8 Banana suckers (2 of each variety) Eleele, Manaiula, Maoli, Popouli

The Isabella Grapes

This is a strain of the Isabella variety of grape which appears to be acclimated to the cooler tropics. It was introduced at the Experiment Gardens from Hawaii where it has prospered for many years since its introduction from Madeira. In Hawaii, under irrigation, it produces two crops per year of excellent grapes. The conditions at Summit appear to be unfavorable for it, and it is therefore being tried at various places in Chiriqui. In El Volcan these are located with Messrs. J. G. Macoubrey, J. L. Miller, and C. A. Escoffery. In Concepcion, which is perhaps the more promising location, cuttings have been placed with Mr. Walter Spalding. In the Boquete district, they are with Messrs. W. J. Wright, Paublino Ruiz, Nicholas Taylor, and Dr. J. H. Talboy.

Cubé (*Lonchocarpus nicou*)

Cubé is a plant that is now attracting considerable attention because of its content of rotenone, a substance highly poisonous to insects but not dangerous to man and the domestic animals. Hence it is being used in the manufacture of some of the newer insecticides and is under further investigation for such purposes. If rotenone is found to be an economical and highly effective insecticide capable of displacing to a considerable degree the arsenical compounds which have been the standard stomach poisons in insecticides, there may be a large demand for it. Cubé, being one of the possible sources of rotenone, is under trial in several countries. As the plant is native of the highlands of Peru and probably other parts of South America, it is doubtful whether it will prosper in the heat of the lowlands. It is under test at the Experiment Gardens, but to date has not given much indication that it will flourish here. Hence, of the few plants that we have, two were placed with Mr. J. L. Miller in the Volcan coffee district at an altitude well above 4,000 feet and also with Mr. Wright and Dr. Talboy in the Boquete district.

Derris elliptica—Another source of rotenone

This climbing or trailing plant is native in parts of the Oriental tropics where it is used as a fish poison and is now under study as a source of

rotenone. It appears better adapted than Cubé to the conditions at Summit, in the Canal Zone. The seed was introduced at the Experiment Gardens direct from Java and the plants have made good growth, but it seems desirable to test this species under other conditions in Panama. Hence plants were placed with the Chiriqui Land Company, with Mr. Escoffery and Mr. Miller in El Volcan, and with Messrs. Wright, Ruiz, Monniche, Jose Yenez, and Dr. Talboy in the Boquete district and the surrounding country.

Cracca toxicaria—Another source of rotenone

This is a leguminous plant, native in the higher altitudes of Bolivia, which was introduced by the United States Department of Agriculture from which source it came to the Canal Zone. It is another of the plants under investigation as possible sources of rotenone. It has not been under cultivation at the Canal long enough to determine its adaptability here but considering its source, it seemed desirable to place a part of the very few plants in the higher elevations of Chiriqui. Hence they were placed with Messrs. J. L. Miller and W. J. Wright. Also, to ascertain the effect of entirely different soil conditions combined with altitudes not widely different from those at the Experiment Gardens, one plant was placed with Mr. H. S. Blair, Manager of the Chiriqui Land Company plantation at Puerto Armuelles.

Eugenia floribunda

This is a small fruit which has been introduced from the Virgin Islands where it is much used for making jam. The tree is of medium size and is adapted to low altitudes, but its adaptability to higher places should be tested. The young trees were placed with the Chiriqui Land Company for lowland planting and with Messrs. Jennison, Macoubray, Wright, and Dr. Talboy in the higher altitudes.

Asparagus

(*Asparagus officinalis*)

This is the ordinary garden asparagus, grown as a vegetable and for decorative purposes. It is not suitable to lowland conditions in the tropics, but at altitudes of 4,000 to 5,000 feet in the friable soils of the Volcan and Boquete regions it should prosper. A few plants were left with Messrs. Jennison, Miller, Escoffery, Paublino Ruiz, Nicholas Taylor, and Mrs. J. F. Keiser.

Bamboo Species

Two species of small bamboo, *Sasa variegata pygmaea*, F. P. I. 52,614 and *Sasa pumila*, F. P. I. No. 52,673, were placed in the Volcan with Mr. Miller; and *S. variegata* was placed also in Boquete with Mr. Wright and with Dr. Talboy.

*Bambusa polymorpha**

This is a bamboo that has proved very succesful in the Canal Zone and is one of the most beautiful among the many species now under cultivation at the Experiment Gardens. It is without thorns and being very compact in habit of growth it is not so hard to control in limited space as are some of the other species. It was placed for trial in the rich lowland soils of the Chiriqui Land Company.

Nut-bearing Trees

The macadamia nut tree, also called the Queensland nut, (*Macadamia ternifolia*) is native of Queensland, Australia, but has been established in various parts of the tropics. The production of these nuts has become a small but growing industry in Hawaii. Several introductions of seed from Honolulu have been made and the trees at Summit are making good progress. As this is one of the most excellent of all the nuts, it will doubtless become widely disseminated in Panama if it succeeds here. It is believed that the macadamia will not require much altitude but it should be tested from sea-level to 5,000 feet. Plants were placed with Mr. Miller and Mr. Monniche and also with Mr. Blair. It is regretted that the supply was quite limited.

The Brazil nut (*Bertholletia excelsa*), known also by various names as Para nut, butter nut, nigger-toe, etc., is so well known in the market that no description is necessary. It is native to the warm, moist parts of Brazil and may be expected to do well in the rich soils of the banana region about Puerto Armuelles where three plants were left with the Chiriqui Land Company.

The Sapucaia nut or Paradise nut (*Lecythis zabucajo*), a close relative of the Brazil nut, is also native to Brazil where it is said to be more highly prized than its better-known relative. The reason for its being less widely known may lie in the fact that the "monkey-pot" or capsule in which the nuts are contained has a natural opening or lid through which the nuts when ripe are dropped to the ground and are immediately the objective of a wild scramble of monkeys and other animals of the forest so that man has a poor chance to collect and market them. The Brazil

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* Through an error this bamboo was cultured and disseminated under the name *Bambusa tulda*. It has since been determined as *B. polymorpha*.

nut is difficult to open and man has a better chance in competition with the beasts of the forest. Both of these excellent tropical nut trees have been introduced at the Experiment Gardens, and the sapucaia has made very good growth. The Brazil nut trees have been slower. It is believed that both species will do better in Chiriqui than in the Canal Zone. Three sapucaia trees were placed with the Chiriqui Land Company.

Lecythis tuyrana and *L. elliptica* are two other nut-producing trees related to the two just mentioned. The first of these is native to Darien, Panama, and the second comes from Colombia. They also have been placed in the lowlands for trial in rich soil.

The Waringian Fig (*Ficus Waringiana*)

This is a tree of the banyan type and is sometimes referred to as the Waringiana banyan. It is one of Dr. David Fairchild's introductions from Java and of it, in his book *Exploring For Plants*, he says, "Of all the strange avenue trees that I have seen, the Waringian is the strangest." He adds: "Little plants of it are now struggling with the lime-stone soils of Florida and with the clay soils of Cuba, the Panama Canal Zone, and Honduras."

At the Experiment Gardens in the Canal Zone, there appears to be no longer any struggle, for the Waringian has become an easy victor and is expanding upwards and outwards more rapidly than almost any other tree in the Gardens. It resembles the "Chinese Banyan" or "Laurel de India" (*Ficus retusa Linn.*) *F. Nitida Thunb*, which is so much admired on Roosevelt Avenue, in Balboa. It is even more handsome and, unlike its relative, it is apparently not subject to attack by thrips which cause much leaf curling on *F. retusa*. At the Chiriqui Land Company's plantation it will doubtless become a remarkable tree. Three small trees were left there.

Hawaiian Cooking Bananas

These, from horticultural and culinary standpoints, are essentially like the plantains of the West Indies and tropical America, but they are of exceptional quality and appearance. In the opinion of the writer, these cooking bananas have considerable possibilities of development into an export fruit. It is desired to have them tested in the banana soils of the Chiriqui Province. They include the varieties Eleele, Maoli, Manaiula, and Popoulu. Two of each variety were placed with the Chiriqui Land Company for testing and report.

The Coffee Situation

Coffee production has become the leading industry in the district about Boquete and on the slope of the mountain and in recent years a

PLATE II

FIGURE 1.—Avocado trees at Blanco, Chiriqui

FIGURE 2.—Coffee Plantation Center in the mountains above Boquete

coffee industry has sprung up on another shoulder of the mountain in what is known as the Volcan region. In Plate II, Figure 2, may be seen part of the lay-out of a very successful coffee plantation above Boquete at an elevation of about 5,000 feet. The coffee growers in and about Boquete are Panamanians and foreigners including several Americans, while in the Volcan, Americans and Scandanavians seem to predominate. Some quite large plantations have been made by joint stock companies and there are many good-sized plantations owned and operated by individuals or partnerships. Plate III, Figure 1, shows a hybrid coffee tree in the Volcan region, heavily laden with fruit. This coffee belt is located at altitudes ranging from 3,000 to 5,000 feet, on the mountain slope, below the extinct crater, El Volcan de Panama, on soil that is of volcanic origin. In general the soil of the virgin forest consist of a surface layer of varying depth and rather well supplied with humus, below which is a thin stratum of rather coarse volcanic ash, subtended by a very deep stratum of black powdery material. The surface soil is known locally as "la crema," the second stratum as "ceniza," (ashes) and the third as "negro," because of its very dark color. No soil survey of the region is on record and the writer has failed to find authentic, reliable, and representative soil analyses.

Coffee Diseases

In the Volcan coffee region and also in Boquete my attention was solicited concerning several coffee diseases. The most important of these and the one which has caused deepest concern among some of the planters is a leaf spot disease which causes defoliation, suspension of growth, the destruction of young branches, injury to the cherry and bean, and sometimes almost complete loss of crop. In some instances this disease has caused the abandoning of the plantations and certainly will do so on many plantations if it is not brought under control. Hence the deep concern among some growers is well founded, although other plantations have so far been kept rather free from the disease and the owners do not seriously fear it. There are, however, few if any fincas that are entirely free from it and none that are not endangered by it if uncontrolled.

There has been much misapprehension among planters as to the identity and the cause of this disease which locally has been confused with the devastating coffee "Rust" of the Orient that caused the ruin of the plantations of Arabian coffee in Java, Ceylon, the Philippines, and other parts of the Oriental tropics. The latter is also a leaf spot disease and is caused by a fungus known to science as *Hemileia vastatrix*, but the spots are so entirely different that the two are easily distinguished by general external

appearance. It was possible, therefore, to assure the planters at once that their trouble is not that of the Orient.

The chief leaf spot disease found in the Chiriqui Province and the one that we are now discussing is that which has been variously known as the "American Leaf Disease" of coffee, "Viruela" (small-pox),"Leaf-Spot," "Mancha de Hierro" (iron stain), etc.

The disease is characterized by spots one-quarter inch to one-half inch in diameter on the leaves, at first dark in color but later turning gray or almost white, and showing equally on both surfaces of the leaf. This diseased tissue frequently falls out as the spots become older, leaving perforations in the leaf. Many of these spots may occur on a single leaf. Partial or complete defoliation follows if the disease is not controlled. Similar spots but inclining to be elongated in shape, appear upon the cherries (coffee fruits) and upon the twigs. These young shoots may be killed and the coffee beans within affected berries are likely to be discolored.

The tree, seriously affected, thus presents a generally distressed appearance although it may retain its crop of fruit more or less diseased. Without leaves the tree cannot make new growth and hence is not prepared to produce the next crop of cherries, as fruit of the coffee tree is yielded chiefly on the growth of the preceding season. Also, without leaves there can be no root growth and without new rootlets little food can be taken up. Thus the vicious circle continues. A typical tree thus defoliated is shown on Plate III, Figure 2.

The organism which causes this disease is a fungus. Its decription will be found in the literature of the subject under various names that have been given it during the progress of the study that has been made of it. The students of the subject will look for it under the names *Stilbum flavidum*, *Stilbella flavida*, *Sphaerostilbe flavida*, and *Omphalia flavida*. Which of these determinations is best founded from a purely mycological point of view will not concern the planters but with a knowledge of the several names it will not be difficult for planters to avoid confusing this disease with others in reading of its history and treatment in other countries.

This fungus is propagated by vegetative parts which appear as small round heads on yellowish thread-like supports resembling very small pins. They arise in wet weather out of the brown spots on leaves, branches, or berries. The rounded heads drop off and are carried by wind, water, gravity, on the clothing of laborers, or otherwise until they find a lodging place. If this happens to be upon the vulnerable parts of a coffee tree or upon some other favorable host plant, it begins to grow and soon produces another spot which in turn becomes a new source of infection. Under dry atmospheric conditions the disease makes no

FIGURE 1.—Coffee tree, said to be a hybrid

FIGURE 2.—Coffee tree defoliated by the Leaf Spot disease

progress but with the arrival of wet weather or dense fog it immediately springs into activity.

From the standpoint of control of the disease, it is most unfortunate that there are many host plants upon which it thrives and these include wild plants of the forest and several kinds of weeds which spring up everywhere among the coffee. McClelland lists under their local Puerto Rican names at least 24 different species of host plants, commonly found in coffee fincas in Puerto Rico, and although coffee appeared to be the preferred host there were several almost as susceptible. The guava, *Inga vera*, used as a shade tree for coffee, was found to have numerous spots but in only one instance was a fruiting body found and hence it was concluded that the danger of infection from this source is very slight. This tree must not be confused with the fruit-yielding species, *Psidium guajava*, which is commonly known as guava where English is spoken. Another species of *Inga* (*Inga laurina*), commonly known in Puerto Rico as guama, and much used as coffee shade, was reported as entirely free from infection. Some of the *Ingas* seen in the Volcan had spots on the leaves but, it being dry season and there being no propagation of the fungus in evidence anywhere, it was impossible to determine whether these trees are in any way responsible for the spread of the disease. Unfortunately there are many weeds upon which the disease does multiply and which are important factors in its spread. This fact must be taken into consideration in any discussion of methods of control. No accurate list of such plants could be prepared during the dry season but many of them are known to the planters.

Control Measures

"Coffee Leaf Spot" or "Viruela" is not a new malady of this crop in Panama, having been known here for many years and has taken its toll from many plantations periodically with varying seasons and destroyed others completely as profitable fincas. Its greatest devastations are in seasons of continuous and prolonged rainfall as in 1933-34, when the rains continued for more than a month later than usual. Little scientific study of the disease has been made in this country and I find no record of any exact experiments in methods of control, but some of the growers have applied control measures more or less successfully while others feel helpless to stem the tide of its progress. As the disease is wide-spread in the American tropics, Panama may benefit from the experiences of other coffee-growing countries in which this disease has received considerable attention. In discussing control measures, reference will be made to some of the experimental and demonstration work done in these countries. The disease is reported in the Central American States, in

Mexico, Colombia, Venezuela, Dutch Guiana, Brazil, Puerto Rico, Dominica, Trinidad, Jamaica, and, doubtless, others of the Antilles.

When confronted with any serious fungus disease of plants, the cultivator naturally thinks first of fungicides of which bordeaux mixture, burgundy mixture, and forms of sulphur are the standards. As remedies for leaf spot or viruela on coffee in Panama, they must be considered of very limited applicability, although they may serve a special part in a control campaign. The limitations of fungicides are due to several practical considerations. First, in wet season, the rains are so frequent and so heavy that it is usually difficult to get the fungicides on the trees and dried before the next shower washes them off, even though there are now quite effective stickers that will keep the protective covering on the leaf a long time if well dried. Each day new growth is made and these new leaves require protection which increases the difficulty. The use of fungicides in dry season, except just at its close, in preparation for the rainy weather is of no value whatsoever, as the disease is dormant at that time, and no application can penetrate to destroy it where it lies within the tissues of the plant. Then the practical difficulties and expense of spraying large plantings, frequently located on steep and rough hillsides, including the transportation of water and machinery, are so great as to render spraying impracticable except in very limited areas.

The most important control measures must consist in avoiding infection and in establishing conditions unfavorable for the spread of the disease. These sources of infection may be diseased coffee trees in the plantation or in an adjoining one over which the grower may have no control; or they may be in one or many of the different species of weeds that cover the ground if uncontrolled; or the requisite shade trees, if not well-chosen, may breed the fungus and shower the propagating parts everywhere; and finally the wild growth of surrounding fields or forests may multiply the offending organism.

I observed one very good finca into which the disease seemed to be advancing from a badly infested and neglected adjoining plantation. In such situations the planter may do much to protect his plants by cutting down a few rows and replacing them with a thick stand of some rapidly growing plant which will form a barrier immune to viruela. Bananas have been reported as effective for this purpose but the planter must make sure that his variety is immune and in making the selection must not be deceived by the presence of such brown or gray spots on the leaves as do not produce the propagating parts of this disease. I have nowhere found any record of bananas serving as a host but it would not be safe to state that all varieties are immune. If the disease appears on the coffee inside the barricade, steps must be taken to eradicate it but this control of the disease within the plantation must be discussed later.

It is often observed that the disease enters the plantation from an adjoining forest. Obviously it would be impracticable to eradicate all the possible host plants from the forest. If any special offenders are found in the nearby forest, and particularly high trees from which infection would be carried by winds, such trees should be cut down, but the entire clearing of the forest is not indicated.

Sometimes special locations are found where the disease enters from the forest and in such localities the banana or other barricade might be effectively and economically used if the offending host plants are low. If not too far from market the banana fruit has a sale value and in any case is valuable as food and as feed for livestock. In these locations close to the edge of the forest, the coffee trees are especially vulnerable because of the dense shade cast by the forest trees. Shade and the consequent atmospheric humidity are especially favorable to the disease organism.

When the disease has already entered at the edge or, as sometimes occurs, on isolated trees well inside the plantation where it may have been carried by wind, water, birds, men, or other agencies, what methods must be adopted to arrest its spread? First, it must be remembered that shade favors the disease and excessive shade should be removed but the coffee trees themselves require some shade and to go beyond the limit of the demands of the coffee, in the removal of shade, would involve further trouble. But more active measures than the adjusting of shade must be adopted. The sources of infection within the plantation must be removed. All weeds that act as hosts must be kept down and insofar as possible must be destroyed at least in and about the infected area. Under present conditions this implies the cutting of all weeds and grass rather close to the ground. Some planters shave the ground with a hoe or a very sharp, especially devised shovel so as to remove every vestige of living vegetation above the surface, except the coffee trees. This cannot be recommended for general practice and is seldom advisable. It exposes the soil to the excessive heat of the sun during dry season and to the serious effect of erosion during wet weather. Fortunately it is very difficult to maintain such a practice during continuous and prolongd rainy weather when weeds spring up persistently. The practice, unless maintained by a very great amount of labor, tends to establish a grass cover for the soil which is undesirable.

On the one hand, the planter is beset with the dangers of disease-breeding weeds and on the other with serious soil erosion and the risk of the carrying of the disease on the clothing of laborers engaged in the cutting the weeds. It would appear that, ultimately, the way out of these difficulties must lie in the selection of some low-growing immune species of

plants, preferably legumes which can be used as cover crops during wet season and as a dry mulch during dry season in infested areas. It is impossible to predict in advance which of the many legumes might prove to be immune to the disease and otherwise adapted to the location and the need. Experiments should be begun at once with all promising varieties of which seed may be obtainable. In selecting cover-crop seed for this purpose, climbing legumes should be avoided and those of low-growing habit should be tested. Those that are too quick in maturing will not be best as it is desirable to find one whose period of growth will extend through the wet season. It is also essential that the legume shall be vigorous in growth and able to contend with the weeds. No attempt can be made here to list all the legumes that should be tested out for this purpose. Among them may be mentioned *Pueraria phaseoloides*, *Indigofera endecaphylla*, *Dolichos hosei*, *Centrosema pubescens*, Jack Bean (*Canavalia ensiformis*), the *Crotolaria* in several species, the Yam Bean (*Pachyrhizus angulatus*), *Dolichos uniflorus*, *Melilotus alba*, *Tephrosia species*, *Calapogonium mucunoides*, *Lespedeza striata*, *L. sericea*, *L. stipulacea*, etc.

The Coffee Trees Themselves as a Source of Infection

Thus far we have been discussing the avoidance of infection from host plants other than coffee. But the coffee trees themselves are preferred hosts. The methods that may be followed to rid the plantation of centers of infection in the coffee trees themselves, depend in part upon the extent of the infestation.

In plantations that have been extensively devastated by the disease so that the most of the trees in certain areas have become affected, drastic measures are necessary. In Trinidad, Briton-Jones has reported a successful experiment in the restoration of a plot which had been heavily infested with the disease. It was severely pruned so as to remove such tender growth as would be most susceptible to the disease and all leaves were removed. The leaves and prunings were allowed to remain where they dropped as it was claimed that earlier experiments had shown that the burning or even the gathering in heaps of all this material was unnecessary, because the disease did not seem to propagate itself on this decaying material. This severe pruning and defoliation was accompanied by clean culture to rid the place of weeds and was followed by fertilization to stimulate new growth. The treatment resulted in the loss of about one year's crop but on badly infested trees the crop is almost negligible without any treatment.

This defoliating and heavy pruning involves very much work and many planters will think it best to follow the Puerto Rican method de-

scribed by McClelland and adopted on many fincas on that island. This consists of cutting back all trees in badly infested spots to a stump about six inches high. The cut should be clean with no ragged edges and should be diagonal in direction so as to shed water and to heal. The trees are chopped into pieces and allowed to lie on the ground and rot. It is important to leave not a single tree in the treated area as such would quickly infect the new growth. This stumping is preceded and followed by clean culture and a close watch is kept for local reinfection in order to remove any disease as soon as it appears. It is admitted, the trees can produce no coffee worth picking until the third year after treatment is begun and not a full crop until the fourth year, but it is claimed that the method, where faithfully followed, has resulted in the rehabilitation of the plantation which otherwise would soon have become worthless.

It will always be necessary for coffee planters in Chiriqui to maintain a constant watchfulness against the inroads of this disease. Whenever it is found it must be promptly treated and where the disease is well established one or other of the methods described above should be applied. But even after the plantation has been cleaned there will be new infections from time to time. When a few diseased leaves have been discovered on a tree these should be removed at once and if a tree appears with extensive infestation, either very severe pruning with complete defoliation or cutting to a six-inch stump will probably prove to be the safest and the most economical method of treatment. I do not consider it necessary or economical to cut down an entire tree for no other reason than that a diseased leaf has been found upon it. The disease is not bacterial and does not travel within the tree from the leaf to other parts. If this were the case, then the removal of the entire tree would be indicated, but the facts are quite otherwise. It is quite true that where the disease has been found it may appear again as a result of the same influence that caused the first appearance, but it is as likely to appear upon the immediately surrounding trees. The same agency which brought it to the one tree is quite likely to have brought it to others in the immediate vicinity where it may appear soon after. The tree, when it has been found and those surrounding it, should be marked in some way so that they can easily be found and should be especially examined periodically until the planter is satisfied that he has exterminated the disease in that locality. It is quite possible that here bordeaux mixture might be made to serve a useful part in the control of viruela. A good coating of a tightly adhesive fungicide upon the tree which leaf spot has been found and upon others in the immediate vicinity, would give all the covered parts protection from attack.

Bordeaux Mixture

Although much has been written about bordeaux mixture, not all planters know how to prepare it and it will therefore not be out of place to repeat some of the formulae, state simple essentials in its preparation, and call attention to adhesives which are more important on coffee foliage than on the leaves of many other trees.

A standard formula for bordeaux mixture is expressed as 4-4-50, which signifies 4 pounds of copper sulphate, 4 pounds of quicklime, and 50 gallons of water. It is important that these ingredients be properly mixed. The copper sulphate is placed in a sack and suspended in a wooden tub containing about 25 gallons of water. It is usual to leave this over-night, as in cold water several hours may be required to dissolve the chemical. The 4 pounds of quicklime are slaked in another tub by slowly adding water and after the slaking is completed more water is added to make a total of 25 gallons. These two stock solutions are then poured, simultaneously in a uniting stream, through a strainer into a 50-gallon barrel or spray-tank where they are thoroughly mixed and are then ready for use. It is important to thus strain the mixture to avoid the frequent clogging of the spray nozzle. It should be applied at once as the mixture quickly breaks down. Stock solutions of the lime and of the bluestone may be kept almost indefinitely in closed containers which prevent evaporation of the water. When necessary, the mixture may be preserved by adding a heaping tablespoonful of sugar, dissolved in a little water, to every 100 gallons of mixture. It is often difficult, expecially in this country of humid atmosphere, to get quicklime or to hold it because it rapidly acquires the moisture from the air and becomes hydrated lime. This hydrated lime can be used but the amount must be increased by using 6 pounds of the hydrated lime for every 4 pounds of copper sulphate.

In this country of torrential rains, the adhesiveness of a spray mixture is most important and a so-called "sticker" is generally used under such conditions. One of these is resin soap prepared by boiling 4 pounds of finely broken resin with 2 pounds of washing soda in 2 gallons of water until the mixture is clear. This is sufficient for one 50-gallon tankful of bordeaux mixture and should be added to the mixture and thoroughly agitated. It should not be added to either of the ingredients separately.

Glue is also used as a sticker in the proportion of one-half ounce to 50 gallons of spraying material.

For spraying on an extensive scale, a concentrated stock solution containing 1 pound of copper sulphate in each gallon of water is prepared and another stock of the lime solution containing 1 pound to each gallon.

These are diluted as needed and the diluted solutions are mixed to prepare bordeaux mixture. For large operations special equipment is set up. Every coffee grower should have a good bulletin on bordeaux mixture and these can be obtained for a few cents on application to the Superintendent of Documents, Washington, D. C.

General Soil Management and Fertilization

Some program of soil management for the maintenance of fertility is important throughout these coffee districts. Such a program, if well-planned and carried out, would also aid the trees in overcoming the effects of disease. One of the most important matters is the maintenance of a supply of decaying organic matter. In some of the older fincas this appears to have become much reduced and low-growing grasses have become established. Even in some of the newer plantations, the error of burning over the land before planting has been made, thus consuming much of the humus. In the newer plantings, there is a natural growth of vigorous weeds and if these are not breeding the leaf spot disease, they can be made to serve a useful purpose in maintaining the humus supply if they are cut and allowed to cover the ground. I believe it to be a better practice to leave this vegetation where it falls than to gather it all up and place it in the rondas or circles about the trees, not because it does any injury in the rondas if kept from immediate contact with the trees but it is needed, especially in dry season, to cover all the ground surface and at all times to build up the humus supply. The value of an immune leguminous plant in the places infested with viruela has already been emphasized. If a suitable legume, adapted to the location and need can be found and established throughout the plantations, such would be a tremendous achievement in coffee growing in Chiriqui. The ideal would be a permanent legume which could be allowed to grow through the wet season, and be cut back as needed and especially at the beginning of the dry season, thus furnishing a ground cover. Some of the legumes tend to reseed themselves. But even a legume that would require planting at the close of each dry season would probably well pay for the cost, not only in humus supply but in the direct increase in nitrogen brought about by their root nodules. Also if the legume is not too high in habit of growth but dense enough to hold down the weeds, it would reduce the cost of labor in cleaning which many careful planters do from three to five times per year. As emphasized above, it is impossible to predict which of the many legumes would best fit into such a program and the most adaptable could be determined only by experiment with a large number of kinds.

The judicious application of chemical fertilizers, as supplementary to other good management, would doubtless give beneficial results on many of the fincas and would probably prove very profitable on some. But here again only careful experiments in the plantations can determine just what combinations of fertilizing elements can be most economically used to supply the need. There is a popular belief prevalent in Chiriqui, as elsewhere, that all that is necessary to determine the right fertilizer formula is a chemical analysis of a few samples of the soil. Nothing could be farther from the facts. In corroboration of this statement I quote from Lyon and Buckman of Cornell University as follows:

"The conclusion that chemical analyses are of but little direct practical value as a guide to soil productivity is unavoidable. In spite of the great importance of chemistry in research and teaching it fails to indicate either the permanent or the immediate fertility of the land."

This is typical of what might be quoted from many authors. These and similar statements are in no sense intended to detract from the well-recognized position of chemistry as a basal soil science or its value to soil scientists but analyses of samples, especially those collected by men untrained in this work, cannot be regarded as more than suggestive of possible fertilizer needs and are likely to be misleading.

Therefore, the only means of determining formulas for fertilizers that may prove profitable in coffee growing in Chiriqui are by carefully conducted fertilizer tests in the plantations. However, in the absence of such experimental data and of any plans for conducting such experiments, the planters themselves by trial on a small scale can at least determine something of the results to be expected by the use of different fertilizers. Small quantities of ready-mixed fertilizers can be tested but some of the principal fertilizing ingredients should be tried alone.

For example a dressing of 100 to 200 pounds per acre of nitrate of soda or of 75 to 150 pounds of sulphate of ammonia applied at the beginning of the rainy season would indicate whether there may be a decided insufficiency of available nitrogen. An application of 200 to 400 pounds of dissolved phoshpate rock or of dissolved bone-black might indicate improvement by the use of phosphoric acid. The use of 100 to 200 pounds of sulphate of potash per acre might show a response due to the supply of potash. However, these responses are not always immediate and sometimes are difficult to evaluate. Also planters can secure ready-mixed fertilizers of different formulas and by trial get some suggestions at least as to their relative usefulness. But carefully planned experiments in fertilization, scientifically carried on for a period of years, are the only means of determining the most economical fertilizer formulas for the coffee crops on a given soil. An application of 150 to 200 pounds of

nitrate of soda is likely to be especially beneficial in the rehabilitation of the parts of plantations which have been injured by viruela.

Vegetable Tests

The Gardens have never undertaken much work with vegetables but the new arrangement for apprenticeships has made possible and desirable a limited amount of work in the culture of vegetables. There is some demand for information as to the varieties of vegetables that will succeed under conditions existing in and near the Canal Zone. Mr. Walter R. Lindsay, Supervisor of Cultures has conducted a considerable number of tests with the student labor group. His report of such work follows:

REPORT OF VEGETABLE TESTS

By Walter R. Lindsay, *Supervisor of Cultures*

Part of the instruction work given the student laborers during the past year consisted of the maintenance of an experimental vegetable plot.

The seed was offered and supplied by commercial seed houses in the United States with request that they be supplied with reports of tests. The following were the seeds tried:

13 varieties of Bush Beans
2 varieties of Dwarf Bush Lima Beans
7 varieties of Pole Beans
4 varieties of Cantaloupes
2 varieties of Egg Plant
4 varieties of Peppers
1 variety of Spinach
2 varieties of Squash
15 varieties of Tomatoes

The students were very enthusiastic about their work and not only learned modern methods of gardening but also accumulated valuable data concerning the varieties of vegetables under test. Brief mention may be made regarding the results obtained.

Very little difference was noted in the yield between the different varieties of bush beans tried. "Full Measure" and Landreth's "Extra Early Stringless," however, were slightly more resistant to mildew and damping off in the young stages than the other varieties and were slightly superior yielders.

A marked difference was noted in the fruiting habits of the two varieties of dwarf bush lima beans. Henderson's "Dwarf Bush Lima" produced an abundance of delicious beans while the variety "Fordhook,"

planted beside them, failed to produce a single fruit. Both varieties received the same amount of fertilizer and care but the former variety had the ability for setting fruit under wet humid conditions while the latter variety did not. Possibly reverse results might be had if these varieties were grown during the dry season.

"Nancy Davis" variety of pole bean has repeatedly shown its superiority as a green bean in this region and is about the only variety grown in the local Chinese gardens. It is resistant to most common bean diseases of Panama and produces an abundance of excellent, long, tender green beans which are practically fiberless.

In wax beans "McCaslan," Landreth's "Tennessee Wonder," and "Golden Cluster Wax" all did fairly well but were more subject to diseases and produced less uniform fruits than the green pod variety "Nancy Davis." It may be noted that one authority stated that he had never tasted a more delicious bean in this country than the "Golden Cluster Wax." This variety far surpassed the other varieties of wax beans in both yield and hardiness.

No success was achieved in the growing of any variety of cantaloupe during the rainy season although excellent crops were produced during the dry season. Seeds should be sown during the latter part of December or early January thus allowing the plants plenty of time to mature their fruits before the May rains commence. "Hearts of Gold," "Rocky Ford," and "Hale's Best" have all given satisfactory results here in dry season.

Practically the same things may be said about raising summer squash as was said about cantaloupes. The varieties "Patty Pan" and "Golden Summer Crook Neck" produced a few fruits when planted during the rainy season.

Excellent results were obtained from the varieties of lettuce, "New York Green" and "White Big Boston." The latter however, was not as good as the New York Green variety because it started to flower too early. Salamander and Black Seeded Simpson both started flowering before they were large enough to harvest. None of these varieties showed any sign of heading.

The results obtained from tomato experiments this year were better than in any former years. Several varieties matured excellent fruits but no one variety was entirely free from wilt (probably some form of Fusarium wilt). Some of the varieties which have been reported as most wilt-resistant in the United States proved to be most susceptible to the disease in this region. The only variety found to be highly wilt-resistant here is the native tomato which produces small and very irregular fruits. "No Substitute," "Landreth," "Norton Certified," "Improved John

Baer," and "Walter Richards Extra Globe," were the five varieties least attacked by wilt this year.

An excellent substitute for spinach may be found in the plant *Tetragonia expansa*, commonly called New Zealand spinach. It was introduced into the United States from New Zealand in 1932. Two years' trial here with this variety has proved very satisfactory and we feel that eventually this variety will replace the so-called Chinese or "slippery spinach" (*Bassella alba*) grown by the Chinese gardeners.

The egg plant and peppers are growing nicely at the date of this writing but have not yet matured their fruits.

Sweet corn is usually not succesful in the tropics. None of its varieties have succeeded here. This year we received a small sample of seed of the variety "Mayaguez Sweet Corn" from the Puerto Rico Experiment Station of the United States Department of Agriculture, located at Mayaguez, Puerto Rico. This seed represents their latest achievement in hybridizing to create a sweet corn suitable for tropical conditions. It is too early to state how this variety will yield here but so far excellent growth has been attained and one to two ears are appearing on each stock.

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