59TH CONGRESS } SENATE { DOCUMENT
2d Session } { No. 356

BULLETINS

ON THE

RUBBER PRODUCING CAPACITY OF THE PHILIPPINE ISLANDS

BUREAU OF INSULAR AFFAIRS

WAR DEPARTMENT

WASHINGTON
GOVERNMENT PRINTING OFFICE
1907

59TH CONGRESS, 2d Session. } SENATE. { DOCUMENT No. 356.

RUBBER-PRODUCING CAPACITY OF THE PHILIPPINE ISLANDS.

LETTER

FROM

THE SECRETARY OF WAR,

SUBMITTING,

PURSUANT TO SENATE RESOLUTION OF FEBRUARY 18, 1907, INFORMATION AS TO THE RUBBER-PRODUCING CAPACITY OF THE PHILIPPINE ISLANDS.

FEBRUARY 27, 1907.—Referred to the Committee on the Philippines and ordered to be printed, with the illustrations.

WAR DEPARTMENT,
Washington, February 25, 1907.

SIR: In compliance with resolution of the Senate of February 18, 1907, directing the Bureau of Insular Affairs, through its Chief, to inform the Senate as to the rubber-producing capacity of the several islands in the Philippine Archipelago that belong to the United States, and that he give an approximate area of rubber-producing lands in said several islands, and of the different descriptions of rubber-bearing trees, vines, and bulbs from which india rubber is derivable, and the general bearing productiveness of such islands as commodities of commercial value, I have the honor to inform you that immediately on receipt of the above the following cablegram was sent to the Governor-General of the Philippine Islands at Manila:

> Senate resolution calls for report rubber-producing capacity of the several islands, Philippine Archipelago, approximate area rubber-producing lands, descriptions different rubber-bearing trees, vines, and bulbs. Have you any more definite data as to these points than that in bulletins dated September 20, 1903, November 15, 1905, Government laboratories at Manila? Hurry answer.

and this day the following reply has been received:

> Referring to telegram from your office of 19th instant, rubber found indigenous in the Philippine Islands only in vine, a species of *chonemorpha* mentioned

in bulletin, 1903, and *Paramcria philippinensis*, although the latter commercially unimportant until process perfected for extracting rubber from the bark.

Three tropical American trees, producing *para*, *ccara*, and *castilloa* rubber, introduced since American occupation, and there are now planted in the Moro Province 77⅕ acres of these three trees. Successful cultivation these trees northern provinces problematical on account of liability to destruction by typhoons and heavy winds. Conditions in the southern provinces were favorable, especially in Mindanao. From contemplated plantings it is estimated that on June 1 acreage of the trees above mentioned will be 376 in the Moro Province. Subject of gutta-percha: All forest product, no plantations; exhaustively treated in bulletin, September, 1903.

I have the honor to inclose herewith the two bulletins referred to. The bulletin by P. L. Sherman, jr., published in 1903, is a general study of the subject of gutta-percha and rubber in the Philippine Islands, more, as will be seen on examining it, with reference to the possibilities of improved rubber and gutta-percha culture than with reference to the then existing condition of living industries in the Philippine Islands.

I also inclose the bulletin of the Bureau of Forestry, dated November 15, 1905, on the same subject.

It will be seen that both of these bulletins contain a great deal of matter foreign to the inquiry in the Senate resolution, but it is almost impossible without inclosing them both to show clearly why more exact information can not be given. Briefly, while a great part of the southern islands of the archipelago are believed to be suitable to the cultivation of rubber, there has been up to the present commercially no such cultivation. Those interested in this matter in the archipelago are hopeful, but as the industry is in its merest infancy, no statistics bearing thereon are available.

Very respectfully,

Wm. H. Taft,
Secretary of War.

The President of the Senate, *Washington.*

BUREAU OF GOVERNMENT LABORATORIES.

(Bulletin No. 7.)

THE GUTTA-PERCHA AND RUBBER OF THE PHILIPPINE ISLANDS.

By Penoyer L. Sherman, Jr., Ph. D.

LETTER OF TRANSMITTAL.

Department of the Interior,
Bureau of Government Laboratories,
Manila, P. I., September 20, 1903.

Sir: I have the honor herewith to transmit for publication as a bulletin a monograph on the gutta-percha and rubber of the Philippine Islands, by Penoyer L. Sherman, jr., Ph. D., chemist in the bureau of government laboratories.

I am, very respectfully,

Paul C. Freer,
Superintendent Government Laboratories.

Hon. James F. Smith,
Acting Secretary of the Interior.

INTRODUCTION.

The material for this bulletin was collected under the direction of the bureau of forestry and of the bureau of government laboratories. As early as 1900 the attention of the government was called to the fact that many of the wild tribes in the southern islands were engaged in cutting down large numbers of forest trees in order to secure the gutta-percha and rubber which they contained. These products they bartered to the Chinese, who in turn exported them to Singapore.

The matter was considered important enough to demand investigation, because—

(1) The trees were being cut down in violation of forestry rules.

(2) No forestry dues were paid by those either collecting or exporting these forest products.

(3) Judging from the experience of the English and Dutch in the Malay Peninsula, Sumatra, and Borneo it would only be a question of a short time, if the wild tribes were allowed to have their own way, when there would not be one tree of this class left standing in the Philippines.

Unfortunately there was no information at hand on the subject. In June, 1901, I was sent as a special agent of the forestry bureau to Singapore, the Malay Federated States, and Java to study the laws and conditions under which these forest products were grown, collected, and marketed.

Provided with the information thus gathered and which is detailed below, upon my return to Manila four months later I was again sent to the southern Philippines to repeat my investigations and as before, to make collections of herbarium material and samples of the various kinds and grades of gutta-percha and rubber found there.

This first southern trip consumed several months, for while specimens of marketable gutta-percha and rubber could be secured in the principal towns, all herbarium material and gums from each tree species had to be taken personally to avoid all sources of error.

The trips along the coasts and rivers of many of the islands were made in small native sail and row boats, and the journeys into the forests of the interior were completed on foot with native guides and carriers. The native gum collectors themselves, their method of felling the trees and vines, securing the gutta-percha and rubber, preparing the same for market, the prices they received both in money and barter were thus seen at first hand, and of course opportunity secured for making herbarium collections of the various species of trees and vines yielding gutta-percha and rubber. In the principal towns the market conditions of supply, demand, prices, etc., were studied.

Upon my return to Manila I was ordered to be transferred to the bureau of government laboratories, in order that all specimens collected might be tested chemically and physically so as to determine their relative values. This analytical work, as well as several subsequent trips to the southern islands, Paragua, Mindoro, and Culion, in search of new material, has been carried out and is here reported.

The identification of the various species of gutta-percha and rubber trees and vines was kindly undertaken by Mr. E. D. Merrill, botanist for the bureau, who also assisted greatly in collecting herbarium material in Mindoro and Culion.

My thanks are also due to Messrs. J. H. Thigpen and Paul Stangl for much assistance in the analytical work. To Capt. George P. Ahern, chief of the forestry bureau, and Dr. Paul C. Freer, superintendent of government laboratories, I wish to express warm appreciation for their many courtesies and valuable suggestions in planning and carrying out the work.

Part I.

GUTTA-PERCHA.

1. HISTORICAL.

As is the case with many other commercial products coming from oriental lands, the date of the discovery of gutta-percha is lost in oriental history. The famous Tradescant Brothers in 1656 (1) exhibited in their museum of curiosities in London a piece of gutta-percha which they had secured in the Far East. Also in 1822 Dr. William Montgomery (2), an English surgeon, saw whips and other articles of gutta-percha in use by the natives of Singapore. It is therefore safe to assume that the real discovery of this remarkable substance was made at some time previous to either of these dates.

The western or commercial discovery of gutta-percha was delayed until 1843, when both Doctors Montgomery and D'Almeide sent specimens of the gum and leaves of the tree to London. While the specimens of D'Almeide were neglected, those of Montgomery received enough attention from the scientists of the Royal Society of Arts to demonstrate some of the uses to which the substance might be put. The botanists agreed that the tree belonged to the family *Sapotaceæ*, but as neither flowers nor fruit were at hand they could go no further with the identification.

In 1847 the greatest advance was made toward the utilization of gutta-percha. Considerable amounts had from time to time been shipped to London, and experiments were made to determine its physical and chemical characteristics. Luckily a sample fell into the hands of a young German artillery lieutenant, Werner von Siemens, who was then experimenting with insulating material for subterranean and submarine telegraphic cables (3). The ease with which gutta-percha lent itself to this object and the high efficiency obtained induced him to construct a machine for insulating cables. The methods he adopted, as well as the kind of machinery, have been with few modifications in use ever since.

The subsequent history of gutta-percha runs parallel with that of submarine and subterranean electric cables, for three-fourths of all the gutta-percha produced has been used on them. With the construction of the great trans-Atlantic cables in the sixties and seventies of the past century, the demand for gutta-percha became enormous and the details of its value and ready market traveled over all this part of the Orient.

When the Malay Peninsula adjacent to Singapore failed to supply sufficient quantities to meet the demand the adjacent islands of the Rhio Archipelago and Sumatra were invaded and rich finds made. Finally Borneo was included in the producing zone, and lastly the Philippines.

At what date the Philippines began to export gutta-percha to Singapore, the center of the trade, can not be learned with any degree of certainty. Probably twenty years ago varing quantities were exported, but apparently the trade died out, owing, it is said, to the wholesale adulterations practiced by the Chinese exporters and the prohibitory laws of the Spanish Government. For the last ten years prior to the American occupation of the islands but little had been shipped, though the collecting and exporting began very soon afterwards and increased at once to large proportions.

II. BOTANICAL.

In the year in which Von Siemens made his great discovery of the insulating value of gutta-percha for submarine cables Sir Joseph Hooker, Bentham, and others worked out the status of the gutta-percha tree. From the first specimen of leaves, which had been sent to England several years previously, it was seen that the tree belonged to the natural family of *Sapotaceæ* (4). The many species of this family are scattered over the tropical and semitropical world and are distinguished by the curious property all possess of secreting a milk or latex in the inner layers of the bark. When the bark is cut or bruised and the capillary sacks and tubes which contain the latex are ruptured it flows out with greater or less abundance, according to the species of the tree. This milk probably serves in the plant economy as a protection; still its is primarily an excretion, since it is discarded by the tree in its dead leaves and bark, and the bark of the live tree can be tapped and the latex removed with no apparent injury to the tree.

As has been stated, it was in 1847 that specimens of the flowers and fruit finally reached London and the complete botanical determination of them made, which resulted in giving to the tree the name of *Dichopsis gutta* Benth et Hook. fils. A few years later the Dutch botanist, Burck, pointed out the fact that as early as 1837 Padre Blanco (5) had given the name of *Palaquium* to this genius of *Sapotaceæ*, and accordingly most botanists have adopted the generic name *Palaquium* for these wonderful species[a] of forest trees which produce the bulk of all the gutta-percha of commerce.

As the demand for gutta increased and the trees of the species *Pal. gutta* became scarcer and more difficult to reach, the native collectors were not slow in finding other species that produced gutta-percha, though of an inferior quality. Among these *Pal. treubii* Burck, *Payena leerii* Benth. et Hook. fils, and *Mimusops balata* Gaertner, fils, are the best known. Many other species have been found in Sumatra, Borneo, Celebes, and the Malay Peninsula, but what part they play in the production of the gutta-percha of commerce has not yet been determined.

The accompanying figures will show some of the resemblances and differences between the species above mentioned. The trees of the genus *Palaquium* are among the largest of the tropical forest and are generally to be noted by the brilliant green color of their leaves above and the golden to copper-brown shimmer below.

The following general description of the botanical characteristics of *Palaquium* is made by Mr. Merrill:

PALAQUIUM, BLANCO 1837 (DICHOPSIS THWAITES.)

Usually large trees with rusty-tomentose branchlets. Leaves obovate or oblong, acute or obtuse, petioled, coriaceous, glabrous beneath, or densely rusty-tomentose. Flowers fascicled, axillary on the naked branches below the terminal leaves. Calyx lobes 6, in two series, corolla lobes 6. Stamens 12 to 18, attached near the base of the corolla. Ovary 6-celled. Fruit fleshy, elipsoid or ovoid, 1 to 2 seeded. Seeds exalbuminous, cotyledons large, fleshy.

In regard to the species *Mimusops balata* mentioned above, it is to be noted that it is the only representative so far known of gutta-percha producing trees in the Western Hemisphere. It was discovered in the Guianas in 1857 and contains a fairly good grade of gutta-percha. Obach (6) designates it in his

[a] Of late years the Dutch and English botanists in the Orient have been inclined to divide *Pal. gutta*, the most valuable of the gutta-percha producing species, into three species, viz, *Pal. gutta*, *Pal. oblongifolium*, and *Pal. borneense*, but as no certainty of differentiation yet exists, while the gutta-percha from all is the same, they may for the present be all classed under *Pal. gutta*.

description as a substitute for gutta-percha in all its chemical and physical characteristics. Though of an inferior grade to that coming from *Palaquium gutta*, it may well be classed among the rest of the *Palaquium* and *Payena* species furnishing second and third grade gutta-percha.

The gutta-percha trees of the Philippines embrace both *Palaquium* and *Payena* species, and while their complete determination or identification is still unfinished, those which produce the gutta-percha of commerce have been located, and their final identification is only a matter of collecting more complete herbarium material.

The following table (No. 1) gives the species at present known. Those marked (*) probably furnish the largest part of the gutta-percha exported from the southern islands:

TABLE NO. 1.—*Present known species of gutta-percha.*

Species.	Local name.	Locality.	Botanical description.
Leaves rusty tomentose beneath:			
Pal. latifolium Blanco.	Palacpalac or Alacap.	Luzon to Mindanao.	Leaves obovate, obtuse, 10 to 30 cm. long, 5 to 15 cm. wide; nerves, about 15 pairs.
Pal. oleiferum Blanco.	Alacap or Baracan.	Luzon	Leaves obovate-lanceolate, 10 to 25 cm. long, 6 to 10 cm. wide, acute; nerves, about 15 pairs; closely related to the preceding.
Pal. barnesii Merrill.	Nato	Masbate	Leaves obovate, obtuse, thin, 12 to 15 cm. long, 7 to 8 cm. wide; nerves, 11 pairs.
*Pal. ahernianum Merrill.	Calapia	Mindanao	Leaves ovate or obovate, obtuse or acute, 12 to 14 cm. long, 5 to 6 cm. wide; nerves, 15 pairs.
Leaves glabrous beneath:			
*Pal. celebicum Burck.	do	do	Leaves lanceolate, acute, 15 to 20 cm. long, 5 to 6 cm. wide; nerves, 12 to 14 pairs.
Pal. cuneatum Vidal.	Dulitan	Luzon	Leaves ovate, lanceolate, or obovate, acute or obtuse, 5 to 7 cm. long, 2 to 3 cm. wide; nerves, 11 to 12 pairs; indistinct.
Pal. gigantifolium Merrill.		Tayabas	Leaves obovate, 50 cm. long, 20 cm. wide; nerves, 20 to 24 pairs.
Pal. luzoniense Vidal.	Bagalañgit	Luzon	Leaves ovate, acute or obtuse, 10 to 14 cm. long, 4 to 6 cm. wide; nerves, 12 pairs.
*Pal. mindanaense Merrill.	Calapia	Mindanao	Leaves ovate, acute, 9 to 12 cm. long, 4 to 5 cm. wide; petioles 3 cm. long; nerves, 14 to 16 pairs.
*Payena leerii Benth. and Hook.	do	Tawi-Tawi	Leaves ovate or ovate oblong, 5 to 10 cm. long, 2.5, to 4 cm. wide, cuneate at the base; short acuminate at the apex.

III. GEOGRAPHIC DISTRIBUTION.

As previously stated, the first gutta-percha trees were reported from the island of Singapore, and in fact within a few miles of the city itself. When the substance became a marketable article these trees were the first to fall and all of the island was soon devastated. The explorations from Singapore as a center were made in all directions and with remarkable success. All of the forest of the southern half of the Malay Peninsula gave large yields, as well as the islands of the Rhio Archipelago, Borneo, and most of Sumatra. However, from all of the data which have been gathered from native sources, as well as from the information collected by many Dutch, English, and French explorers, it appears that the area of distribution of *Palaquium gutta* is sharply defined. Beyond the sixth degree north on the Malay Peninsula the trees become scarce or cease altogether; on the northern end of Sumatra they are likewise lacking. Java, bordering close on Sumatra, contains none, and Celebes to the east of Borneo has been found to be equally destitute. Reference to map (No. 1) will show the area of distribution of the *Palaquium gutta*, which is practically included in a parallelogram inclosing the above-mentioned peninsula and islands. This area includes some 450,000 square miles of land, of which only a very small per cent is or ever was covered by gutta-percha trees.

Obach, in his celebrated book on gutta-percha, practically limits the area of gutta-percha production for the entire world to this small territory (7). While this statement is probably true so far as the gutta-percha from *Palaquium gutta* is concerned, we have already seen that the area of distribution of the other or inferior species is extended eastward so as to take in the Philippines, and the same is also true of Celebes, Java, and the northern half of the Malay Peninsula.

The number of gutta-percha producing species in the Philippines has already been listed, and some of the localities given where they have been found. Attention is again called to the distribution of these localities, extending so far north as well as south, and it can be confidently expected that when the forest surveys are completed nearly all of the islands will be found to contain some species in more or less abundance.

Owing to the limited extent of the areas where gutta-percha trees have so far been found on most of the islands, the regions which produce gutta-percha for the market at the present time are confined to the islands of Mindanao and Tawi-Tawi. The accompanying map (No. 2) is arranged to show the places where gutta-percha species have been found as well as to give some idea of the size of the districts producing the gutta-percha now being exported. The exact or even approximate extent of these areas is difficult to calculate. Much has not yet been explored, and the information derived from the natives is vague and contradictory. The areas on the map are given conservatively and are known to produce gutta-percha at the present time. Other territories will probably become known as our intercourse with the wild tribes inhabiting these regions grows more friendly and open.

List of towns and forest regions from which gutta-percha is exported to Singapore.

Central point for collection and exportation of gutta-percha.	Point of collection of gutta-percha from the various forest regions.	Name of forest regions from which gutta-percha is collected.
Cottabato	Tukuran and Dinas	Dinas-Subano Camalarang, Labangas, Tukuran.
	Malabang	Laguna de Lanao, Baras, Liangan, Segayan.
	Clan, Sarangani, and Binang	Tagabuli, Manobo, Bilan, Binang.
	Reina Regente and Salaya	Dama Balao, Malingauanan, Talayan.
Zamboanga	Balnan, Curuan, Taluesangi, Puerta Santa Maria, Dapitan, Misamis.	Western and northern Subano.
Jolo (Sulu)	Transshipped from Davao Cottabato, Zamboanga, or Siassi.	Tawi-Tawi.
Bongao	Siassi, Balambing, Buan, Dajapatan	Do.

The islands of Paragua (Palawan) and Balabac were found destitute of either gutta-percha or rubber-producing trees, although long and careful search was made for them in many localities. Owing to their close proximity to Borneo, and the fact that botanically and geologically these islands are supposed to be more closely allied to Borneo than to the rest of the Philippines, it was confidently expected that both gutta-percha and rubber would be found there. The absence of these forest products is probably due to the uneven distribution of the rainfall with a long drought in January, February, and March.

IV. METHODS OF COLLECTING AND MARKETING.

(*a*) COLLECTING.

The question of what is the best method for collecting gutta-percha has troubled owners and dealers from the beginning, and a satisfactory answer is still lacking. The trees are in the tropical forest regions of the Malay Archipelago, Borneo, and the Philippines, which are inhabited by the wildest pagan tribes only. These natives are the natural gutta-percha collectors, and as a matter of fact have done all the collecting since the beginning. They evolved a method which answered their requirements very satisfactorily. As might be inferred, they wished the maximum yield of gutta-percha from each tree with the minimum expenditure of work or time. That the method was extremely wasteful did not concern them nor were they bothered over the prospect of a bankrupt future.

The method, which is still in vogue from the westernmost part of Sumatra to the easternmost point of Mindanao, is, with various minor modifications, practically as follows: The tree is first cut down and the larger branches at once lopped off, the collectors say, to prevent the gutta-percha milk from flowing back into the small branches and leaves. As has been previously stated, the milk or latex is contained in the inner layers of the bark and leaves, in small capillary tubes or ducts. (See fig. 14.) To open these so as to permit the maximum amount of the milk to escape, the natives cut rings in the bark about 2 feet apart along the entire length of the trunk. The milk as it flows out is collected in gourds, cocoanut shells, large leaves, or in some districts in the chopped-up bark itself, which is left adhering to the tree for the purpose of acting as a sort of sponge. (See fig. 16.) After one or two hours, when the milk has ceased to flow, the contents of the receptacles are united and boiled over a fire for the purpose of finishing the partial coagulation. The warm, soft mass is then worked with cold water until a considerable amount of the liquid is mechanically inclosed. To further increase the weight, chopped bark, stones, etc., are added and the whole mass worked into the required shape with most of the dirt on the inside.

The gutta-percha gathered in this way well repays the amount of work expended. The two vital defects of the method are—

(1) The method is very wasteful, the yield from each tree being a small proportion to the total amount. What this per cent is has been investigated by scientists with the result that the figures differ widely. Remembering that the gutta-percha milk is contained in capillary ducts and tubes, it will be seen that a considerable amount can not flow out on account of capillary attraction, no matter how much cutting is done. It very seldom happens also that a tree falls in such a way that all its trunk is exposed so as to admit of ringing on all sides. As a general thing from one-third to one-half of it is inaccessible to the process of ringing, and all the milk within this portion is consequently lost. Even the larger limbs are not deemed worth ringing, and consequently all the milk in them and in the leaves also goes to waste; to this must be added the considerable quantity spilled on the ground through carelessness and lack of enough receptacles for every cut or bruise from which the milk flows. (See fig. 19.)

The method employed to find what percentage of gutta-percha has been removed from a tree by the native collectors was to determine the per cent of gutta-percha remaining in a given area of the bark, multiplying this by the total bark area of the tree, and adding 15 per cent of this amount for that contained in the bark of the branches and in the leaves.

The amount which the native collectors secure from the average full-grown tree apparently varies according to the species, season, personnel of collectors, etc. Most authorities place the amount per tree at one-fourth of a pound. The director of the botanical garden in Penang (8) secured 1½ pounds of clear gutta-percha from a large tree (*Palaquium gutta*) estimated to be 60 years old. Wray (9) obtained somewhat over 2 pounds from a *Palaquium gutta* tree at least 100 years old and 2½ pounds from one of an inferior species.

Burck (10) made some extended experiments in Sumatra and secured an average of less than 1 pound from full-grown trees, while Serullas (11) in Sumatra obtained almost 1 pound from a giant tree. Trees of inferior grade have been found to give as high as 8 pounds. Probably the best average obtainable is 3 pounds. In the Tiruray district of Mindanao I secured 1 pound of clean gutta-percha from a tree 135 feet high and 5 feet 4 inches in circumference at the base. The work was carefully done by the natives. Taking a measured amount of the bark of this tree after no more gutta-percha could be collected by the native method and extracting all of the gutta-percha which it still contained, it was estimated that after collection there still remained 6½ pounds of gutta-percha. Taking into consideration the fact that had the tree not fallen in such a way as to leave almost all of the trunk propped high enough above the ground to allow the milk to be extracted from the bark on the underside, the amount extracted would undoubtedly have been much less, or, in other words, ten times more gutta-percha would have been left to rot with the tree than was taken from it by the natives. Other investigators have secured figures as large as these, and some found that forty times more gutta-percha was left behind than was secured by the careless collectors.

(2) It leaves the future unprovided for. It has been seen that the invariable practice of the native collectors is to fell the tree in order to extract the gutta-percha. (See fig. 20.) In some cases it has been reported that the stumps stool afterwards, and in course of time produce new trees, but it can be safely asserted that this is the exception and not the rule. Of those I have found cut down in the Philippines, none have ever stooled, though in one case I saw some of the roots of the stump alive long after the felled tree was well advanced toward decay. (See fig. 21.)

It is fortunate that only the full-grown trees contain enough gutta-percha to repay the work of felling, ringing, etc.; otherwise the complete extermination of the gutta-percha forest would only be a matter of a year or so. On the other hand, the felling of all the trees old enough to bear seed works to the same end with a somewhat longer limit.

(*b*) MARKETING.

Having been collected and put in marketable shape, the gutta-percha is carried in baskets on the back of the collectors to the nearest waterway, and thence by boat (see fig. 22) to the most accessible town, where, applying the description to the Philippines, it is exchanged for barter to some Moro, Chinese, or Filipino merchant (comerciante) living there for the purpose of dealing in all kinds of native products. From here it is shipped to one of the ports doing an export trade with Borneo and Singapore. The entire gutta-percha trade is practically in the hands of the Chinese in the latter city, and they guard the secrets of boiling, working over, mixing, adulterating, and coloring the gutta-percha for European markets most zealously. All who have tried to investigate their methods agree that there is no connection between the various grades and the different tree species, and that pure gutta percha from the species *Palaquium gutta* is no longer found on the market unmixed with inferior grades.

Strangely enough, I was unable to find in Singapore any statistics regarding the importation of Philippine gutta-percha. The Chinese dealers denied receiving any, and beyond a few piculs noted in the annual report statistics no mention of it was found anywhere. I afterwards ascertained that the gutta-percha first goes to Sandakan and Labuan, in British North Borneo, and is there transshipped to Singapore, entering as North Borneo gutta-percha.

Unfortunately the amount collected for exportation can not be given with any degree of accuracy, as the export statistics (12) include gutta-percha with all other gums. It is known, however, that the amount reaches into tens of thousands of pounds.

V. LAWS REGULATNG COLLECTING AND SHIPPING.

Considering the almost lawless way in which gutta-percha is collected and marketed, it is pertinent to review briefly the few steps taken toward legislating on the subject. The English long ago realized that the gutta-percha forests of the Malay Peninsula were doomed to destruction unless radical measures were taken to change the method of collecting. The first law passed was to prohibit the felling of trees in order to collect the gutta-percha. As the law never penetrated to the wild tribes of the interior, where the collecting was done, it was not effective. As a surer mehtod of stopping the destruction, a second law was passed which prohibited the exportation of gutta-percha from coast towns in the Federated Malay States, in which the English could, of course, exercise personal supervision. The result was that the exportation from those places ceased promptly, but the felling of trees did not stop, the export simply traveling northward by overland routes until it was outside of English jurisdiction, and from there it was shipped to Singapore. I can not find that anything effectual has been accomplished by the English or by the Dutch authorities in Sumatra and Borneo toward remedying the difficulty. It seems to be generally realized at last that wild natives can not be prohibited from doing things where there is no law nor show of authority.

Certainly they will not cease felling gutta-percha trees until some one can show them an easier method for collecting the same amount or more of the material, so long as gutta-percha has a market value. The English had the true idea when they took away its market value through prohibiting exportation. The only trouble was that the Malay States are on a peninsula and not an island. This law, if applied to the Philippines, might succeed better by reason of their geographical situation, but so far nothing of this kind has been tried here. As soon as the forestry bureau was established, in 1899, the felling of gutta-percha trees was prohibited (13). Rules and regulations were provided for tapping the bark of the tree with a bolo in such a manner as to allow the milk to be secured without killing the tree. As the amount of gutta percha obtained by this process was much less than that secured from felling the tree, while the labor was fully as great and was dangerous besides (some trees being 70 feet to the first limb) the wild natives never practiced this method, nor did they ever hear of it, and all the gutta-percha so far exported has been at the expense of so many trees killed.

Islands such as Mindanao and Tawi-Tawi can not stand this for any length of time and already the gutta-percha trees have entirely disappeared from the vicinity of the coast regions and of the large rivers. According to the forest surveys made so far in the islands the average number of trees of 1 foot in diameter is between 40 and 50 per acre, and considering the large number of species found in the forests the number of trees of any one species is generally placed at four or five. With this liberal allowance the forest acreage of the southern islands will probably supply gutta-percha at the present rate of cutting for three or four years longer, but not for more than that.

It must not be supposed that scientific invesitgation has not been directed toward solving this vexed question of securing gutta-percha in paying quantities without killing the trees, but before describing the results of this work the chemical and physical characteristics of gutta-percha, as well as the prices to be realized for it, must be considered in order to demonstrate the difficulties to be overcome.

VI. GRADES AND PRICES.

The prices governing the sales of all grades and kinds of gutta-percha in Singapore, the chief market of the world, seem to be most arbitrary and uncertain. As a general thing they have increased continuously and steadily since the beginning of the industry.

Formerly the different grades of gutta-percha were named from the well-known districts or shipping ports from which they came. An attempt was also made to designate the species of tree furnishing the product, and a further distinction was given as to quality. For instance, "Koatei guta merah No. 1" was first grade of gutta-percha from *Palaquium gutta*, coming from Koatei, while "Pahang white soondi No. 1" was first-grade gutta-percha from *Payena leerii*, from the Pahang district.

These names and gradings are still kept up as a matter of convenience for cable codes, etc., but the significance of the names is almost entirely lost, certainly as far as any indication of the tree species is concerned, and often as regards the district of production as well. The Philippine gutta-percha, for example, has neither grading nor price in Singapore, and probably comes in under Sarawak white, red, etc.

As has been stated previously, the secrets governing the selection, boiling, adulteration, coloring, etc., of the various grades are closed and known to the Chinese exclusively. This is also true in the Philippines, though very little, except boiling and cleaning, is attempted before shipping to Sandakan.

Most of the Philippine gutta-percha passes through three hands, and the rise in price is quick and decided. My experiences in the gutta-percha districts of Mindanao and Tawi-Tawi were to the effect that the wild native collector had to take about what he could get, which was on an average of $10 Mexican for a picul of 162½ pounds. Money was seldom paid, the usual thing being barter in rice, cloth, copper wire, cheap jewelry, beads, etc. It is needless to remark that the middleman realized a good profit on his merchandise. He in turn carried the gutta-percha to the export towns and sold it to the Chinese at the rate of $40 to $80 Mexican per picul of 137½ pounds. As this latter amount was the legal weight for a picul, his profits were increased by the additional pounds which he deliberately stole from the ignorant natives. The Chinese exporter pays $5 to $7 Mexican per picul forestry dues (he being the only one of the three with a fixed residence and amenable to forestry regulations) and exports the gutta-percha to Sandakan or Singapore, where it probably brings $100 to $150 Mexican per picul of 133½ pounds. There is no definite information on this subject, however, as Philippine gutta-percha, as has been stated, is neither rated nor graded in Singapore. A year and a half ago, when the best grade of gutta-percha in the Philippines was said by the Chinese of Cottabato to be worth $80 per picul, the following analyses of Singapore gutta-perchas were made by Van Romburgh and Tromp de Haas (14):

Grade.	Dirt.	Water.	Resins.	Gutta.	Price per picul.[a]
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	
Bila (red) soondi	33.6	7.0	31.4	28.0	$150
Sarawak soondi No. 2	37.1	6.8	25.5	29.6	135
Penang gutta Palelo No. 1	2.1	5.8	53.8	38.3	180
Sarawak red soondi No. 1	19.0	3.9	35.5	41.6	350
Bagan white soondi No. 1	.7	8.6	36.5	54.2	350
Koatei guta merah No. 2	21.7	5.1	28.5	44.7	360
Indragiri white soondi	2.0	4.1	46.2	47.7	370
Sambas white soondi	1.0	4.4	53.6	41.0	380
Koatei guta merah No. 1	14.8	3.8	34.8	46.6	500
Pahang white soondi No. 1	4.2	.5	12.8	82.5	500

[a] Mexican currency.

According to these analyses the best grades of Philippine gutta-percha may well rank with any of the first four on the list, especially as my chemical and physical tests show the high grade of the gutta in them.

Another example of the difficulty in dealing with the Chinese gutta-percha merchants in Singapore is the experience of an American merchant of Manila, who, about this time, took a considerable quantity of the best grade of gutta-percha from Mindanao over to Singapore by way of speculation. He was only offered $8 per picul by the leading merchants there, and it was not until they found out he was not anxious to sell at all, but would ship the product to America, that they finally closed with him at $70 per picul. How much the gutta-percha was really worth he never found out.

The evidence, then, all goes to show that the price of Philippine gutta-percha jumps from about $8 a picul in the mountains, where it is gathered by the wild tribes, to $150 in Singapore. Thus the native collectors get almost nothing, the government about as much, and the Chinese the rest. The Chinese might possibly get even higher prices by exporting direct to London or America, though apparently that has not yet been tried.

It is stated on good authority that the Chinese in all their manipulations for preparing the gutta-percha for the European market go solely by smell, color, toughness, and the softening and hardening test in hot, then cold water. At any rate they are certainly very skillful in the work, although careful inspection of the above table, as Van Romburgh points out, would tend to show that their prices were not at all warranted by the analyses. So long as the collecting of the gutta-percha is all in the hands of wild natives and the manipulating and marketing controlled by the Chinese, we can not hope to have the gutta-percha trade on a fair business basis. However, as the supply steadily decreases while the demand and prices increase, the attention of governments and manufacturers will more than ever before be directed to the subject and perhaps the hoped-for relief will come through scientific propagation of gutta-percha trees and scientific collecting of the gutta-percha.

VII. CHEMICAL PROPERTIES.

A chemical examination of the milk or latex above referred to as coming from the gutta-percha trees upon wounding the bark shows it to be composed of an emulsion of water and oil in a finely divided state. According to the species of tree the water varies from a small (best species) to a very large percentage (poor species). A drop of the milk caught on the finger undergoes no apparent change for a few minutes, but by the end of this time a thin rubbery scum can be observed to have formed on the surface. If this be removed, a second film will form, and so on until the entire drop has become a small piece of a tough, leathery substance. When a fresh drop is worked between the fingers the hardening process or coagulation takes place very quickly, and by boiling or adding certain chemicals, such as mineral or vegetable acids, alum, salt, etc., it takes place almost instantaneously. What the nature of this hardening process is appears to be unknown. The subject will be investigated in this laboratory.

After coagulation sets in (see below), the oily portion becomes hard and tough, while most of the water separates or is inclosed mechanically. Subjecting this hard and tough mass, taken, for example, from the *Palaquium gutta* species, to further examination, it proves to be insoluable in water and very stable against the action of either dilute acids or alkalies. In chloroform or carbon bisulphide it is easily soluble, while ether, petroleum ether, and alcohol dissolve it only in part. By subjecting it to the action of cold alcohol, a yellow amorphous resinous powder can be extracted. Hot alcohol further extracts a white crystalline resin, leaving a tough, horn-like residue, which is easily soluble in chloroform and carbon bisulphide and can be precipitated from these solutions by alcohol as a white flocculent mass, which by warming or through pressure quickly returns to its original appearance. Taking the three constituents of gutta-percha in the order described above, the names fluavil, alban, and gutta were given them by Payen (15) in 1852. Besides these constituents, all gutta-percha was found to contain more or less dirt, coloring matter, and water inclosed mechanically.

TABLE No. 2.—*Analyses of representative samples of gutta-percha from Singapore and Philippine markets, as well as from different species of gutta-percha trees, to show composition and comparison.*

Source of specimen.	Appearance.	Gutta.	Resins.	Water.	Dirt.	Grade.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	
1. Collected from Pal. gutta trees in experiment garden, Buitenzorg, Java.	Close, compact, tough, whitish to pink and brown.	74.77	20.74	2.49	1.99	Superior, but not on Singapore market.
2. Sample analysis of product of Pal. gutta made by Van Romburgh.	....	85.15	11.02	2.08	1.75	Do.
3. Product from two trees of Pal. leerii, Tawi-Tawi.	White, somewhat elastic, very tough.	48.19	41.38	6.59	2.05	Superior in Philippines.[a]
4. Product from tree of Pal. mindanaense; in mountains southeast of Cottabato.	Somewhat tough, white, pinkish, and brown.	38.42	49.08	9.76	2.72	First.
5. Brought into Cottabato by Moros from Subano region, northwest of Tucuran.	Clean pinkish balls; tough.	32.49	54.08	7.61	5.76	Do.
6. Purchased from Moros at Bongao.	Tough, compact slab.	28.37	37.42	18.32	15.83	Second.
7. Product from tree of Pal. celebicum; in mountains southeast of Cottabato.	Inclined to crumble; white to brownish.	31.10	51.86	.04	16.79	Do.
8. Brought into Cottabato by Moros from Binang region; botanical origin unknown.	Long coils on piece of bamboo; dirty and dark colored.	30.20	57.40	7.80	4.60	Do.
9. Product from unknown species in mountains southeast of Cottabato.	Dark brown, hard, and crumbling.	23.64	53.99	13.87	8.48	Third.
10. Product from Pal. ahernianum; in mountains north of Tucuran, Mindanao.	Heavy compact mass, crumbling easily; light reddish brown.	24.55	43.21	15.19	17.04	Fourth.

[a] The grading of the Philippine gutta-percha is done by the Chinese exporters.

The method adopted for making the above analyses is a modification of those used by Obach (16) and Van Romburgh. The former determined first the per cent of water by drying a weighed sample to constant weight on a water bath or desiccator, determining the water by difference. The resins were then extracted with ether and weighed after the solvent had been completely evaporated. The gutta and dirt were thus left and were separated by chloroform, which dissolved the gutta, leaving the dirt to be filtered, dried, and weighed. The chloroform was then evaporated and the gutta weighed.

Van Romburgh (17) in his latest analytical work uses the following scheme: The weighed and finely divided substance is dried to constant weight in an atmosphere of dry carbondioxide gas, which fulfills the double purpose of drying and at the same time preventing oxidation. The sample is then dissolved in hot chloroform, thus allowing the undissolved dirt to be filtered off, washed, dried, and weighed. The chloroform solution containing the gutta and resins is diluted with chloroform to 100 c. c. and an aliquot portion taken, evaporated, and dried to constant weight as above. By extracting the residue with hot alcohol or acetone the resins are removed, when the remaining gutta is dried and weighed. The resins are then estimated by difference. Van Romburgh points out that the largest source of error in using this method is due to the evaporation of the chloroform. To avoid this loss and save time the following modifications were adopted by me:

DIRT.

A fair sample of the gutta-percha to be analyzed was finely divided and quartered down to a small amount. Of this 0.3 to 0.5 gram was taken in a weighed thimble filter and extracted hot in a Soxhlett apparatus, chloroform being used as the solvent. When all was dissolved but the dirt, the latter was dried on the filter and weighed.

RESINS AND GUTTA.

The chloroform solution is then evaporated to dryness in the flask (previously tared) attached to the extractor and dried to constant weight on the water bath in a stream of dry carbon dioxide gas. After weighing, the contents are extracted with hot alcohol or acetone, when the flask is again dried as before and weighed. The loss in weight equals the weight of resins and gain of the flask the weight of gutta. The water is estimated by difference.

Analyses of samples taken from several trees of one species show the percentages of the constituents to vary considerably, they being influenced, probably, by the age of the tree, the conditions of its growth (soil, moisture, shade, etc.), as well as by the season at which the sample is taken. For illustration of this, two analyses of gutta-percha known to have been taken from different trees of *Palaquium gutta* are given to show the large variation in the percentage of gutta. It must, therefore, be understood that the figures obtained from the analyses of the gutta-percha taken from any one tree will not necessarily represent the exact values for that species. An average from a number of trees is necessary to secure true values. In the same way samples from any commercial grade of gutta-percha may vary quite a little in their percentage composition, the differences, however, generally falling within a well-defined limit.

The "dirt" found in all commercial gutta-percha, as has been stated, may be there unintentionally, or have been added with intent to defraud. In either case it generally consists of finely chopped bark, leaves, small sticks, etc. From 2 to 6 per cent of dirt is not only admissible, but generally unavoidable, while more than that is looked upon with suspicion. So intimately is some of the dirt mixed with the gutta-percha that even the best machines fail to eliminate the last 1 or 2 per cent.

A certain amount of coloring matter which exudes from the bark when it is cut is also mixed with the gutta-percha milk and colors the resulting product. Certain species give a distinctive color to the material taken from them, so it has become a practice of the Chinese in Singapore to boil inferior grades with the bark of the best species in order to give them the correct color.

Under "resins" are considered the resinous-like substances which with gutta go to form the substance gutta-percha. These resins vary greatly in appearance. In gutta-percha from *Palaquium gutta*, for example, as has already been stated, one is a white crystalline mass while the other is a yellow amorphous powder. In other species they may be oily or brittle, colored or white. Judging from the formulas $C_{10}H_{16}O$ and $(C_{10}H_{16}H)_x$, which have been given to alban and fluavil, respectively, it might be inferred that these resins are oxidation of products of gutta $(C_{10}H_{16})_x$. Sufficient work has not yet been done on these bodies, however, to make this anything more than conjecture.

Again, taking the gutta-percha from *Palaquium gutta*, for illustration, it is found that the 10 to 20 per cent of resins which it contains is not a detriment, but rather a decided advantage. Besides adding much to the bulk, these substances are insoluble in water, poor conductors of electricity, and quite stable against the action of air and moisture. In fact, gutta-percha at present prepared for the insulation of submarine cables is composed of one part of resins to every two parts of gutta. When the amount of resin passes this percentage, however, the toughness of the gutta-percha is lessened and other objectionable qualities become apparent. The necessity, then, of knowing the percentage of resin in a given quality of gutta-percha before using it for manufacturing purposes is plainly apparent.

As might be inferred from the preceding, the "gutta" is the principal constituent in gutta-percha. The methods of separating it from the other constituents have been given and its indifference toward dilute acids and alkalies noted. Concentrated nitric acid causes violent oxidation, while sulphuric acid carbonizes it in a short time. Alkalies, even when concentrated, have practically no action on it. The best solvents for gutta are chloroform, carbon bisulphide, and carbon tetrachloride. From all of these solutions it may be reprecipitated by the addition of alcohol.

If gutta be subjected to dry distillation isopren, C_5H_8, and kautchin, $C_{10}H_{16}$, (18) distill over as the chief decomposition products, and are identical with the isopren and kautchin (19) recovered from the dry distillation of rubber. Tilden (20) succeeded in changing isopren back again into a rubber-like substance through the action of concentrated hydrochloric acid. Isopren, according to Ipatiew and Wittorf (21), is methly divinyl, $CH_2=C(CH_3)-CH=CH_2$, so that both gutta and rubber will perhaps be found to be polimerization products of isopren.

The discussion has so far been of the gutta found in the species *Palaquium gutta*. Dr. Eugene Obach (22), as chemist for a large cable insulating company, made analyses of specimens of gutta-percha from different species of trees, as well as from many grades of commercial gutta-percha. In his table of analyses he puts under the name of "gutta" the substance, found in each sample, which was insoluble in boiling alcohol but soluble in chloroform. The "guttas" thus found were variously colored from white to dark brown and possessed different tensile strength, from "elastic" and "very strong" to "brittle." Obach thus used certain slight chemical similarities as his criterion of a gutta, and neglected, apparently, the wide physical differences, which, as will be shown later, these bodies display. Provided there are many kinds of guttas, it is easily understood why a chemical analysis alone of a gutta-percha will give almost no insight into its value unless accompanied by physical tests of the gutta contained in it.

VIII. PHYSICAL TESTS OF GUTTA.

Before going further with the discussion as to whether chemical or physical tests should decide what is or is not "gutta," attention is called to the various physical properties of these bodies. To provide material for these physical tests, they were isolated in considerable quantities from various representative Singapore and Philippine gutta-perchas by means of solvents, and after evaporation were dried in a stream of dry carbondioxide gas to prevent any possible oxidation. When heated to the temperature of boiling water they could be easily cut or molded into the necessary shape for performing the following experiments:

Gutta.	Color.	Action toward light.		Heat, softening temperature.	Stress, tensile strength (pounds).
		Refractive index.	Rotation in 0.5 per cent solution.		
		70° C.		° C.	Sq. inch.
No. 1	Light brown	1.5093	6.75	62	5,262.4
No. 3	Cream white	1.5088	6.50	60	6,668.15
No. 4	Yellowish white	1.5089	7.50	61	5,134.7
No. 5	Very light chocolate	1.5093	6.50	61	6,451.45
No. 10	Cream white	1.5076	4.75	56	(a)

[a] Brittle. (The numbers in this table refer to Table No. 2.)

EXPLANATION OF TABLE.[a]

The "color" of the guttas undoubtedly comes from the bark of the tree when cut to secure the gutta-percha, for by repeated solution and precipitation the color may be almost entirely eliminated, leaving the gutta only slightly tinted from a cream color to light pink and pure white when finely divided. It is my opinion that all variations of color are only incidental and not connected with the chemical structure of the gutta itself. The amount of color in the above samples was a minimum and not sufficient to have any material effect on the physical properties. The experiments with light, namely, those given under refractive index and rotation, are employed with great success in the commercial analysis of sugars, oils, fats, butters, etc. This is due to the fact that each chemical individual, providing it is capable of transmitting light, has an index of refraction peculiar to itself, which, for purposes of comparison, must be taken under constant conditions and, provided it is able to rotate the plane of polarized light, a degree of rotation which is also constant.

[a] The results given in this table and some of the explanations appeared in the previous annual report of the superintendent of government laboratories; but as subsequent experience and the completion of botanical data have led me to take up the subject from a different standpoint, they are again appended for the sake of completeness.

While two chemical individuals may show identity in some one physical property, they can not continue this identity in two or more, so that more than one method was necessary to determine the relationship of the guttas examined by me. Substitution, adulteration, or variation in chemical structure can in this way be easily discovered and determined. Owing to certain mechanical and chemical difficulties encountered in making these determinations on the guttas, the limits of error of experimentation are outside of the differences found between Nos. 1, 3, 4, and 5, but do not include the marked difference displayed by No. 10. In determining the refractive index an Abbe-Zeiss refractometer was employed and a small amount of a concentrated solution of pure gutta in chloroform placed on each of the prisms and allowed to stand until the odor of chloroform had entirely disappeared. The prisms were then closed, and kept at a temperature of 70° C. until the readings became constant, showing that all chloroform had evaporated. The above figures are the results of many determinations made with carefully prepared samples.

The rotation was determined in chloroform, 0.5 per cent solution being used, because when more concentrated the absorption of light was too great to admit of accurate readings.

The physical tests given in the above tables are so diversified as to bring out clearly the extent of resemblance between the various samples of gutta submitted to them. The results show little variation between Nos. 1, 3, 4, and 5. Indeed, these samples may be regarded as practically identical in composition. The physical constants appear to be those of a single chemical individual, the refractive index varies only in the third decimal place, the rotation is the same within the limits of ony 1°, and the softening points vary only from 60° to 62°. The small amount of resins in the specimens, which it was impossible to remove, would be sufficient to account for even greater variations. No. 1, however, is the best sample, used for a standard and taken from *Dichopsis gutta;* Nos. 3, 4, and 5 are from the Philippine Islands. It would appear from this that gutta is a chemical individual, identical in all cases, and any substance, such as No. 10, for example, which varies from the properties recorded above should not be designated as such. This opinion is, however, advanced subject to further confirmation by extended chemical investigation looking toward the determination of the chemical constitution of gutta. In the case of sample No. 10 the substance designated as gutta and the real gutta of No. 3 are very similar in appearance and chemical behavior. In tensile strength, however, they are widely divergent, and this difference is accentuated and not lessened by the other physical tests; for while these latter differences are not so marked, yet they clearly show that all the physical constants of No. 10 differ more or less from all the others, and hence this substance must certainly be different in chemical constitution.

The action of heat in softening gutta-percha and making it plastic has previously been used as a test of value. It has been found that the best grades require a higher temperature to soften them than the lower grades. According to the results obtained by me, the inferior grade of gutta (No. 10) also possesses the property of softening at a lower temperature than the superior gutta. The softening point was determined by molding a piece of gutta into the bottom of a glass tube sealed below, placing a sharp-pointed glass rod in contact with the surface, and gradually heating in a bath of sulphuric acid until the point of the glass rod just began to enter the gutta.

The tensile strength, or toughness, possessed by gutta, next to its resistance to sea water, is undoubtedly its greatest merit commercially. Even the inferior grades of gutta-percha are used for objects requiring toughness combined with pliability and strength. In the insulation of a submarine cable great toughness is imperative, for during the laying of the cable it is constantly subjected to great strains from kinking, pulling, rubbing, etc., and when it has reached to the ocean bottom, where the pressure is often 3½ tons to the square inch, it must not have sustained a fracture even as large as the diameter of a fine hair, for otherwise the moisture would slowly penetrate to the wires, the insulation would not be complete, and the cable would have to be pulled up and repaired.

In order that the measurements made might be within the limits of the instruments at hand, only small strands of gutta could be used for testing. To make these strands free from minute air bubbles was well-nigh impossible, in consequence of which the breaking was in most cases brought about by weakness due to this source. The figures, while thus only approximate, are below and not above the true values and show clearly the enormous tensile strength of my samples. Obach (23) gives a tensile strength of 5,000 pounds for the best gutta-percha, while for the gutta from it he found about 6,500, which closely corresponds to results given above. This also brings out most clearly the excellent quality of the best Philippine gutta-percha.

The results of the combined chemical and physical tests on various samples of so-called "guttas" extracted from gutta-perchas of different origin seem to show that the gutta from the gutta-percha of *Palaquium gutta* has certain well-defined chemical and physical properties, and they also demonstrate that some so-called gutta-perchas contain a substance which chemically resembles to a certain extent the above-mentioned guttas, but differs widely from it in many of its physical properties. As the gutta from the species *Palaquium gutta* has stood the test of usage for fifty years, it is only fair that its chemical and physical constants should be used as the standard of comparison. Until more is known chemically of such substances as I found in No. 10, a chemical analysis will not be sufficient to determine the value of a gutta-percha, but it must be supplemented by physical tests. This laboratory will undertake the task of so determining the chemical properties of gutta and its allied bodies in the hope of discovering a method of chemical analysis which alone can be used to determine the value of any gutta-percha.

IX. SCIENTIFIC PROPAGATION.

As soon as the native collectors made such heavy inroads on gutta-percha forests as to make certain of their serious decimation, if not entire destruction, the various governments having tropical possessions in the East began to take note and make inquiries, but it was not until the last four or five years that the notes became serious or the inquiries anxious. Both explorations and inquiries revealed that the greater part of the Malay Peninsula had lost most of its trees, and that the portions of Sumatra and Borneo which were still productive were in the most inaccessible mountain forests of the interior. So thoroughly had the seed-bearing trees been cleared out of the Malay State that a standing reward by government officials for seeds of the species *Palaquium gutta* was not claimed, though the offer stood for a long time. Van Romburgh (24) in a very extensive tour of Sumatra and Borneo, made for the purpose of reporting to the Dutch Government the condition of the gutta-percha regions, saw but a few seedbearing trees, and these in almost all cases had been protected by native chiefs.

In the botanical gardens of Singapore, Bukit, Tiniah, Penang, and Buitenzorg, *Palaquium gutta* trees were growing which had either been protected from destruction or had been planted for a sufficient length of time to be seed bearing. These formed the nucleus of the gutta-percha nurseries now being planted by the English and Dutch Governments, with the purpose of obtaining reliable information as to methods of propagation, the rapidity of growth, the time necessary for maturing, and above all to furnish material for testing scientific methods for extracting gutta-percha without killing the trees. Owing to the scarcity of seeds everywhere the government botanists were obliged to resort to various methods for securing young plants, and their experiments have been along the following lines:

(*a*) PLANTING FROM SEEDS.

The fresh seeds are laid in beds of rich earth and allowed to germinate and grow under partial shade. When about a foot high they are transplanted to the future plantation, where the soil may be entirely free from trees, shrubs, or other vegetation (Dutch method) or where small patches of earth have been cleaned and loosened for their reception in a forest of secondary growth, heavy enough only to furnish a light shade (English method). By the Dutch method a light shade is required around each seedling until a vigorous growth is secured. The seedlings are set out about 5 by 5 yards apart, though where it is desired to obtain the largest amount of leaves per acre the space allotted is 4 by 4 yards. No special care seems necessary except to keep them free from weeds. Too much stress, however, can not be laid on the care which should be taken not to break or injure the long taproot of the young plant during the process of transplanting, for any injury to it stunts the growth materially or even causes death. Mr. Curtis, director of the Penang Botanical Gardens, has modified the manner of starting the germination and first growth, by placing each seed in a separate bamboo joint filled with earth. This joint is made long enough to allow the taproot to strike downward undisturbed, and when the time comes for transplanting it can be transferred, joint and all, without any fear of injury, to the place made ready for it. The bamboo is then cracked open and the plant inserted in the ground with almost no disturbance of its roots.

The Dutch Government in Java, having many seed-bearing trees, is now deeply engaged in carrying out a programme which contemplates the planting of some 150,000 seeds annually until at least 1,000,000 trees are growing. This will be done on extensive Government plantations at Tjipitir, Java. The entire management is intrusted to Doctor Van Romburgh, director of the Government chemical laboratory at Buitenzorg, who has a corps of assistants intrusted with testing the gutta-percha contained in the seed-producing trees in order that none but the best stock may be used.

(*b*) PLANTING FROM SELF-GROWN SEEDLINGS.

In the forests both of Sumatra and Borneo the natives are still able to find comparatively large numbers of self-grown seedlings of the *Palaquium gutta* species. These, when carefully taken up and transplanted into air-tight boxes provided with glass covers and rich earth, can be packed in large numbers in a comparatively small space and shipped to almost any desired distance. For instance, 60,000 such seedlings were shipped two years ago from southern Borneo to the French Kongo via Antwerp. The plants transported from Borneo to Singapore in this manner are doing well in the gardens at the latter place. The German Government is planning a nursery of such seedlings in its tropical possessions in New Guinea.

(*c*) PROPAGATION BY MEANS OF MARCOTTAGE.

As neither direct slipping nor grafting has ever succeeded with gutta-percha trees, the method called marcottage was tried in Java and the Malay States with some success. This consists in selecting a young straight limb from a large tree and at the point where the roots are to grow the bark is removed for the length of an inch around the entire limb. The denuded spot is then packed with rich mud, which is held in by a coating of cocoanut or other fiber. (See fig. 25.) If the mud is kept moist, and only if this is the case can good results be secured, small roots will generally appear in three to nine months, when the limb can be cut off and planted.

The principal gutta-percha plantations now under cultivation and in which much useful and desired experimenting is being done are located at Tjipitir and Buitenzorg in Java, on Rhio Island at Singapore and Bukit Timah on Singapore Island, on Penang Island, and at one or two places in the Federated Malay States. Enough time and work have been spent to demonstrate most conclusively that gutta-percha trees can be raised not only successfully, but also without much trouble or great outlay of money, and all the nations having tropical possessions in the East, except the United States, have made a start toward gutta-percha plantations, but the Dutch are the only ones so far who have gone into it on a grand scale, and unless appearances are deceitful they will have a monopoly on the plantations of the gutta-percha of the future as sure as they have on the forest gutta-percha of the present day.

X. SCIENTIFIC METHODS OF COLLECTING.

Modern methods of collecting gutta-percha have advanced along two lines. Needless to say they were not proposed nor carried out by the wild native collectors, who are unwilling to discontinue present gains in favor of future returns. It was previously remarked that the gutta-percha is all contained in the bark of the tree and in the leaves. The problem resolved itself into either—

(*a*) Extracting some of the gutta-percha from the bark and leaves without injuring the tree, or

(*b*) Felling the tree and securing the gutta-percha from all of the bark and leaves.

To carry out the first proposition a method was devised similar to that used in South America for extracting rubber milk, by which incisions were made in the bark in a slanting direction up and down the trunk (see fig. 27), so cut that the gutta-percha ducts were opened, but no injury done to the inside wood of the tree. The milk flowed out to a greater or less extent and coagulated in strings on the bark. After the flow had ceased and complete coagulation had set in (one day) the strings of gutta-percha were pulled off by hand, washed in hot water, and pressed into cakes. The advantage of this method was that no injury was done the tree, although it was tapped repeatedly. (See fig. 29.) The disadvantage lay in the fact that only a small per cent of the total gutta-percha in the tree could be extracted at any one time. According to Van Romburgh's (25) latest experiments with plantation trees (*Palaquium gutta*) about 15 to 17 years old, the yield was 100 grams (nearly one-fifth of a pound) per tree. The gutta-percha thus secured was of the very best.

In addition to the amount thus taken the leaves both from the living and dead trees contain 8 to 10 per cent by weight of gutta-percha calculated to the dry leaf. To extract this gutta-percha two processes have been devised:

(1) The mechanical one, in which the leaf is ground to a powder and then treated with hot water in such a way that the gutta-percha is gradually worked into a compact mass, while the pulp of the leaf is washed away. Up to the present the process has not been perfected, for although the gutta-percha contained is of a good quality the percentage of recovery is smaller than it should be. The largest factory of this kind is being erected near Singapore, and it proposes to use the leaves from a plantation of 100,000 trees on the island of Rhio, some five hours from Singapore.

(2) The chemical process is carried out on the same lines as the mechanical one so far as the grinding of the leaves is concerned. The powder is then extracted with solvents and the dissolved gutta-percha recovered either through precipitation or through evaporation of the solvent. The details of the process, as well as the solvents used, are kept secret and no patents for this or the mechanical process have been taken out.

The largest factory producing gutta-percha for the market is located at Sarawak, north Borneo, and is very advantageously situated as regards securing leaves from the surrounding gutta-percha forests. It has been claimed, however, that the factory defeated its avowed object of preventing the destruction of the trees, for the native collectors employed would never risk their lives trying to collect leaves from forest trees over 100 feet high when they could gather them much easier by felling the tree and collecting a goodly amount of gutta-percha in addition. It thus appears that the supply of leaves must come from a plantation where supervision can be exercised.

The plan of felling the gutta-percha trees of the forest and securing all of the material from the bark and leaves is worthy of serious consideration. In the first place, the trees are surely doomed as long as present conditions obtain. If the native can sell the entire bark and leaves for more than he could get for the gutta-percha which he could extract, he will be tempted to bring them in. A second inducement for this method is the fact that many gutta-percha trees cut down even years previously have still much perfectly sound gutta-percha in the rotting bark, which could also be secured. The process of recovering the substance from the bark is practically the same as from the leaves, and about the same per cent is found there as well. With a yield of from ten to fifteen times the present amount recovered from each tree the gutta-percha market would be relieved at once and the extermination of the trees put off many years, long enough at any rate to allow plantation trees to take their place.

A large amount of work has been done in this laboratory with the purpose of finding a practical method for extracting the gutta-percha from the bark and leaves of the gutta-percha trees. The process calls for a solvent for the gutta-percha which will dissolve it easily, can be recovered and again used, and above all has no deleterious effects on the substance.

The result of the experimentation led to a modification of the Obach (26) hardening method for gutta-percha. The process consists in extracting the gutta-percha bark and leaves by means of hot gasoline, the apparatus being provided with reflux condensers. While the gutta-percha has entirely dissolved, the solution is allowed to stand until all of the dirt and most of the coloring matter has settled. The clear supernatent liquid is then poured off and cooled to 10° or 15° below freezing. The gutta, with a small amount of resin, is thereby precipitated and can be filtered off through cloth bags and dried. The resulting gutta can be further purified by redissolving in distilled gasoline and reprecipitating. The filtrate containing the dissolved resins is redistilled and the recovered gasoline used for effecting further solution of gutta-percha, thus making the process continuous.

The gutta so secured, on being warmed, can be pressed into any desired form for experimentation. The gutta used in the above experiments was so prepared, and the results of the physical and chemical tests showed it to be unaffected by the process to any appreciable extent. A year's exposure to laboratory fumes has not changed the substance in any way. The accompanying figure (No. 30) shows some of pressed cakes prepared in the laboratory.

It is to be noted that the process gives practically pure gutta and not gutta-percha, the resins remaining dissolved in the gasoline. This is in itself a great advantage, as the gutta could be used directly for bringing up the percentage in inferior grades of gutta-percha, and so make them suitable for cable insulation. The commercial value of this gutta has not been determined, but should be rated at about $600 Mexican per picul, judging from the price of the best gutta-percha. In this way three piculs of Philippine gutta-percha at $210 Mexican will produce 1 picul of pure gutta valued at $600 Mexican, or a gain of $390 for every 3 piculs of gutta-percha (or the equivalent in bark and leaves) handled.

XI. PESTS AND PARASITES.

An instructive bulletin has been issued by Doctor Zimmerman (27) of the 's Lands Plantentuin at Buitenzorg, Java. His field of observation covered the large experimental gardens of Buitenzorg and at Tjipitir, where many thousands of gutta-percha trees of various species are now growing. While the same conditions do not obtain there as are encountered in the forest, it is certain that they are as badly if not worse off on account of the multitude of insects of all kinds which are attracted by the other plants of the gardens. In fact, he considers the test a severe one, and his conclusions that there are practically no insect pests which might be considered dangerous is very gratifying. Cattle and goats eat the leaves greedily, and young trees must therefore be protected until high enough to be out of reach.

Part II.

RUBBER.

I. HISTORICAL AND DESCRIPTIVE.

Even the shortest outline presenting the subject of rubber in its historical, geographical, botanical, and commercial aspects would be beyond the scope of this report, nor does the part which the Philippines have taken in its production or are likely to take for several years to come, warrant anything more than a brief explanation of the present state of the rubber industry, in order to better understand the present conditions here and the possibility of these islands becoming a new center of the ever-increasing rubber industry.

Rubber, or india rubber, as it seems best known in the United States, was discovered by the Spaniards in the second voyage of Columbus. The Indians of Haiti were found playing with rubber balls which they said were formed from the hardened milk of certain forest trees on the island. In 1755 Dom José, King of Portugal, sent several pairs of his boots to South America to be coated with rubber milk. They must have been made satisfactorily waterproof, for the rubber industry has increased from that day to this.

Not alone was the valley of the Amazon found stocked with rubber trees and vines, but new species were discovered in Central America and Mexico as well. In 1798 rubber-producing vines and trees were encountered in southern Asia, later on in Central Africa, and by the middle of the nineteenth century almost every tropical country of the world had been searched, and the search had not been in vain.

The number of genera and species—even the families representing the rubber plants—is very large, especially because the production is not confined to trees alone nor to any one country, as is the case with gutta-percha, but includes a large number of vines as well, and its area of production is practically that of the tropical world. While rubber trees predominate in tropical America, Africa and Asia apparently draw their greatest supply from vines. Borneo especially is rich in them to the exclusion of trees. The Philippines were said to contain more trees than vines, but systematic search has so far revealed only vines.

Not until the middle of the last century were the manifold uses to which rubber could be applied well understood and the rubber industry thoroughly established. Statistics show that London imported in 1830 some 46,400 pounds of rubber, and by 1870 this had increased to the enormous amount of 15,211,800 pounds for that one year alone. Since then the consumption has steadily increased, the statistics reading by tons and not pounds, and for 1902 amounted to some 62,650 long tons. London, the former chief center of the rubber trade, has retired in favor of New York. While tropical America in the beginning produced nine-tenths of the rubber supply, it now exports but very little more than one-half of the total amount, India, Burmah, Borneo, and Central Africa especially having made giant strides in rubber production. Last year's production for the Malay States, Java, and Borneo was about 1,000 tons. In this was included the amount exported from the Philippines. How much that amount was there is no way of finding out, nor for how long this exportation of rubber has been going on. My investigations in the southern islands convinced me that whatever collecting and exporting has been done concerns the island of Tawi-Tawi alone, and in all probability the latter amount was small. This conclusion is reached because the natives only of Tawi-Tawi know of the commercial value of rubber, and also because I found rubber vines very near the coast on Tawi-Tawi, a sure indication that the search for rubber has not been very careful nor for a long time.

The Philippine Islands are then practically a new field for the development of a rubber industry. It will be my purpose, therefore, to show—

(1) The species of rubber-producing plants indigenous to the islands and the amount of territory covered.

(2) The grade of rubber produced.

(3) The Philippines as a rubber-producing country: (*a*) Through utilization of natural supply; (*b*) through introduction of foreign species.

Reference to figures 31, 32, and 33 will show the two species of vines now known to be well distributed over the islands, both of which produce a good grade of rubber. Owing to my inability to find a vine in fruit or flower, one of them has not yet been determined botanically. Mr. Merrill contributes the following botanical descriptions:

"*Parameria philippinensis* Radlk. (Apocinaceæ.)

"An evergreen woody vine, reaching a height of 40 or 50 feet and a diameter of 1 inch or more. Bark gray, with an abundant milky sap. Leaves opposite, ovate, acute, or somewhat acuminate, glabrous, 2 to 3 inches long; nerves four pairs; petioles short. Flowers small, white, fragrant, in terminal panicles. Fruit a long, slender, distinctly torulose follicle, 10 to 12 inches long, the swellings over the seeds an inch apart. Seeds one-half inch long, brown, coma white, about twice as long as the seed.

"(*Apocinaceæ.*) Genus undetermined, specimen with leaves only, from the island of Basilan.

"A very large vine 150 to 200 feet in length, with a diameter of 6 to 8 inches the bark somewhat rough, greenish. Leaves broadly ovate or obicular, 8 to 10 inches long, abruptly very shortly acuminate, the acumen less than one-half inch long, glabrous above, pubescent on the nerves beneath, the nerves prominent, about 10 pairs."

It has already been stated that no rubber-producing trees have been found. That is to say, a great many species of trees have been discovered which are known to produce a milk or latex, and while none so far studied contain rubber, it is scarcely to be supposed that when material from all has been collected some at least will not be found to yield a good product.

The extent of territory covered by these two rubber vines is given by map No. 2 (facing page 9). While the *Parameria* is found in Mindoro, Culion, and the other northern islands, the indetermined species is found on Tawi-Tawi, Basilan, and Mindanao. The extent of territory covered in these various places was estimated after extensive personal investigations when all available data had been secured from natives, merchants, etc. In the northern islands, excepting Mindoro, the area covered is given as reported by those who found specimens of the vine. There is every reason to believe, however, that careful investigations would show much larger areas. In Mindoro the natives in all the coast towns knew the rubber vine as "Dactang Ahas" (medicine for snakes), and many of them brought us samples from the neighboring forest. They all reported large numbers of vines in the interior of the island, and the three expeditions made there from the north, west, and south sides confirmed their statements.

In Mindanao the two areas given between Dinas and Tucuran in the mountains near the south coast are the only ones known so far, and even these were only found by accident. The natives knew nothing of rubber, but they had a vine which contained a milky substance, good either as a medicine or for making the heads of their drumsticks. On securing a piece of this peculiar substance from the latter it was found to be a good sample of rubber. Further explorations to the west and east will probably prove that this vine covers about the same area as that occupied by the gutta-percha trees.

In Basilan and Tawi-Tawi the vine grows abundantly and to a large size. In the latter island the Moros understand its commercial value, and those engaged in collecting gutta-percha gather rubber at the same time, sometimes mixing the rubber and gutta milk.

II. THE GRADE OF RUBBER PRODUCED.

Rubber milk or latex is contained in the bark of certain vines and trees in exactly the same manner as is gutta-percha. (See fig. 35.) When made to flow, the same phenomenon of coagulation apparently sets in quickly or slowly, according to the species of the plant. In many species of trees the coagulation is very slow and the flow of milk more abundant than with gutta-percha trees. As a result the natives have evolved the method of tapping the trees similar to that shown in fig. 36. The milk thus secured is coagulated in a manner similar to that employed with gutta-percha.

Another method, which seems to give the best results and which is employed in the preparation of Para rubber, consists in subjecting thin layers of the milk, placed on the broad end of a paddle, to the coagulating action of smoke produced by burning certain husks which are similar to those of cocoanuts. The smoke contains creosote and acid fumes, which quickly destroy all fungus growths and bacteria which might tend to cause decomposition of the rubber, while the heat removes the greater part of the moisture at the same time.

A chemical analysis of many grades of rubber coming from different species of trees and vines shows them, with the exception of variable amounts of water and dirt, to be composed almost entirely of rubber, with a small per cent of resins. The rubber in all has apparently the same chemical composition, an ultimate analysis giving the formula $C_{10}H_{16}$. Chemically then there appears to be only one rubber, while physically certain differences are to be found between samples from different species. Whether the superiority of Para rubber is due, therefore, to the excellency of the rubber itself or to the above-mentioned method of coagulation has not yet been determined. However, it is a fact that Para rubber from the tree species *Hevea brasiliensis* Muell. Arg., is recognized as the standard for grading rubber commercially.

It will be noted that the method before mentioned is one requiring skill, judgment, and the expenditure of considerable labor. In most rubber countries the native collectors possess none of these requisites and are content to employ the crudest methods. In consequence the rubber obtained is of a low grade even thought the species of tree is of the best.

The Philippine rubber collectors are Samal and Joloano Moros living in Tawi-Tawi and the adjacent coral islands. The method of coagulation used by them was undoubtedly learned from the Moros of North Borneo, who, with the Dyaks, collect much of the rubber in that island. It consists in first pulling the vine down to the ground so as to be better able to tap it along its entire length. The milk is caught in cocoanut shells or leaves, and coagulated by pouring into sea water. The coagulation is almost instantaneous, and when properly manipulated a large amount of water can be mechanically inclosed inside the large balls along with plenty of chopped-up bark. The resulting rubber, of which I secured many samples, is white, tough, and very elastic so long as it is kept in sea water. On exposure to the air it blackens and decomposition slowly sets in.

The chemical analysis of a sample of this rubber, after much of the dirt and water had been removed, resulted as follows:

	Per cent.
Dirt	3.76
Rubber	81.57
Resins	3.16
Water	11.51

Judging from this analysis the rubber in Singapore would be rated as Borneo No. 1, which sells for $125 (Mexican) per picul of 133⅓ pounds.

The vines generally die after being pulled down and tapped, probably because of their inability to again reach light and sunshine.

The rubber from the Mindoro species has never apparently been gathered in any quantities even by the natives. When the bark is cut the milk flows readily and coagulates quickly. In appearance it is very similar to the Tawi-Tawi rubber. As yet no chemical analysis has been made. In order to get a valuation of it a sample was submitted to the Goodyear Rubber Company, of Akron, Ohio, who placed it at about 60 cents per pound after allowance is made for the percentage of water. Larger samples of both kinds of rubber are now being prepared in the laboratory in order that they may be submitted simultaneously to rubber experts.

III. THE PHILIPPINES AS A RUBBER-PRODUCING COUNTRY.

(*a*) THROUGH UTILIZATION OF THE NATURAL SUPPLY.

Judging from the way the natives of Tawi-Tawi gathered rubber when left to their own devices, I was convinced that they wasted as large amounts of the milk as they did when they collected gutta-percha—that is, ten to forty times more than they took away. It is evident, then, that under present conditions the history of the rubber vines will be the same as that of the gutta-percha trees, only on a smaller scale. It is useless, in my opinion, to think of tapping them only, for an inspection of their tortuous windings up and around the high forest trees (see fig. 37) will show the impossibility of ever collecting the milk, no matter how carefully the tapping were done.

To get the full value from the vine the rubber must be extracted from the entire bark. Experiments along that line are now in progress in the laboratory and so far promise well. If the entire vine be cut into pieces and dried, the bark easily separates from the wood and forms 44 per cent of the entire plant. By grinding the bark in any ordinary mill, the rubber separates in the form of small balls while the bark passes off as powder. The dried bark contains 9 to 10 per cent by weight of pure rubber, which shows this substance to be about 4 per cent of the entire vine. The other conditions and details will be investigated by the laboratory with a view of determining methods which will make possible the investment of American capital.

It is true that the method of collecting rubber given above kills the vine. The answer to this objection is found in the fact that when the vine has been cut off the roots stool again quickly. On a hillside in Mindoro where the natives had burned the forest for the purpose of planting rice, scores of stools from rubber vines were counted while the fire was yet smoldering in some of the old stumps and roots of the large trees.

(*b*) THROUGH INTRODUCTION OF FOREIGN SPECIES.

It was stated previously that no rubber trees were found in the islands. Exception should be made to the beautiful specimens of the india-rubber tree (*Ficus elastica* Linn.) which were introduced throughout the archipelago by the Spanish years ago as ornamental shade trees rather than as rubber producers. They are excellent examples of the way foreign species of rubber trees will grow here, and may also serve the still better purpose, that of furnishing seeds and slips to start rubber plantations. Many plantations of this tree have been begun in Java, the reasons for the selection of this species being: (1) The seeds are numerous and the plants grow well; (2) the method of starting new plants by marcottage (see fig. 25) succeeds admirably and the plants have vigorous growth (see fig. 38); (3) the method of coagulation best suited for this milk is the simplest of all. It consists of making many small cuts in the bark of the trunk and allowing the flowing milk to coagulat in strings. When dry and hard they are pulled off and pressed into a compact mass (see mass of rubber on the left, fig. 39) for shipment. The work can be done by even ignorant workmen, and with no damage to the tree.

In the Malay States a great many plantations are now being started with Para rubber trees, the seeds of which are secured from the various government botanical gardens as well as from private plantations. (See fig. 41.) One of this species of trees is now growing in Manila, and apparently the climate is suitable. The bureau of agriculture has distributed many Ceara rubber seeds during the past year, and the growth of the seedlings is marvelous.

In general the climatic conditions of most of the islands seem very favorable for the rubber industry. Mindoro and the southern islands especially are advantageous on account of the abundant rainfall distributed throughout the year, with no long season of drought.

What pests and parasites the rubber trees would be troubled with can only be conjectured by reference to the experience of Java, etc. Doctor Zimmerman (28) extended his work on parasites to include rubber trees, and has found one or two species of insects that may cause damage.* Cattle and goats must also be guarded against.

It is needless to dwell on the commercial side of rubber plantations. They are now flourishing in all tropical countries and as an agricultural investment are highly considered. However, in all new countries a certain amount of experimental work must be done before large capital can be safely invested. In India, Burmah, the Malay States, and Java this has been accomplished by the respective governments. As soon as methods were perfected and seed supplies provided, private capital began operations at once. From the number of injuries already made about rubber planting in these islands, it would look as if some movements in this direction are contemplated here, investors only waiting for the government to pave the way. By profiting from the extensive experience of our neighboring countries the experimental era should be short and inexpensive, as a great deal of the pioneer work has been done.

LITERATURE.

(1) "Die Gutta Percha," by Dr. Eugene Obach. Page 6.
(2) Mech. Magazine. London, 1846. Vol. 45, p. 415.
(3) C. W. Siemens, Journal of Soc. of Telegraphic Engineers, 1876. Vol. 5, p. 82.
(4) London Jour. Botany, 1847. Vol. 6, p. 463.
(5) Flora de Filipinas, 1837. Page 40.
(6) "Die Gutta Percha," Obach. Page 59.
(7) "Die Gutta Percha," Obach. Page 15.
(8) Personal communication.
(9) Jour. Straits Branch, Asiat. Soc., 1884. No. 12, pp. 212-214.
(10) "Die Gutta Percha," Obach. Page 24.
(11) E. Jungfleisch, "La Production de la Gutta Percha." Paris, 1892, p. 4.
(12) Vid. Export Statistics from Bureau of Forestry, 1901, 1902, 1903.
(13) Rules and Regulations of the Bureau of Forestry for Utilization of Forest Products, 1900.
(14) Bulletin de L'Institut Botanique de Buitenzorg, No. XV, p. 28.
(15) Rep. Chem. appliqué; vol. 1, p. 455. Jahresber. d. Chemie, 1859, p. 517.
(16) "Die Gutta Percha," Obach. Page 27.
(17) Bulletin de L'Institut Botanique de Buitenzorg, No. XV, p. 22.
(18) "Die Gutta Percha," Obach. Page 8.
(19) On Isoprene and Caoutchine. C. G. Williams, Proc. Roy. Soc., 1860. Vol. 10, p. 516. Harris, Ber. d. chem. Ges. 35, 3256, and Weber, Ber. d. chem. Ges. 33, 779.
(20) Chem. News, 1882. Vol. 46, p. 120, and 1892, vol. 65, p. 265. Comptes Rendus, 1875, vol. 80, p. 1446; 1879, vol 89, pp. 361 and 1117.
(21) Jour. Prakt. Chem., 1897. Vol. 55, pp. 1 and 4. Jour. Russ. Phys. Chem. Soc., 1896 [1], 316.
(22) "Die Gutta Percha," Obach. Pages 28, 30, 34, etc.
(23) "Die Gutta Percha," Obach. Page 87.
(24) "Caoutchouc en Getah-Pertja." Mededeelingen uit 's Lands Plantentuin, No. XXXIX.
(25) Private communication.
(26) "Die Gutta Percha," Obach. Page 49.
(27) Bulletin de L'Institut Bontanique de Buitenzorg, No. X.
(28) Bulletin de L'Institut Bontanique de Buitenzorg, No. X.

FIG. 1.—MORO SAILBOATS, "VINTAS."

FIG. 2.—LEAVES OF PALAQUIUM GUTTA BURCK, GROWN IN BOTANICAL GARDEN, SINGAPORE.
FURNISHES FIRST GRADE GUTTA-PERCHA.

FIG. 3.—LEAVES AND FRUIT OF PAYENA LEERI BENTH. ET HOOK, FROM BUITENZORG, JAVA. FURNISHES SECOND GRADE GUTTA-PERCHA.

FIG. 4.—LEAVES OF PALAQUIUM TREUBLI BURCK, GROWN AT BUITENZORG, JAVA. FURNISHES SECOND-GRADE RUBBER.

FIG. 5.—PALAQUIUM LATIFOLIUM BLANCO, PROVINCE OF TAYABAS, LUZON.

FIG. 6.—PALAQUIUM BARNESII MERRILL, ISLAND OF MASBATE.

FIG. 7.—PALAQUIUM AHERNIANUM MERRILL, TUCURAN, DISTRICT OF ZAMBOANGA, MINDANAO.

FIG. 8.—PALAQUIUM CELEBICUM BURCK, DISTRICT OF COTTABATO, MINDANAO.

FIG. 9.—PALAQUIUM CUNEATUM VIDAL, PROVINCE OF TAYABAS, LUZON.

FIG. 10.—PALAQUIUM GIGANTIFOLIUM MERRILL, PROVINCE OF TAYABAS.

FIG. 11.—PALAQUIUM LUZONIENSE (F. VILL) VIDAL, PROVINCE OF TAYABAS, LUZON.

FIG. 12.—PALAQUIUM MINDANAENSE MERRILL. DISTRICT OF COTTABATO, MINDANAO.

FIG. 13.—PAYENA LEERII (T. ET B.) BENTH. ET HOOK, TAWI TAWI.


MAP
SHOWING DISTRIBUTION
- OF -
PALAQUIUM GUTTA.
Taken from Obach's "Gutta Percha."
P A C I F I C
O C E A N
NEW GUINEA OR PAPUA
AUSTRALIA
135°
140°
145°


MAP
SHOWING DISTRIBUTION
- OF -
PALAQUIUM GUTTA.
Taken from Obach's "Gutta Percha."
PEGU
SIAM
ANNAM
HAI-NAN
CHINA SEA
LUZON
PHILIPPINE ISLANDS
MINDANAO
SANDAKAN
LABUAN
ANDAMAN ISLANDS
NICOBAR ISLANDS
MALACCA
NATUNA IS.
SINGAPORE
BORNEO
BATU IS.
SUMATRA
GREATER SUNDA ISLANDS
BANCA
Bandjermassin
CELEBES
MOLUCCA IS.
CERAM
PACIFIC OCEAN
NEW GUINEA OR PAPUA
INDIAN OCEAN
Buitenzorg
MADURA
Tjipalir
JAVA
LESSER SUNDA ISLANDS.
TIMOR
AUSTRALIA
English Miles
0 100 200 300 400 500
95°
100°
105°
110°
115°
120°
125°
130°
135°
140°
145°
20°
15°
10°
5°
0°

Map No. 1.

MAP SHOWING DISTRIBUTION OF RUBBER AND GUTTA-PERCHA.

FIG. 14.—GUTTA-PERCHA LEAF (PALAQUIUM GUTTA) ENLARGED, SHOWING FIBERS OF GUTTA-PERCHA PERMEATING THE LEAF INTERIOR.

FIG. 15.—READY TO FELL A LARGE GUTTA-PERCHA TREE FOR EXPERIMENTAL PURPOSES, DISTRICT OF ZAMBOANGA, MINDANAO.

FIG. 16.—LARGE GUTTA-PERCHA TREE TAPPED SO THAT THE FLOWING MILK IS ALL ABSORBED, TIRURAY DISTRICT, MINDANAO.

FIG. 17.—TAPPING A GUTTA-PERCHA TREE SO THAT ALL THE MILK IS COLLECTED IN SHELLS BENEATH. DONE BY MOROS IN TAWI TAWI.

FIG. 18.—A GUTTA-PERCHA TREE FELLED BY THE SUBANOS, NEAR CURUAN, DISTRICT OF ZAMBOANGA, MINDANAO.

FIG. 19.—A GUTTA-PERCHA TREE TAPPED SO THAT MUCH OF THE MILK IS LOST ON THE GROUND, TUCURAN, DISTRICT OF ZAMBOANGA.

FIG. 20.—LARGE GUTTA-PERCHA TREE FELLED AND RINGED, DISTRICT OF ZAMBOANGA, MINDANAO.

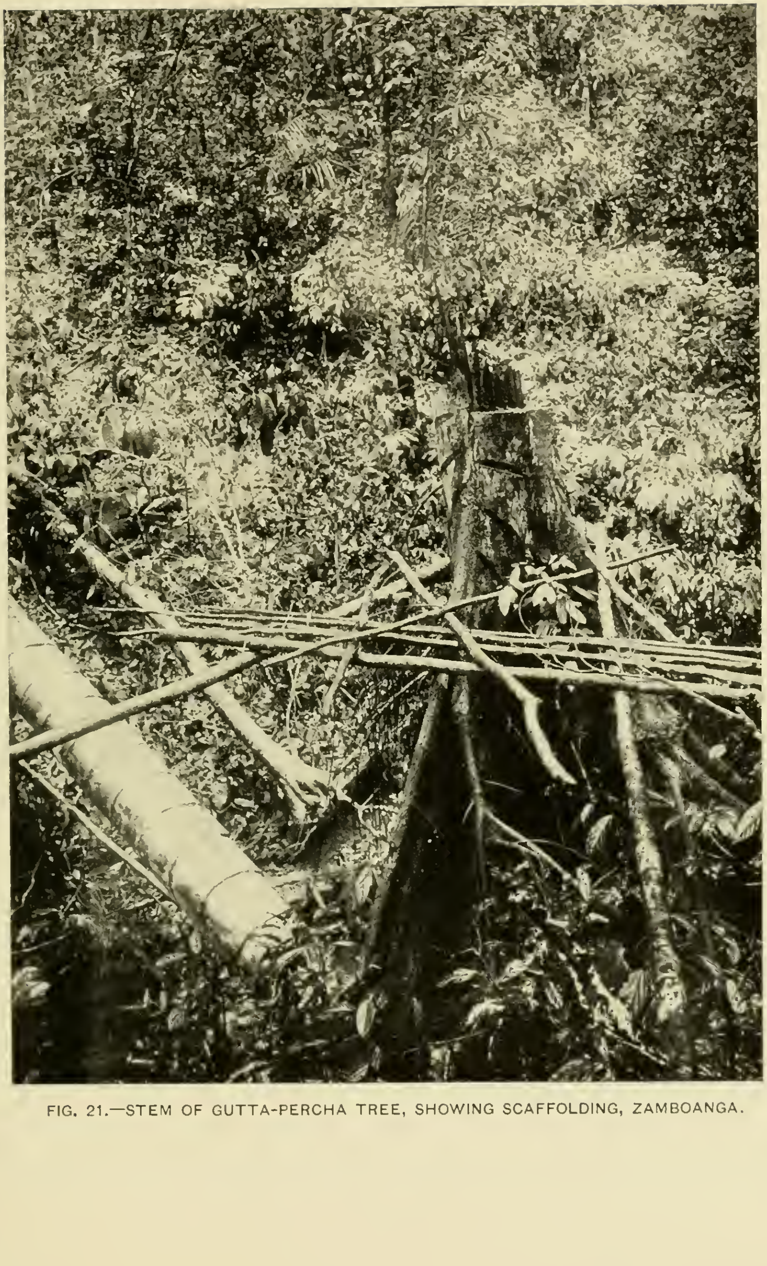

FIG. 21.—STEM OF GUTTA-PERCHA TREE, SHOWING SCAFFOLDING, ZAMBOANGA.

FIG. 22.—CHINESE TRADING BOAT COLLECTING GUTTA-PERCHA AT PARANG PARANG.

FIG. 23.—ENGLISH METHOD OF STARTING GUTTA-PERCHA PLANTATION, BUKIT TIMAH, SINGAPORE.

FIG. 24.—PLANTATION OF GUTTA-PERCHA TREES (PALAQUIUM GUTTA) OF VARIOUS AGES, BUITENZORG, JAVA.

FIG. 25.—SHOWING METHOD OF PROPAGATING GUTTA-PERCHA TREES BY MEANS OF MARCOTTAGE, BUITENZORG, JAVA.

FIG. 26.—A PALAQUIUM GUTTA TREE GROWING IN THE OPEN, BOTANICAL GARDEN, SINGAPORE, STRAITS SETTLEMENTS.

FIG. 27.—A TREE OF PALAQUIUM GUTTA JUST TAPPED, TJIPITIR, JAVA.

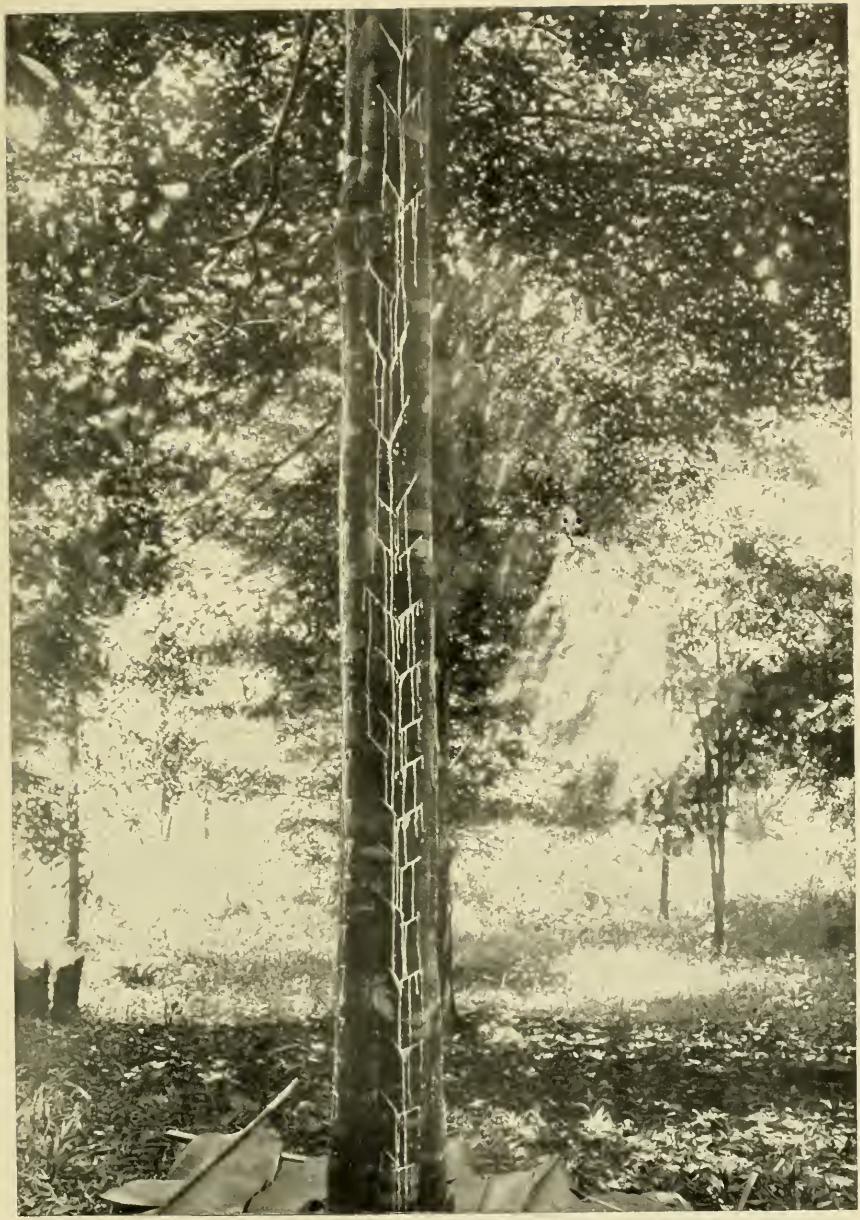

FIG. 28.—PALAQUIUM TREUBII JUST TAPPED, TJIPITIR, JAVA.

FIG. 29.—ABSENCE OF DEEP SCARS AFTER SEVERAL YEARS TAPPING, BUITENZORG, JAVA.

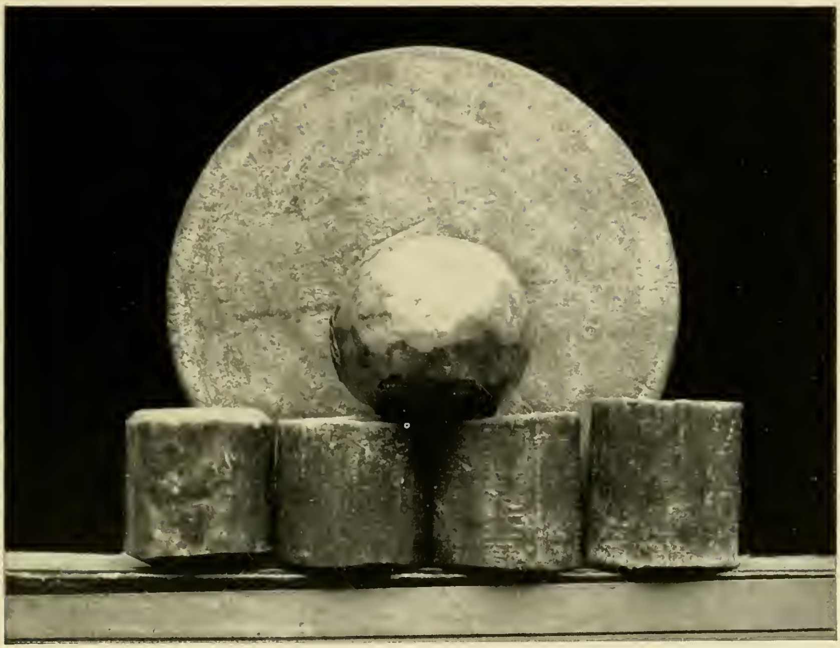

FIG. 30.—SAMPLES OF PURE GUTTA PREPARED IN THE LABORATORY FOR EXPERIMENTAL PURPOSES.

FIG. 31.—A RUBBER VINE (PARAMERIS PHILIPPINENSIS RADLK), WESTERN MINDORO.

FIG. 32.—RUBBER VINE (PARAMERIA PHILIPPINENSIS RADLK.), GROWING IN GREAT ABUNDANCE ON ISLANDS OF MINDORO AND CULION.

FIG. 33.—RUBBER VINE FOUND IN TAWI TAWI, BASILAN, AND MINDANAO. SPECIES UNDETERMINED.

FIG. 34.—RUBBER VINE (WILLUGHBEIA FIRMA BLUME). THIS SPECIES SUPPLIES MOST OF THE RUBBER PRODUCED IN BORNEO.

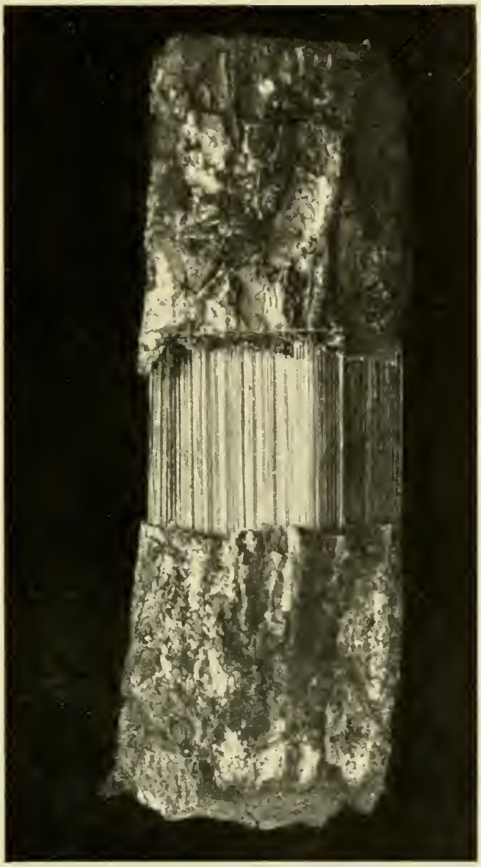

FIG. 35.—PIECE OF DRY BARK FROM RUBBER VINE, SHOWING THE IMMENSE NUMBER OF RUBBER FIBERS IN THE INNER BARK.

FIG. 36.—METHOD OF TAPPING A PARA RUBBER TREE THIRD DAY AFTER TAPPING, EXPERIMENTAL GARDEN, BUITENZORG, JAVA.

FIG. 37.—RUBBER VINE GROWING IN THE FOREST, WESTERN MINDORO.

FIG. 38.—PLANTATION OF INDIA-RUBBER TREES (FICUS ELASTICA), BUITENZORG, JAVA.

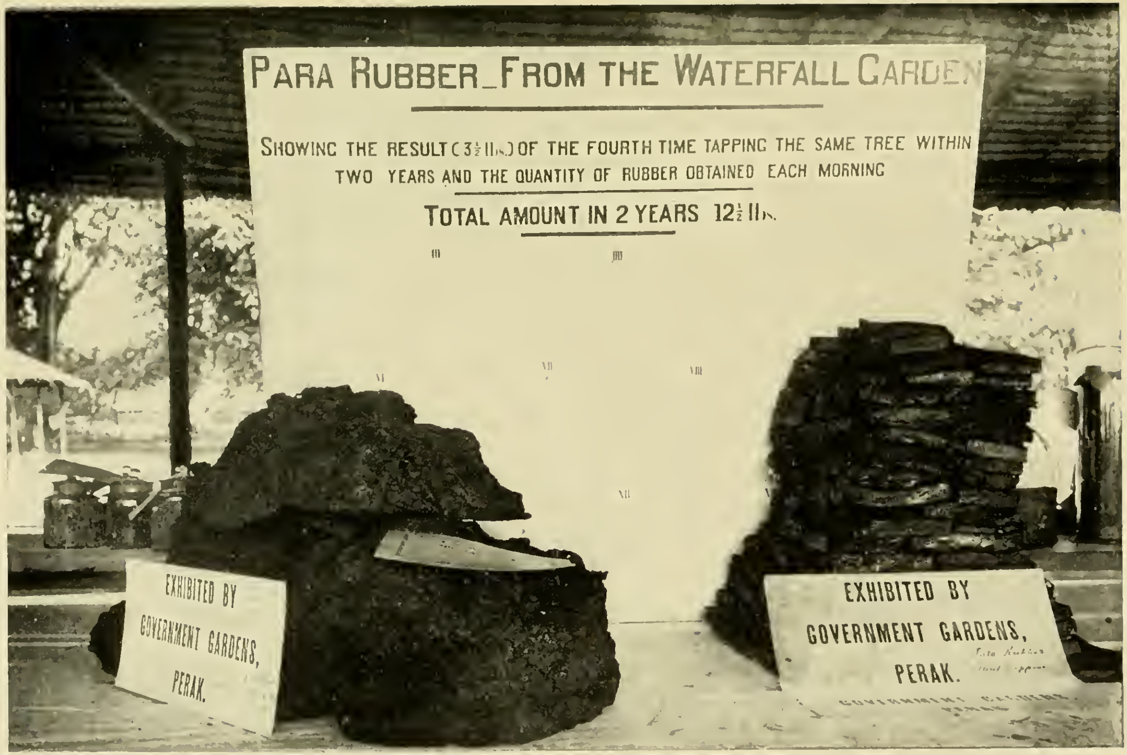

FIG. 39.—EXHIBIT OF PARA RUBBER, SHOWING YIELD OF TREES AND METHODS OF PREPARING FOR MARKET, PERAK PROVINCE, FEDERATED MALAY STATES.

FIG. 40.—LARGE INDIA-RUBBER TREE (FICUS ELASTICA L.), BUITENZORG, JAVA.

FIG. 41.—PLANTATION OF PARA RUBBER TREES, PRODUCING SEED, BOTANICAL GARDEN, SINGAPORE.

FIG. 42.—CEARA RUBBER PLANTS, EXPERIMENT STATION, MALATE.

BUREAU OF FORESTRY.

(Bulletin No. 3.)

A COMPILATION OF NOTES ON INDIA RUBBER AND GUTTA-PERCHA.

By Capt. GEORGE P. AHERN.

LETTER OF TRANSMITTAL.

BUREAU OF FORESTRY,
Manila, November 15, 1905.

SIR: I have the honor to submit herewith for your consideration a compilation of notes on rubber and gutta-percha, giving data concerning the requirements, growth, and treatment of the most important rubber-producing species in different parts of the world. A large number of writers, acquainted with the commercial exploitation of rubber trees and vines, have been consulted and their conclusions compiled.

These notes were gathered together after a number of requests had been made of the undersigned for information concerning the market for crude rubber, price, prospects for rubber growing in these islands, requirements of soil and climatic conditions for the growth of rubber trees, etc.

The data collected by Doctor Sherman and by Philippine botanists and collectors show that the soil, climate, and other conditions are favorable to rubber and gutta-percha in certain parts of these islands.

The government nurseries at Lamao, Bataan Province, have on hand for distribution a number of the more important species of rubber plants, including *Hevea brasiliensis*, *Castilloa elastica*, *Manihot glaziovii*, and *Ficus elastica*.

Of the 29 rubber-producing species enumerated in the above-mentioned notes, the 4 just mentioned furnish the greater part of the world's rubber supply. All of these species have been extensively cultivated in the Orient and have been found to be well suited to the climatic conditions.

In two or three years we should have available for distribution an abundance of seed from each of the above-mentioned species. Experiments in planting rubber trees should be encouraged in a great many different districts in the islands, so that we may learn just where the trees thrive best and under what leoal conditions a good quality of rubber is produced.

The three great rubber-producing centers of the world at the present time may be broadly classified as follows:

1. *East Indies:* British India, Ceylon, Burma, Straits Settlements, Java, Borneo, etc.
2. *Africa:* Numerous foreign possessions and free states along the coast of Africa; Madagascar.
3. Mexico and South America.

The demand for crude rubber continues to exceed the supply, and from statements made by the leading rubber merchants this condition of affairs shows no prospect of changing.

I would respectfully recommend that these notes be published as Bulletin No. 3.

Very respectfully,

GEORGE P. AHERN,
Director of Forestry.

The SECRETARY OF THE INTERIOR,
Manila, P. I.

"Twenty-five years ago Mr. John H. Cheever, one of the most successful rubber manufacturers the world has known, bought raw rubber as low as the prices appended, in comparison with which we note the highest New York quotations for corresponding grades within the current year:

[Prices stated in United States currency.]

Grade.	1879.	1905.	Grade.	1879.	1905.
Fine Para	$0.50	$1.33	African	.24	1.04
Coarse Para	.34	.97	Borneo	.47½	.41
Assam	.34	.91	Mozambique	.35	.9

"The demand for rubber never ceases nor becomes diminished; it promises to grow in years to come as it has done in all the years since the first rubber goods were vulcanized." (From India Rubber World, December 1, 1904, p. 69.)

During the past ten years the imports of raw rubber into the United States have nearly doubled. If we use the official customs returns for the fiscal years ending June 30 the comparison is as follows:

	Pounds.
1893–94	33,737,783
1903–4	59,015,651

Meanwhile, the imports for consumption in other countries have probably increased at a corresponding rate.

An old axiom avers that supply regulates demand, but in regard to rubber we already have an overdemand, and it is the supply that the manufacturers are seeking. The greater the supply, the more numerous will be the uses to which rubber will be applied, and we are assured by both scientists and business men that such a thing as overproduction is impossible. In view of this fact, a large number of companies have in recent years become interested in the establishment and commercial exploitation of various rubber-producing trees.

RUBBER AND GUTTA YIELDING SPECIES.

Of the large number of rubber and gutta yielding species especially fitted for tropical cultivation, M. A. Godefroy-Lebeuf, an eminent French horticulturist, in his Catalogue of Economic and Ornamental Plants, cites:

Landolphia kirkii: Zanzibar rubber.
Landolphia owariensis: Casamance rubber.
Landolphia klainii: Fernand-Vas (French Congo) rubber.
Landolphia sp.: Dubreka (west Africa) rubber.
Landolphia tomentosa: Conakry (west Africa) rubber.
Urceola esculenta: Burma rubber.
Urceola elastica: Borneo rubber.
Manihot glaziovii: Ceara rubber.
Euphorbia sp.: Fort Dauphin (Madagascar) rubber.
Vahea madagascarensis: Diego-Suarez (Madagascar) rubber.
Tabernaemontana sp.: West African tree, with fruit-yielding rubber.
Kickxia africana: Lagos rubber.
Kickxia latifolia: Kassai (Congo) rubber.
Ficus elastica: Assam rubber.
Ficus vogelii: Conakry (west Africa) rubber.
Ficus rubiginosa: Australian rubber.
Castilloa elastica: Central American rubber.
Hevea confusa: Brazilian rubber.
Hevea brasiliensis: Para rubber.
Hancornia speciosa: Pernambuco or "Mangabeira" rubber.
Sapium biglandulosum: Tolima (Colombia) rubber.
Sapium thomsonii: Another Colombian species.
Willoughbeia firma: Malaysian rubber.
Willoughbeia edulis: Laos (China) rubber.
Chonemorpha macrophylla: An ornamental plant from India.
Isonandra gutta: Gutta-percha.
Payena leerii: Gutta-sundek.
Mimusops balata: Balata.
Achras sapota: Chicle. (India Rubber World, Vol. XXIII, No. 1, 1900, p. 14.)

GRADES OF CRUDE RUBBER.

INDIA RUBBER.

"India rubber or caoutchouc consists of the dried coagulated milky juice of various trees and shrubs, belonging chiefly to the natural orders *Euphorbiaceæ*, *Moraceæ*, *Artocarpaceæ*, and *Apocynaceæ*. Although a milky juice is found in plants of many other families, it does not in all cases yield caoutchouc, nor do different species of the same genus yield an equal quantity or quality of that substance. On the other hand, there are many plants which afford a good rubber, but have not yet been sought out for the commercial purposes.

"* * * Caoutchouc differs from other vegetable products of like origin by possessing considerable elasticity, by being insoluble in water or alcohol, alkalies, and acids (with the exception of concentrated nitric and sulphuric acids). Although apparently simple in constitution, it contains not only the elastic substance to which its commercial value is due but a small quantity of an oxidizing, viscid, resinous body soluble in alcohol. This latter substance varies in quantity in different kinds of rubber, those containing the smallest amount, such as Para and Ceara, being considered the most valuable, while those in which it is present in greatest proportion, such as the Guatemala and African rubbers, are the least esteemed." (From Encyclopedia Britannica.)

CAUCHO.

"Caucho is a distinct sort of a rubber, inferior to the Para. * * * It is not cured by smoking, but by the admixture with the milk of lime, potash, or soap."

BALATA.

"In character this gum occupies a position between india rubber and gutta-percha, combining in a degree the elasticity of one with the ductility of the other, and freely softening and becoming plastic and easily molded in hot water. The milk, diluted with water, is said to be drunk by the natives as a substitute for cow's milk. Balata is dried ordinarily by evaporation. A more rapid coagulation is effected by the use of spirits of wine. Alum and sulphate of aluminum are sometimes used to coagulate, but are not very satisfactory. The gum is sometimes mixed during the gathering with the milk that produces gum known as Touchpong and Barta-Balli. Balata shrinks in washing from 25 to 50 per cent. It is used principally in the manufacture of belting and for insulation work. It has also been utilized for golf balls and as a substitute for india rubber in dress shields.

GUTTA-PERCHA.

"Gutta-percha, which was introduced into Europe from Singapore in 1843, was for a while confounded with india rubber, from which it differs in some very important particulars. It becomes soft and plastic on immersion in hot water, retaining the shape then given it on cooling, whereupon it becomes hard, but not brittle, like other gums. India rubber, on the other hand, does not soften in hot water and retains its original elasticity and strength almost unimpaired. The water, as such, exercises no softening action on gutta-percha, the effect being purely one of temperature, which may equally be produced by hot air, only somewhat more slowly. The degree of heat required depends upon the quality of the material, but even the hardest kind becomes plastic above 150° F. Heated in air considerably above the boiling point of water, gutta-percha decomposes and finally ignites, burning with a luminous smoky flame and emitting a pungent odor, resembling that from burning rubber.

"A curious characteristic of gutta-percha is that when it is softened in water, although it is so plastic that it will reproduce the most delicate impressions, it will bear blows from hammers or allow itself to be thrown against a stone wall without being marred." (From Crude Rubber and Compounding Ingredients, pp. 27, 228, by Henry C. Pearson.)

CEARÁ RUBBER (MANIHOT GLAZIOVII).

SOUTH AMERICA.

"The cultivation of Ceará rubber (Manihot glaziovii) was begun in Nicaragua about four years ago. The splendid condition of the plantings and the large yield and excellent quality of the product taken in trial tappings give promise of the success of the enterprise. The Ceará rubber tree is a dry-land plant and will not prosper in a wet soil. In congenial climatic conditions and soil, its early and abundant product and excellent quality make it profitable to plant. The location in which it is being planted in Nicaragua is a part of the districts of La Paz and Momotombo, where the Momotombo Mountain, by driving the clouds to one side, protects this section from the force of the tropical rains, so that it is comparatively dry, receiving just about enough water to grow corn, which is abundant, and for Ceará rubber. The soil is sandy, with an admixture of a very little clay, and very deep or slightly rolling. The elevation above the sea is some 300 feet. The section is traveled by the Nicaragua Central Railroad. The plantation of the San Nicolas belongs to the Nicaragua Rubber Company, and on it are the oldest and largest trees in this section. Three-year-old trees on this plantation measure 26 inches in girth 3 feet above the soil, and are over 30 feet high.

"That Ceará rubber will yield at 2 years of age has been proved on the San Nicolas and neighboring plantations. Twenty-one trees, from 14 to 21 months, with an average age of 14 months, were tapped and together gave 7½ pounds of dry rubber. A tree 15 months old gave 3 ounces of rubber. Many trials have been made, with like results. Still, it is not intended to tap until the trees are 4 years old, in order that they may retain their best development. It is expected that 4-year-old trees will produce 1 pound of rubber per tree, and from that time the product will augment rapidly. There are now in the district, outside of native plantings, four American plantations of Manihot glaziovii, the San Nicolas, La Victoria, El Americano, and El Triunfo, on which are planted some 200,000 trees, while as many more will be planted in another year." (Report of the San Nicolas Plantation, Nicaragua, South America. India Rubber World, Vol. XXVII, No. 3, Dec., 1902, p. 80.)

"* * * Being familiar with the *Manihot glaziovii*, the rubber of Ceará, Mr. Adler decided that this location (La Paz), in Nicaragua, was well suited for it and purchased 1,000 acres of land there under the name of La Victoria plantation. In February, 1902, work was begun on the clearing of the undergrowth on 300 acres, and in the last week in April the ground was burned over. After the first rains in May, 60,000 seeds were planted, mostly at stake, and the rest in a nursery. During June many of the seeds began to sprout and the seedlings had been appearing daily up to the time of Mr. Alder's writing (November 6). At that date the seedlings, which had first appeared being 5 months old, were 10 and 12 feet in height and 3 to 4½ inches in girth 6 inches from the ground, which Mr. Alder considers 'extraordinary growth even for the Manihot glaziovii.' So rapid was the growth of the plants in the nursery that many had to be transplanted at the age of 4 weeks, instead of being allowed to remain in the beds for a year, as originally intended. Mr. Adler has found the best results from allowing the sun's rays full access to the rubber plants, for then the trunks became full and strong, whereas if any other growth is allowed around the young plant, they grow slender and lack strength to support the weight of the leaves." (Report of La Victoria Plantation, La Paz, Nicaragua, South America. Indian Rubber World, Vol. XXVII, No. 3, Dec., 1902, p. 80.)

"* * * The United States consul at Sergipe (Brazil) mentions that in 1898 the State appointed a commission to report upon the introduction of the Ceará variety of rubber for cultivation, should it prove advisable. The commission visited Ceará, where the manicoba rubber trees were originally found wild and are now under extensive cultivation, and as a result of their investigation manicoba has been planted in various parts of Sergipe. The consul has seen two plantations, one with about 17,000 trees and the other with more than 20,000, both 3 years of age and apparently in a flourishing condition. Manicoba is grown from seed, planted at the commencement of the rainy season, 12 to 15 feet apart, usually three seeds to a hill, the most vigorous resulting plant being left to stand. Some planters file one end of the hard seed (which resembles the seed of the castor bean) to assist germination; others soak the seeds before planting; but generally the seed is planted without previous preparation. It is said that the plant will grow on run-down sugar lands. It is cultivated on the sandy soils of Ceará, but it doubtless will succeed best on good farming soil. The tree requires little attention, in many places the soil receiving no cultivation, and reaches a height of from 12 to 36 feet in four to six years. It yields rubber at a very early age, the average stated at about two and a half years from planting, when from 7 to 35 ounces of rubber may be obtained by removing from the trunk a V-shaped piece of bark, to the lower angle of which a small vessel is placed to collect the latex. Coagulation is assisted by smoking, as in the case of Para rubber, though the latex will coagulate spontaneously in the air. The cost of planting and gathering the initial crop is stated to be less than in the case of coffee, sugar, or cotton, while the profit is greater, and the consul believes that the new industry will become important." (India Rubber World, Vol. XXVI, No. 5, Aug., 1902, p. 352.)

CASTILLOA ELASTICA—THE CENTRAL AMERICAN RUBBER TREE, MEXICO AND SOUTH AMERICA.

RUBBER CULTURE.

[By O. F. Cook, Bureau of Plant Industry, United States Department of Agriculture.]

"The culture of the Central American rubber tree has passed the experimental stage, in the sense that the practicability of the agricultural production of rubber has been demonstrated; but, on the other hand, it has been ascertained that the tree may thrive where it will yield little or no rubber. Under favorable natural conditions the culture of *Castilla elastica* (the spelling *Castilla*, instead of *Castilloa*, has been adopted in Washington on account of its being the original form) bids fair to become very profitable, but the experimental determination of the factors which influence the production of rubber has scarcely begun.

"In southern Mexico and Central America, the regions well adapted to the culture of *Castilla* are much more limited than has been supposed. The presence of the wild *Castilla* trees is not a sufficient evidence that a locality is suited to commercial rubber culture.

"Differences in the rubber yield are due not merely to the existence of different species and varieties of *Castilla*, but are also controlled by external conditions. The functions of the rubber milk in the economy of the plant are not well understood or agreed upon by botanists; but there are numerous reasons for holding that in *Castilla* and many other plants it aids in resisting drought.

"A continuously humid climate is not necessary to the growth and the productiveness of *Castilla*. The indications are rather that the quantity of milk and the percentage of rubber are both increased by an alternation of wet and dry seasons. In its wild state *Castilla* does not flourish in the denser forests, but requires more open situations. It is confined to forest regions only by the perishability of its seeds. *Castilla* thrives better when planted in the open than in the dense forests; even young seedlings are not injured by full exposure to the sun, providing that the ground does not become too dry. The planting of *Castilla* under shade or in partially cleared forests is to be advised only on account of special conditions or as a means of saving labor and expense.

"The loss of the leaves in the dry season may be explained as a protection against drought, and does not indicate conditions unfavorable to the tree or to the protection of rubber. The falling of the leaves of *Castilla elastica* in the dry season renders it unsuitable as a shade tree for coffee or cacao. In continuously humid localities, where the leaves are retained, shade trees are superfluous and the yield of rubber declines. The desirable features of shade culture, the shading of the soil, and the encouragement of tall upright trunks are to be secured by planting the rubber trees closer together, rather than by the use of special shade trees. Planting closer than 10 feet, however, is of very doubtful expediency. The percentage of rubber increases during the dry season and diminishes during the wet. The flow of milk is lessened in dry situations by inadequate water supply, but at the beginning of the rains such trees yield milk much more freely than those of continuously humid localities. The claim that more rubber is produced in the forests or by shaded trees seems to rest on tapping experiments made in the dry season.

"Continuous humidity being unnecessary, the culture of *Castilla* may be undertaken in more salubrious regions than those in which rubber production has been thought to be confined; the experimental planting of *Castilla* in Porto Rico and the Philippines becomes advisable, but extensive planting in untried conditions is hazardous. No satisfactory implement for tapping of *Castilla* trees has come into use. Boring and suction devices are excluded by the fact that the milk is contained in fine vertical tubes in the bark, which must be cut to allow the milk to escape.

"In British India it has been ascertained that the Para rubber tree may be repeatedly tapped on several successive or alternate days by renewing the wounds at the edges. The yield of milk increases for several tappings and the total is unexpectedly large. It is not yet known whether multiple tapping is practicable with *Castilla* or whether this new plan may not give the Para rubber tree a distinct cultural advantage over *Castilla*.

"The gathering of rubber from trees less than 8 years old is not likely to be advantageous; the expense of collecting will be relatively large, and the quality of such rubber is inferior, owing to the large percentage of resin. The rubber of *Castilla* is scarcely inferior to that of *Hevea*. The supposed inferiority is due to substances which can be removed from the milk by heat and by dilution with water." (India Rubber World, Vol. XXIX, No. 1, Oct., 1903, p. 3.)

"* * * No cultivated rubber has yet been produced in quantities in tropical Mexico. On the other hand, rubber trees have for some years been grown experimentally. These tests have already established two important facts: First, that conditions are favorable to the rapid growth of cultivated rubber plants, and second, that the rubber trees will yield marketable rubber. The general conditions favorable to the cultivation of rubber, namely, a well-drained soil without shade, have also been determined.

"From estimates obtained from various American planters in Mexico, the lowest yield for cultivated rubber trees at different stages is as follows:

"Average 6-year-old tree will produce without injury 4 to 6 ounces of rubber.

"Average 7-year-old tree bled to death will produce about 1 pound of rubber.

"Average 8 to 10 year-old tree will produce without injury at least 1 pound of rubber.

"The planting on the Rubio plantation in 1902 amounted to 1,499 acres, on which, allowing for failures, there are now estimated to be 1,600,000 plants. It is noted that the height of the trees grown from seeds—about 65 per cent of the whole—is greater than that of transplanted or replanted trees. The planting in 1903 amounted to 520 acres, on which, after again allowing for failures, there are 595,000 plants. The number of plants, of course, is much greater than will be allowed to stand permanently, but it has not yet been decided at what age to begin thinning out." (Report of the official inspector, Tehauntepec Rubber Culture Company, Mexico, India Rubber World, Vol. XXX, No. 2, May, 1904, p. 271.)

"* * * The hardiness of the *Castilloa elastica* tree simplifies its culture very much, and as it possesses a vitality superior to that of the weeds or of any other kind of vegetation, it does not require heavy expense for frequent weedings. If, without any help from man, such trees can grow for hundreds of years in wild woods full of vines, briers, and many other plants, under cultivation they can certainly outlive the weeds.

"* * * The time required to produce gum from this tree depends upon the locality, rainfall, and methods used for cultivation. My estimates of production and tapping age are based upon my personal experience and close observation, and not upon what others have written. The cultivated rubber tree blossoms after the sixth year, and can not be tapped before this time without injury. The rainfall of the previous year generally determines the earliness of the season and the number of the blooms, the quality of the seeds, and the flow and quality of the milk itself.

"The sap furnished by a 7-year-old rubber tree should yield a minimum of 1½ pounds of pure rubber, and as every tree increases its yield by no less than one-half pound of gum annually until its 25th year of age, at least 15 to 20 pounds of pure gum should be obtained yearly thereafter during the life of the tree. So an acre of land containing 220 rubber trees, planted 14 feet apart each way, will give at the end of the sixth year—or, to be more exact, in the first crop made during its seventh year of existence—330 pounds of pure rubber, which, at the rate of 50 cents gold, would give a revenue of $165. If this estimate of 1½ pounds per tree should not seem conservative enough, let it be 1 pound to the tree, and the return per acre will be $110." (Chas. G. Cano, C. E., Mexico. India Rubber World, Vol. XXIV, No. 5, August, 1901, p. 322.)

"An exact record was made of the results of some recent tapping of rubber trees (*Castilloa elastica*) on the San Miguel plantation, owned by the Tabasco Plantation Company, located on the Macuspana River, in the State of Tabasco, Mexico, which are summarized below. There are on this estate about 400 large rubber trees, which were planted in the shade of 'mother' trees (not rubber) planted for shading the coffee while the rubber was getting a start.

"The rubber trees on this plantation are of the variety known throughout Mexico and Central America as *Castilloa elastica*. This variety is divided into two classes, the first of which is known as the yellow rubber tree, *Hule amarillo*, this being the male. The milk from these trees flows very freely, having a fresh yellowish color. It flows so freely that there is scarcely any left in the cuts after tapping. The other variety is known as the white rubber tree, or *Hule blanco*, this being the female.

"A fact well known to the rubber planters is that trees planted in the shade require a much longer time to attain their maturity and full size than those planted in the sun. In fact, the most casual observer could not fail to notice the astonishing difference in size between the trees grown in the sun and those in the shade. It is believed that the size of a rubber tree has more to do with the amount of rubber it will produce than its age.

"The first step in tapping a rubber tree is to clean a small place around the tree, a small gash then being made in the bark with the point of a machete and a leaf inserted therein, which serves at a spout to run the milk into pails. From this point the cuts are made upward at an angle of 45 degrees and extending in each direction a sufficient distance to include three-fourths of the circumference of the tree. Directly above this, a distance of 1 meter, another cut is made exactly like the first, the milk flowing down the side of the tree into the first cut and on into the pail. These cuts are repeated on the entire body of the tree, or until the branches are encountered. You will at once see that all the milk has not been secured, but a sufficient amount left to maintain the tree in good condition for another year. The next tapping, which will be made a year from now, will be made on the same side of the tree, 3 inches above the cut made this year, and the following year 3 inches above that, so that it will be possible to make 13 tappings on one side, or 26 on both sides; or, in other words, a tree can be tapped twenty-six years without retapping the old cuts. The instrument used by the native is a machete, or long knife. The bark of a 10-year-old rubber tree is about three-fourths of an inch thick.

"The milk, gathered in pails, is taken to the rubber-drying house, where it may be converted into rubber through either of the following processes, both of which we have used:

"First, it is spread on a cement floor to a depth of three-fourths of an inch, this floor being so situated that the milk is constantly in contact with the sun's rays, thus drying very rapidly. After it is dry, the sheets are rolled up into convenient sizes for shipment.

"The second process is through coagulation with a native vine known as 'bejuco de necta.' During the coagulation the rubber is left porous, and as it contains more or less water, it is necessary to remove same by using a press. It requires more time to prepare rubber by the first process. The average shrinkage in converting milk into solid rubber is 2.3; or, in other words, 2.3 pounds of rubber milk will make 1 pound of rubber. I have personally attended to the tapping, and the figures given herein are absolutely correct.

Age.	Number of trees.	Average girth.	Latex.	Rubber.
		Inches.	*Ounces.*	*Ounces.*
7 years	257	30.80	11.80	9.30
8 years	14	37.75	20.70	14.25
9 years	7	40.14	21.23	18
10 years	4	43.25	26.75	17.50
12 years	21	50.50	40.50	28.90

"Based upon the above figures, the rubber product from an acre of land containing 200 trees, 7 years old, would be 112 pounds; at 8 years old, 174 pounds; at 9 years old, 240 pounds; and at 12 years old, 314 pounds." (India Rubber World, Vol. XXVII, No. 1, Apr., 1903, p. 225.)

THREE VARIETIES OF CASTILLOA.

"* * * In planting *Castilloa* it would appear that great care is required to make sure that the seeds or seedlings obtained are really those of the best variety of *Castilloa elastica*. It appears that there are at least three varieties of this *Castilloa*, which are respectively distinguished as *Castilloa alba*, *Castilloa negra*, and *Castilloa rubra*. There is not the slighest difference between these three varieties as regards the general form of the tree and its branches, and also the flowers and seeds are in all three apparently identical. The above descriptions refer to the color of the bark. The difference even there, however, is so small that it takes a practiced eye to recognize the different varieties. These differ, nevertheless, very greatly in their value to the rubber planter.

"*Alba.—Castilloa elastica alba* produces a thick creamy milk. It is the hardiest of all *Castilloa* trees, and suffers very little from the tapping operation. It also yields the greatest quantity of rubber. The bark of this variety is white, with a distinct yellowish or pinkish cast.

"*Negra.—Castilloa elastica negra* is characterized by a very rough, dark bark. It yields very rapidly a thin milk, producing a good rubber, but the tree in tapping easily bleeds to death.

"*Rubra.—Castilloa elastica rubra* has a reddish bark, which is very smooth, thin, and brittle, nor does it show the longitudinal furrows which are noticeable in the two first-named trees. This variety yields a very small quantity of milk, but the rubber obtained from it is good. The tree is very common all over Central America, and I am afraid that, in a number of instances, it was this tree which was planted instead of the white *Castilloa*. Indeed, Kosschney is inclined to think that it is this variety with which the experiments in the botanical gardens of Ceylon and Java were made, which gave such discouraging results." ("Castilloa: Its description, yield, etc.," by Dr. C. O. Weber. India Rubber Journal (London), Vol. XXVIII, No. 5, Aug., 1904, p. 229.)

CASTILLOA ELASTICA IN THE EAST.

The tree.—"The real *Castilloa elastica*, or one of the right species, appears to be grown in Ceylon. There are several indications that point to this. We have the peculiar type of great size, with its back covering of short brown hair, the so-called 'dimorphism' of the branches, which consist in the branches which start from the trunk in a downward slope at a certain point taking a turn to a horizontal and then upward direction, and the color of the bark seems correct. The result of tappings made to date in Ceylon prove conclusively that all the trees so far experimented on contain latex capable of coagulation and resultant good rubber, and the variety of *Castilloa* entirely devoid of latex, of which we have been warned, appears so far to be absent from Ceylon. It is impossible to say definitely at present that we have the very best variety of rubber-yielding *Castilloa elastica*, as so little is known on the subject, but that we have one of the well-yielding varieties I am convinced.

Where to grow Castilloa.—"Subject as all my remarks in this paper must be to the somewhat extreme limitation of our present knowledge of *Castilloa*. I advance with confidence the opinion that this species of rubber requires very deep soil, with the best of drainage, and of a rich, loamy character, and consider it speculative to a degree to plant it under less favorable conditions. We have ample evidence at the Henaratgoda Gardens, and to some extent at Peradeniya also, of the fact that in shallow or ill-drained soils *Castilloa* will not grow to pay, if it grows at all. One of two things will happen; either the young plants will refuse to come away at all; or, flourishing for a certain period which may extend for some years, it will eventually be checked in growth and become weakly, diseased, quite useless for rubber-collecting purposes, which will assuredly kill it outright if attempted.

"The elevation at which to grow *Castilloa* I would put at 1 000 to 1,500 feet. Tried at sea level, and in Kalutara at a little above sea level, it refuses to grow after reaching a height of some 10 or 15 feet. Up to this the young plant appears as healthy as in higher elevations but the check is inevitable and the tree may as well then be cleared out as only cumbering the ground. I therefore take the desiderata for successful growth of *Castilloa* in the East at any rate, to be:

"1. Rich, free soil of considerable depth, with good drainage.

"2. Elevation of from 1,000 to 1,500 feet, with some latitude at either end, but for perfection of growth I would favor about midway between the elevations given.

"The *Castilloa* root descends to great depths and hence the necessity for deep soil, for I take it the 'tap' root here is of much importance in relation to the latex-bearing powers of the tree.

"As regards situation and lay of land, I would favor undulating ground, but attach no particular importance to this. The *Castilloa* is a very robust tree and survives serious injury, so that it may be planted, even where subject to much wind, though this will to some extent retard the growth. For reasons given later in this pamphlet, the best conditions of climate for the growth of *Castilloa* and its success as a revenue-earning power would appear to be where wet and dry seasons alternate in well-marked divisions. A constantly humid climate, such as would suit Para, is not desirable. *Castilloa* likes drought, and I have seen it at the end of three months without rain in as healthy and luxuriant a state as can be desired. *Castilloa*, where conditions are favorable, is a tree of very rapid growth, reaching in three or four years' time to a height of some 30 feet, with a girth of 25–30 inches. These are actual measurements taken in Ceylon.

"THE SEED OF NURSERIES AND PLANTING.

"The seed of the *Castilloa* tree was at one time considered to be very perishable indeed, but experience has proved this is not the case, and packed in charcoal it may be sent long distances with safety. It is important, however, that the seed be extracted from its red fleshy covering the same day as picked and at once properly cleaned. Treated thus, as an experiment in planting, seed two months after picking resulted in an outturn of 80 per cent. It is essentially a hardy seed, and where the product of the trees is grown under the favorable conditions I have enumerated above, a very large percentage of plants from the seed laid down may be counted on with confidence. I emphasize this point, as it is of very much more importance to success than that usually laid stress upon by intending purchasers who inquire, 'What is the age of the parent tree?'

"In my own experience I have known of two cases, in one of which the parent trees are from 12 to (it is believed) 20 years of age, and the other 4 years only. The former gave a very poor outturn of plants from seed, whereas with the latter the out-turn of plants from seed, whereas with the latter the outturn was practically 100 per cent, or no vacancies, and the plants most healthy. I see no reason for this but the fact that the older tree was grown in ill-drained land near a sluggish stream as against in the other case, ideal conditions of soil and drainage. Early seeding in *Castilloa* is no sign of weakness, as would be the case with many species of trees, but on the contrary, a sign of vigorous growth.

"The seed is small, being about half the size of a filbert, and is contained in a white, papery coat. It should be well dried before dispatch. The planting in the nurseries should be in baskets under shade, good loamy earth being used. Squirrels are fond of the young plants and nip off the roots to some extent but this by no means kills the plant attached which grows up again from below. The planting out can be done when a height of from 4 to 6 inches is reached.

"If care is taken to plant deep in the clearing with earth well up the stems, there will be very few vacancies and any plants that apparently die back will in most cases send up a fresh shoot from the roots. It is not necessary to cadjan shade: the young plant has been found to come on regularly and well without this expense being incurred. In my own experience dapdap or some fast-growing shade has been planted at the same time as rubbers, but I am not convinced that this is necessary, though useful as a means of keeping down weeds, to the influence of which *Castilloa* is very susceptible. Too dense shade has the result of keeping back the plants or inducing whippy growth as they reach up to the light, whereas in the open the young trees come on well. At the present time and with what experience we have I would advocate the planting of shade trees, say 20 by 20. Unlike the Para variety, the *Castilloa* does not appear to be as tempting a morsel to porcupines and cattle; some damage is done, but not much. Cocoa seems to come well, if planted at the same time as rubber, and personally I see no reason why it should not continue to flourish and to give good crops. The shade of *Castilloa* is not too dense, and being a deep feeder its roots should be well below those of the cocoa. There is considerable litter from the dropping of the large leaves peculiar to this tree, and this must assist to enrich the soil to some extent." ("*Castilloa elastica* in the East," by W. E. G. India Rubber Journal (London), Vol. XXVIII, No. 9, Oct., 1904, p. 418.)

PARA RUBBER.

"The greatest rubber-producing country of the world is the Amazon Valley, embracing many thousands of square miles of rubber forests in Brazil, Boliva, and Peru. The center of the industry is the city of Para, whence the name 'Para rubber.'

"Although chemically there is little difference between samples of rubber from various species of trees, still it is a well-known fact that Para rubber obtained from the tree *Hevea brasiliensis* is recognized as the standard for grading commercial rubbers.

"At Para rubber is classified into three grades, known in the United States as fine, medium, and coarse. The difference in these grades is governed largely by amount of transparency and care in preparation for the market." (All About Rubber, compiled by J. Ferguson, 3d ed.)

PARA RUBBER (HEVEA BRASILIENSIS).

Federated Malay States—"The latest annual report of the United Planters' Association of the Federated Malay States devotes special attention to the cultivation of Para rubber, which continues uppermost in the interest of the planters in that region. A favorable rate of growth is reported and the absence of pests and diseases among the trees. The year covered by the report was the first in which tapping had been done on a large scale, and the result was a better yield from the young trees than had been expected, and the prices realized equal to if not better than those for the finest of rubber from Ceylon. More new rubber estates were opened than in any former year, and the extension of rubber acreage on the old estates was also larger. The total acreage planted with rubber in the Far East is estimated in the report as follows:

Federated Malay States and the remainder of the Malay Peninsula	30,000
Sumatra	5,000
Java	5,000
Ceylon	25,000
India and Burma	5,000
Total	70,000

"The report says: 'We will take it for granted that this 70,000 acres is all good and that it will give a good yield of 200 pounds per acre—14,000,000 pounds. This can not all be in full bearing until the end of 1911, and no more than this 70,000 acres can be in bearing at the end of 1911, for it is not planted.'

"In view of the growing demand for rubber, while the exports from Para remain practically constant, the report takes the position that there is no reason to fear overproduction of rubber, since even the maximum output of Asia by 1911 would be hardly more than 10 per cent of the present world's consumption; but even if rubber should be overproduced some day, it is felt that Brazil can not compete with Asia with rubber at 2s. 6d. per pound, at which price Straits and Ceylon rubber can be sold at a profit." (India Rubber World, Vol. XXXII, No. 5, Aug., 1905, p. 377.)

"A rubber tree from Para seed in the Waterfall Botanic Garden, Penang (Malay States), now 17 years old, has had seven tappings, beginning in June, 1897, the total yield from which, in dry rubber, is herewith stated in detail, as reported by Mr. C. Curtis, superintendent of the garden, to the Straits Agricultural Bulletin. The aggregate is 18 pounds 7¼ ounces, an average per tapping of 2 pounds 10.18 ounces, or an average per year of 3 pounds 1.21 ounces. The system of tapping is thus described: A small perpendicular channel is cut in the bark about a foot in length and one-eighth inch broad, but not deep enough to obtain much latex, its object being merely to conduct the latex to a tin receptacle fastened at the base. This channel is not subequently enlarged or interfered with. Two or three incisions are then cut on eitherf side, leading obliquely to this channel to supply the latex. From the upper side of each of these a thin shaving of bark is removed every morning, or on alternate mornings, which causes a fresh flowing of latex. In each of these seven tappings a thin shaving has been removed thirteen times, which with the initial cutting makes fourteen operations, the whole constituting what Mr. Curtis calls 'one tapping.' Thus the times this tree has been operated upon is 7×14, equaling 98, and the average amount of dry rubber from each operation about 3 ounces. The daily amount, however, varies very much, the yield from the first two or three operations each season being almost nil. No attempt was made until the last tapping to save such rubber as may have been removed with the shavings of bark referred to, and this, Mr. Curtis thinks, would be an important item on a large plantation. A plain carpenter's chisel is considered better than a special tapping tool sent to Mr. Curtis, because a finer edge can be kept on it, and the sharper the implement the better the flow and the less the loss by coagulation in the cuts.

"This tree resulted from a tree planted in the Singapore Botanic Garden in 1885, and was one of a dozen transplanted in Penang early in 1886. It was selected for the series of tapping experiments on account of being the largest in the group.

"'It is not pretended that the results of tapping the tree is of great value as a guide to the results to be obtained from a large number, for we now know,' says Superintendent Curtis, 'that there is a great dissimilarity in the yield of trees of equal size growing side by side under exactly similar conditions. The interest in this particular tree, then, is that it has been tapped six times, * * * that it shows no sign of deterioration, that the incisions made are all healed up, and that the total yield of dry rubber during the period is stated.'" (India Rubber World, Vol. XXVII, No. 4, January, 1903, p. 11.)

TAPPING PARA RUBBER TREES, PERAK, TAIPING.

"In the annual report for 1901 on the government gardens and plantations of Perak, Taiping, Superintendent Robert Derry records his experiments in tapping Para rubber trees. The method adopted involves a vertical incision in the bark, extending from the base some 4 feet up the trunk, with 5 oblique branch incisions on each side. Mr. Derry tapped two trees, making three sets of incisions in each, each set extending over something less than one-third of the circumference of the tree, and compared the result with that from a tree cut with only one set of incisions. He is of the opinion that very little more rubber is obtained from the extensive tapping. The yield of rubber from the first two trees, of the same age and size, was 28¼ and 26⅕ ounces, respectively, while from a single set of incisions in a tree slightly older and larger, 32¾ ounces of rubber were obtained. The tapping was done in September last, the same incisions being reopened day after day, in the case of the first two trees eleven times, and in the case of the third tree eight times. Two of the trees, 10 years old, were 17 and 18 inches in diameter, respectively, 3 feet from the ground, and the third, 14 years old, was 20 inches.

"Thirty-two Para rubber trees in the Taiping garden, about 12 years old, yielded 125 pounds of dry rubber, or an average of 3.9 pounds each. It appears that the best season for tapping is between June and November. The latex seems to exude most freely in wet weather, the occurrence of whichv aries in different years." (India Rubber World, Vol. XXVII, No. 1, October, 1902, p. 16.)

THE CULTIVATION AND PREPARATION OF PARA RUBBER.

[By W. H. Johnson, a book review.]

The book opens with a general introduction on the subject of rubber. Referring to Para, the author states:

"It is estimated that there are about 12,000 acres planted with this tree in Ceylon, while in the Malay Peninsula there is a still larger area under Para-rubber cultivation. The small amount of cultural skill required to successfully plant and cultivate Para rubber, coupled with the high prices paid for the rubber which the cultivated tree produces, in comparison with that paid for other grades of rubber, has no doubt largely influenced planters in selecting the Para tree in preference to other rubber-producing plants.

"The province of Para, from which the product of this tree derives its name, is situated south latitude 1°. It is reputed to enjoy a remarkably uniform climate, with a mean temperature of 81° F., but a very moist atmosphere, and an annual rainfall varying from 60 to 90 inches.

"The tree has adapted itself to various climatic influences, and in the Gold Coast, West Africa, this tree, grown in experimental plots in the Botanic Garden, Aburi, which is situated 1,500 feet above sea level, and where the average mean temperature is about 81.5° F. and the annual rainfall 47 inches, promises better than any other rubber-producing plant, indigenous or exotic. It is likewise favorably reported upon in India, Jamaica, Dominica, St. Vincent, Grenada, Trinidad, Zanzibar, Uganda, and Mozambique.

"An experiment in packing was carried out by the Gold Coast Botanic Gardens last year, with a view to ascertain the better method for packing seeds sent from the Orient to West Africa, viz, packed with moist soil in Wardian cases, or with charcoal and sawdust in ordinary cases. Twenty thousand seeds, packed by the first-mentioned method at the Royal Botanic Gardens, Ceylon, arrived at the Tarkwa Botanic Station, Gold Coast, in November, 1903, and from these 3,400 plants have been raised; while from 30,000 seeds packed with charcoal and sawdust in ordinary cases, sent at the same time, 3,650 plants have been raised.

"Sowing the seed in bamboo pots is perhaps most satisfactory, for by this method the roots of the plants are not as much disturbed when they are transferred to the plantation as in the case where they are lifted from the nursery beds; while if seeds are sown out direct in the plantation and a spell of dry weather follows, a large number will fail to germinate. When large numbers of plants are to be raised, it is advisable to select a well-sheltered spot, possessing a rich, light, friable soil, and near the site for the plantation. On this, temporary nursery shelter should be constructed by fixing stout upright posts about 8 feet high, in lines 10 feet apart each way, and then on these cross bars—the whole sufficiently strong to support a thin layer of palm leaves, split bamboo, or some other similar material. Under this the bamboo pots should be placed.

"Bamboo pots are manufactured by sawing up bamboo into sections about 1 foot long. The bottom of the pot is formed by sawing one end of it off about an inch below an internode or division of the pole, a hole being made in the division to allow the water to drain away. A few rough stones should be placed over the hole to prevent fine soil filtering through, and the pot filled within 2 inches of the top with light, friable soil. Provided the vitality of the seed is good, one seed is sufficient to sow in each pot, and this should be placed on the soil in the pots prepared in the manner above described, and then covered with about an inch of soil. After the seeds germinate and the pots become filled with roots, more frequent waterings will be necessary. If the plants suffer from lack of water at this period, they are liable to receive a severe shock to their proper development." (India Rubber Journal (London), Vol. XXVIII, No. 12, November, 1904, p. 518.)

PARA RUBBER IN CEYLON.

[A complete account of its preparation, cultivation, etc., by Francis J. Holloway.]

"For some years the impression in Ceylon was that Para rubber would only grow in low-lying lands up to an elevation of 500 feet, and requiring more or less swampy flats. The results obtained have dissolved these theories, and now prove that Para rubber will yield in paying quantities on different soils, on hillsides up to 2,700 feet elevation. It is still an open question whether it will pay at a higher elevation than 2,700 feet. It seems to grow well on moist soils, even on a gravelly quartz, but of course it is a different thing whether it yields a paying quantity of latex.

"The only soil I found it would not yield anything on is a blue sandy soil, with more or less sandstones below the surface. In one instance I found a fine large 12-year-old tree growing on a pure blue sand, and on digging a hole beside it, I found 4 feet of sand,

and then a damp, clayey undersoil, which accounts for the tree growing through a structure of sand, and yet looking healthy and large and yielding well. It is true that it grows faster at an elevation of 500 feet, but I much prefer an elevation of 1,000 feet to 1,500 feet, as on tapping the latex, especially in the hot weather, it does not stop flowing as soon at the higher elevation; and as to yield, tree for tree, at the second elevation, of similar ages, there is nothing to choose.

"Para should only be planted on fairly good soil. It will not do very well in very stiff soil. The temperature best suited for the cultivation lies between 74° and 94° F., and the rainfall over 80 inches to 150 inches.

"Now we come to a much-disputed point—how far apart to plant. Some recommend close planting, others distant. My experience leads me to recommend about 15 feet by 15 feet apart, giving about 200 trees to the acre. I have seen rubber planted 30 feet by 30 feet, and 40 feet by 40 feet, but from results obtained in tapping, there is nothing like the extra quantity of rubber from trees planted far apart to make up for the poorer growth of close planting. Trees planted at 30 feet by 30 feet grow much faster, but 30 feet by 30 feet would only give about 4 pounds per tree in their ninth year to equal the 1 pound per tree planted 15 feet by 15 feet. This they certainly do not, but have given 1½ pounds against the 1 pound of close planting.

"Therefore, I certainly do not recommend distant planting, unless you wish to grow some other product as well, such as cocoa, and then a good distance to plant would be 30 feet by 15 feet, or even 30 feet by 30 feet, with no other shade planted.

"It will not pay to plant rubber any closer than 15 feet by 15 feet, for the trees would grow very weedy and give every inducement for canker fungus. Holes should be cut about 2 feet by 1½ feet, and filled with the top soil scraped from around the hole. Holes should be filled as soon after burning as possible in order to get the full benefit of the potash, etc.

"It is scarcely possible to tell good seed from outward appearance, as there is nothing to judge the soundness unless it is absolutely light, which can be felt by weight. Even if soaked in water, one can not tell a good from a bad seed. The only way to strike an average is to take a few seeds out of each bag on arrival and break them open and then take the average. Seed can not be sent on long journeys unless carefully packed, as they lose their vitality very soon. They can be sent on short journeys up to five days simply put in a bag. I have found packing them in damp powdered charcoal a very good way, and put up in this manner they keep up to one month, 75 per cent of them turning out sound and mostly germinating.

"From experiments made in packing in damp charcoal, and opening the boxes at periods of one, two, three, or four weeks, the results are very satisfactory. After four weeks the seed begins to grow too much to stand any longer 'imprisonment' and gets so crooked and entangled one into the other that they form on the top part of the box inside a perfect mass of roots, etc. Seed should be washed in a solution of sulphite of copper and water just before packing. In ten days seeds are above ground, and in twenty days they are nearly 10 inches in height. About 5,000 seeds is nearly 50 pounds. Usually the seed is dispatched for local sale in bags of 5,000, which just weigh 50 pounds—one cooly load. A fresh seed has a very oily feeling outside, and when the seed has fallen off the tree for a few days this oily, smooth feeling disappears and the outer covering gets a dark-brown color and is rough to the touch. The seeds hang in clusters of three in one; each is divided from the other by a hard shell about one-sixteenth of an inch thick.

"About February the blossom appears and has a very sweet smell, reminding one of 'Lankas spicy breezes,' and the buzz of the bees can be distinctly heard all day long as one walks underneath. About the 28th of July the first seeds begin to ripen. The outer shells are perfectly green when unripe and become quite brown when ripe. If it happens to be wet at the time the seed is ripe, not a single one will fall down until the sun appears, and then shortly after a few hours' sunshine you can hear crash, crash, crash, all over the place, especially if there is any iron roofing close at hand. They make quite a noise when they burst open the shell and fall down—on a fine night, after a hot day's sun, they will fall all the night through.

NURSERIES AND PLANTING.

"A good piece of land should be selected for the nursery, fairly flat and with water at hand. First, the jungle growth should be cut down, and, when thoroughly dry, set fire to, to get a good, even fire. This will kill all the insects, etc., and at the same time benefit the soil.

"Secondly, the whole plat should be well turned over to a depth of about 15 inches, and all stumps, roots, and stones taken out and other lumps broken up and made fairly smooth. The plat should then be divided into beds, say about 20 feet by 4 feet, with a drain in between. This drain should be about 1 foot deep and wide. After this the beds should be smoothed off and made ready for the seed. Coolies, armed with small stakes about as thick as the thumb and silghtly pointed, press this tool into the soil about 6 inches apart and just deep enough to put the seed in, and then cover it with soil for about one-half inch. The best way of laying the seed is on its side, as it is not easy to see the germ and it should be laid thus and the root will work down into the soil and leave the shoot to grow upward.

"If plenty of good nursery land is available, the farther apart the seed is planted the better the growth of the plant up to 1 foot by 1 foot. Seed planted 6 inches by 6 inches should grow to an average height of 6 feet in ten months. I have known trees planted in a prepared hole with manure to grow 10 feet in twelve months. The nursery should be well protected, as the young plants are attacked by all kinds of insects and animals, especially rats, which burrow beneath the roots and bite off the shoots under the surface; but, on the whole, the damage done is very small. Nurseries should be most carefully protected from the sun by putting on a good cover about 2 feet above bed, as the germination of the seed will depend on the care taken of them during the first ten days. They should be well watered twice daily. At the end of a month the cover of the nurseries should be gradually taken off. By the end of two months no shade is required and the plants will grow all the better in the open sunshine. Rubber plants after two months in the nurseries do not require any shade, and I have seen whole nurseries badly affected by allowing the cover to remain on.

"If plants are put out, first the prepared hole should be slightly trampled upon, and then a stake about as thick as the thumb and 3 feet long forced into the center of the prepared hole and staked round; the plant put in carefully to the same depth as it was in nursery and the soil pressed against the tap root by pushing the stick into the hole somewhat at an angle and pressing toward the plant and trampled round with the naked foot. Great care should be taken that the tap root is put in straight, and not curled up, as probably the yield of the tree will depend mostly on the depth of the tap root.

"If the estate is kept free from all weeds, etc., few pests will trouble the young plants. Wild animals, such as the pig and porcupine, and even the hare, will attack the plants, but to no great exent if well looked after. Plants require care until they are about 6 feet in height, and then they grow on without much trouble. Near the edge of the jungle, a good plan is to tar the lower 2 feet of all plants, as porcupines, etc., will not touch them if this is done now and again." (India Rubber Journal (London), Vol. XXVII, No. 10, May, 1904, p. 471.)

PARA RUBBER TAPPING, CULLODEN, CEYLON.

"The plantation Culloden, Ceylon, is primarily for tea, the rubber having been planted later through the tea and also in some of the valleys. The land is very rocky, ironstone abounding, but there must be something in the soil that suits the *Hevea*, for it flourished wonderfully. The only place where it did not appear to do well was in very low ground, where there was no drainage. The swampy portions of the land have, therefore, been thoroughly drained; indeed, where some of the 7 and 8 year old rubber now is there had once been a bog where cattle were wont to get mired. The rubber on this soil, which was very rich, had some 3 feet of drainage.

"* * * The tapping of the trees begins just as soon as it is light in the morning, for through the middle of the day the latex does not flow freely, but starts up again apout 4 in the afternoon and is continued until dark. The trees are tapped when they show a girth of 2 feet, without regard to their age. No ladders or supports are used in tapping as it was not found profitable to tap higher than a cooly can reach while standing on the ground. The tool is a very simple V-shaped knife with two cutting edges and a single slanting cut about 8 inches long has been found to be best, a tin cup being placed under the lower end of the cut and held in position by forcing its sharp edge under the bark. These cuts, by the way, are about a foot apart, sometimes closer, and all run in the same direction, the herring-bone and V-shaped cuts being no more in evidence. The practice is also followed now of cutting a very thin shaving from one side of the cut every other day, 11 times; in other words, reopening instead of tapping. Before placing the tin cup under the cut it is rinsed out in cold water to keep the latex from adhering to the tin and also to keep it from too quick a coagulation.

"While I was there a very interesting experiment in scraping the outer bark from the trees had just been finished. The results, as far as could be determined, were such a stimulation to the lactiferous ducts that the flow was increased nearly 50 per cent. The oldest trees on this plantation, by the way, are 18 years, and have produced 3 pounds a year; by scraping the outer bark off they expect to get 6 pounds a year from each of these. There are only a few of these older trees, however, most of them being 7 or 8 years of age.

"All through the rubber orchards on this estate were hundreds of young Para trees that were self-sown; indeed, in many places they had come up so quickly as to be a nuisance.

"* * * After many experiments, the manager at Culloden has satisfied himself that only the very early morning or late afternoon are the proper times to tap, as in the middle of the day the flow of latex is almost nothing. The trees are therefore tapped from 4 until 7 a. m., and after 3.30 p. m., and as long as it is light." (Report of a visit to the india-rubber plantations of Ceylon by the editor of The India Rubber World, Vol. XXX, No. 4, July, 1904, p. 335.)

HEVEA RUBBER CULTIVATION, TAPPING, ETC.

"The *Hevea* certainly dislikes wind and flourishes best in sheltered positions. It seems to grow in the roughest, rockiest positions, and to be quite at home among rocks and bowlders in the old beds of mountain torrents. The plants are raised from seed which freely germinated sown in beds in the nurseries raised about 3 feet, and about 4 to 6 feet wide. The plants are generally put out in holes, dug in lines among the tea or in special rubber plantations, and when about a year old are known as 'stumps.

THE TAPPING OPERATION.

"The age at which tapping should be commenced is now generally considered to be 7 years. Rubber-producing latex is yielded some time before this, but the strain on the young tree, coupled with the fact that the maturer trees' latex is far richer in rubber, make the older age preferable. The bark of the tree is rough and thick, and before tapping is commenced the outer bark must be shaved off. There are several reasons for this.

SHAVING OF THE TRUNK.

"With the rough bark on, it is more difficult to make a proper incision for tapping and harder to fix the cups. If tapping were carried out on unshaven trees, much latex would be lost on the dirty bark, or only result in 'dirty scrap.' But the main reason for shaving is that it increases the flow of latex. The exact use of the latex to the tree is not yet known, but the result of shaving indicates that one of its uses is to heal up wounds and renew bark. For some reason or other, the shaving greatly increases the quantity of latex in the tissues immediately below the shaved portion, and this result is found even if only a small portion of the trunk is shaved. Shaving seems to have an irritating influence on the latex, drawing a great quantity of it into the laticiferous cells immediately above the shaved portion. The tree to be tapped is shaved over the tapping surface about two weeks before tapping is to commence. On some estates the whole trunk, from base to some 6 feet up, is shaved; other planters hold that it is better to shave just those parts where the incisions are to be made; but this, of course, depends to some extent upon the system of tapping to be adopted, and is a subject for much experiment.

VARIOUS TAPPING METHODS.

"V-shaped cuts are in favor, as D in figure 1. The cuts are about 8 to 10 inches in length, and this method is highly recommended by Monsignor Collet. The herringbone system seems not to be in favor in Ceylon, a series of small V cuts being given the preference (see B in fig. 1). Another kind of cut seen on one estate is a twisted cut starting at a point and half encircling the tree, being in all about 24 inches long (as C in fig. 1), but this plan of tapping is not continued. On two estates, leading rubber estates, the method adopted is what, for want of a better name, I will term the 'zigzag' system (E in fig. 1). It consists of a cut 6 inches long, at angle of 45° with the perpendicular, then a vertical cut of 2 inches, and then another of 6 inches cut parallel to the first. A series of these cuts is made down the tree, the initial point of each cut being on a level with the final point of the cut above. For the second day's work a fresh cut is not made, but the lower side of each 6-inch cut is simply pared with a gouge. By those who use this method it is greatly recommended, and the results obtained certainly seem good. This paring of the lower side of the cut, instead of a new incision, might well be extended to other methods of tapping also, and seems to be economical in taxing the bark-renewing resources of the tree, while the flow of latex from the pared portion is first rate. On the accompanying diagram (which is not exactly drawn to scale) the various methods of tapping referred to are represented, and also a method highly recommended by Monsignor Collet. This is a series of cuts in four, each about 4 inches long; the first cut one day, the next a little distance below, followed by more series until the base of the tapping area is reached; then another series of forms is begun parallel to the first one, and so on.

A GERMAN CONGRESS DISCUSSES RUBBER.

"At the second German Colonial Congress (Berlin, October 4–8) a considerable part of the programme was devoted to the consideration of topics connected with caoutchouc and the world's supply of this important commodity. * * *

"The question of the eventual overproduction of rubber was next touched on by the speaker as a matter of practical interest in connection with engaging in its culture. He quoted figures to show that at present some 60 000 hectares (148 260 acres) were devoted to rubber plantations of which 16 000 are in Ceylon, 15 000 in the Malay states, and 4,000 in Mexico. Should the yield be only 1,000 marks per hectare (at present a net profit of twice this sum is calculated on plantations of *Hevea*), within a few years a harvest would be valued at 60 000 000 marks ($14 280 000); or, if we figure the annual yield per hectare at an average of 200 to 250 kilograms of rubber, the 60 000 hectares would yield 12 000 to 15,000 tons of caoutchouc, equal to about 20 per cent of the world's total present production. It must be considered, however, that the production of wild rubber will decrease rather than increase, especially if prices should decline. At the same time a fall in prices would lead to increase in consumption. Therefore the overproduction of caoutchouc is not to be feared for a long time to come. * * *

"The speaker urged participation in rubber-planting undertakings. Hesitation, he said, meant a serious loss to the national capital in the colonies and every ton of rubber obtained in their own colonies was a material gain to the Empire in enhancing its independence of other countries. He solicited earnest support for the Kolonial-Wirtschaftlichen Komitees, which has endeavored to further rubber culture in colonial Germany, and is now preparing to send a caoutchouc and gutta-percha expedition to New Guinea. He touched upon the importance of granting valid titles to colonial lands for planting purposes as a further incentive to capitalists to interest themselves in rubber culture. He regretted that this culture had not started in the German colonies twenty years ago, in which event rubber prices might not be so high to-day, and certain recent failures of rubber factories might have been averted.

"In the ensuing discussion, further proofs were offered of the profits to be expected from rubber planting. Attacks were made, however, on the newly organized Samoa-Kautschuk Compagnie, which was accused of giving rise to too high expectations of profits. In the absence of a representative of the company, Doctor Warburg arose in its defense. He said it was surprising with what energy and intelligence this company had begun operations in securing 400 000 young plants of *Hevea brasiliensis* in Wardian cases and 700 000 seeds in various packings, for shipment from Ceylon and Malacca to the new plantation." (From India Rubber World, Dec. 1, 1905.)

"* * * The qualities vary, even from the same estate, according to the age of the trees, while yet so young. We judge that the rubber has not attained its full strength till the tree is at least 8 or 9 years old; younger than that, though good gum, it has not the strength of hard cure Madeira fine Para and is uneven in strength. There is no difference noticeable in the rubber tree from 8-year-old trees from different plantations. We have used about 4 to 5 tons in testing it from about 20 plantations. As yet it is not safe to use for the finest work, such as india-rubber thread and the best bladders, but where a 'weak Para' will do, it is all right." (From India Rubber World, Dec. 1, 1905. By P. J. Burgess, public rubber expert, F. M. S.)

COPIES OF LETTERS REGARDING PARA RUBBER SEEDS.

AMERICAN CONSULATE-GENERAL,
Singapore, S. S., December 23, 1904.

SIR: I have the honor to inclose herewith copy of letter from Mr. W. Dunman, of this city, as to prices of Para-rubber seed. Mr. Dunman is a practical planter and is here an admitted authority on rubber culture.

I have the honor to be, sir, your obedient servant,

O. F. WILLIAMS, *American Consul-General.*

The Hon. DEAN WORCESTER,
Secretary of the Interior, Manila, P. I.

SINGAPORE, *December 19, 1904.*

DEAR SIR: I have made arrangements with some of the leading planters in the F. M. S. for the supply of Para-rubber seed, and am in a position to supply selected seed from trees 5 years and over at $5.50 (silver) per 1,000, packed in boxes of 50,000 in dry pounded charcoal, delivered in Singapore.

The season is between August and November.

As there is a considerable demand, it would be as well to book orders as soon as possible, and I am prepared to do this for the next five years.

I am, dear sir, yours, faithfully,

W. Dunman.

O. F. Williams, Esq.,
United States Consul, Present.

Singapore, *March 28, 1905.*

Sir: I have the honor to acknowledge the receipt of your order for 5,000 Para seed. As the Para trees appear to be fruiting earlier than usual, I hope to be able to dispatch the lot in May or June. * * *

I have the honor to be, sir, your obedient servant,

W. Dunman.

Capt. George P. Ahern,
Chief Bureau of Forestry, Manila.

Singapore, *July 6, 1905.*

Sir: I have the honor to acknowledge the receipt of your letter of the 23d ultimo in regard to Para-rubber seed.

I have to report that the Para trees all over the Peninsula are uncommonly short of crop this year, and, in addition to this, the crop will be later than usual.

You may rest assured that your order will be sent forward as soon as ever the seeds ripen and are procurable.

I have the honor to be, sir, your obedient servant,

Dunman & Pickering.

Capt. George P. Ahern,
Chief, Bureau of Forestry, Manila.

Singapore, *September 29, 1905.*

Dear Sir: I have to advise you that I am shipping per steamship *Isla de Luzon*, leaving this 15th of October, 5,000 Para seed, which is carefully selected and packed, either in charcoal or sawdust. Please see that they are planted out into nursery at once or they will not germinate.

I find that similar seed sent to Java resulted in about 60 per cent germinating.

Should you want further seed this season, you will have to let me know promptly.

I am, dear sir, yours, faithfully,

W. Dunman.

The season has been abnormally late this year.

Capt. George P. Ahern,
Forestry Bureau, Manila.

Singapore, *October 14, 1905.*

Sir: I have the honor to advise the shipment to-day, per bearer, of two cases of Para-rubber seed, and have drawn on your Government for cost at Ex. 106—₱31.80. The documents are in the hands of the Chartered Bank.

Please see that delivery is promptly taken of the seed, and that same is planted without delay, as they go off very quickly. About 60 per cent should germinate.

Large quantities of seeds have been exported this month at very high prices (about 12). The season was very late, which accounts for the delay.

Trusting you will get satisfactory results and that you will be sending me large rders,

I am, sir, yours, faithfully, W. Dunman.

Capt. George P. Ahern,
Chief Bureau of Forestry, Manila.

LETTER TO A. DETERMANN.

Department of the Interior, Bureau of Forestry,
Manila, P. I., February 19, 1906.

Mr. A. Determann,
Baer Senior & Co.'s Successors, Manila, P. I.

Sir: I have the honor to acknowledge receipt of your letter of the 14th instant, requesting information concerning privileges to extract rubber and gutta-percha, timber, and other forest products from public lands in the Philippine Islands as follows:

Attention is invited to the following sections of the forest act:

"SEC. 13. The chief of the bureau of forestry, with the approval of the secretary of the interior, may, as herein provided, issue licenses for the cutting, collection, and removal of timber, firewood, gums, resins, and other forest products from the public forests and forest reserves. Every license so issued shall specify in detail the rights to which it entitles the holder and shall provide, whenever practicable, for exclusive territory in similar products to each licensee. All licenses for timber shall provide for the selection of said timber before cutting: *Provided*, That when absolutely necessary the selection of timber or the granting of exclusive territory may, in the discretion of the chief of the bureau of forestry, be omitted in any license terminating not later than June thirtieth, nineteen hundred and eight, after which date the selection of timber and the granting of exclusive territory, whenever practicable, shall be required.

"SEC. 14. No license granted under the provisions of this act shall continue in force for more than twenty years. The chief of the bureau of forestry, with the approval of the secretary of the interior, may, in granting any exclusive license, prescribe such terms, conditions, and limitations, not inconsistent with the provisions of this act, including a minimum amount of timber to be cut within a specified period or periods of time, as may be deemed by the chief of the bureau of forestry and secretary of the interior to be in the public interest and may provide in such licenses for forfeiture thereof in case of violation of such terms, conditions, or limitations.

"SEC. 26. Whenever an exclusive license of any class shall have been issued to any person, company, corporation, or other association for the cutting or removing from the public forest or forest reserves, of timber, firewood, or other forest products, stone, or earth, it shall be unlawful for any other person, company, corporation, or association, while such license is in force, to enter or operate within the territory covered by such exclusive license contrary to the terms thereof: *Provided*, That the residents within or adjacent to said territory may be permitted to cut or remove timber, firewood, other forest products, stone, or earth for domestic purposes.

"If, contrary to the provisions of this section, any person, company, corporation, or other association shall enter upon, and shall cut or remove, or attempt to cut or remove, timber, firewood, other forest products, stone, or earth, said property so attempted to be cut or removed shall be seized as government property by the local forest official or other representative of the forestry bureau, and the person making the seizure shall promptly notify the holder of the exclusive license affected thereby, and the said property so seized shall be surrendered to him upon the payment of the proper government charges thereon. Should, however, acceptance of said property and the payment of the charges thereon be refused, it shall be disposed of in the manner provided in section thirty-two of this act for the disposition of forest products, stone, or earth upon which the government charges have not been paid, and the proceeds turned over to the proper official to whom the government charges thereon should have been paid."

No charge is made for any class of license issued by this bureau. Government charges on forest products are imposed after said products are gathered, as prescribed in the forest act. In Mindanao the charges on timber per cubic meter range from 50 centavos up to ₱2.50, depending upon the class of timber taken. Native woods are divided into four groups. The charges on firewood are as follows: Ten centavos per cubic meter for small pieces less than 60 centimeters in length and 7 centimeters in diameter. Larger pieces of firewood are known as "rajas." They range in size from 60 centimeters to 1½ meters in length and from 7 to 15 centimeters in diameter. One peso is charged for each 1,000 rajas.

On all gums, resins, and other forest products a charge of 10 per cent on the actual market value at the place where gathered is charged.

At Cotabato, Mindanao, where a large porportion of the gutta-percha is brought to market, the price per picul of 139½ pounds is fixed at ₱70, on which the government collects 10 per cent, or ₱7 per picul. At times as much as ₱2,000 per month was collected on gutta-percha alone in this town. Very little rubber has been brought to market at this point.

All but two licenses granted by this bureau expire at the end of each fiscal year, June 30. Two licenses are for twenty years; one is for a tract in Mindoro Island and the other in the province of Occidental Negros.

A few months ago, when the last leader of hostile Moros was killed in the Rio Grande Valley near Cotabato, a number of applications for licenses to gather rubber and gutta-percha were sent in by Chinamen who were located in the town of Cotabato. These applications were not granted for the reason that this office does not wish the present methods of extracting rubber and gutta-percha to be continued. The gutta-percha trees are felled before the latex is extracted. This destructive practice would, within a few years, destroy all of the large gutta-percha trees of this valley. Recently several of the leading Moro chiefs in Mindanao have expressed a desire to assist in teaching the natives the proper methods of extracting gutta-percha. The forester in charge of the district has been ordered to give these people the necessary instructions.

In accordance with the provisions of the forest act, the undersigned would approve an application for a twenty-year exclusive privilege to gather all forest products in the Rio Grande Valley south of the town of Cotabato, provided the applicant makes a satisfactory showing that the privilege granted would be used, and that each of the forest products asked for would be gathered in quantities according to the area of the country granted.

The Rio Grande Valley is one of the most fertile regions in the world. The soil is very rich, easily drained, and easily cultivated. The foothills on each side of the valley afford a variety of elevation above sea level suitable to the planting of rubber and gutta-percha. The rainfall averages about 2,000 millimeters per year. The conditions of soil and climate and elevation seem to warrant the planting of rubber and gutta-percha on a large scale.

The applicant for a twenty-year exclusive privilege would be required to state that, in addition to fulfilling the ordinary requirements of the forest act, regulations and orders, he would make an effort to stop the felling of gutta-percha trees in his district, and that he would plant at least 250 acres of rubber and gutta-percha trees per year, until he had planted the full area of public land that an incorporated company would be allowed to purchase from the government. At present, this limit is fixed at 2,500 acres. The provision of purchase of public land has not been extended to the Rio Grande Valley at the present, but will be in the near future.

The company will not be required to plant any special variety of rubber, but will be expected to plant at least 50 acres in gutta-percha each year. The land so planted would be land that the company has purchased or desires to purchase from the Philippine government.

Every assistance will be afforded applicants in looking over the region desired. A trained forester will be placed at the disposal of the applicant for this purpose, and all data in this office concerning the region and its resources will also be made available.

The Philippine Islands comprise an area of more than 73,000,000 acres, of which less than 6,000,000 acres are under cultivation. At least 50,000,000 acres are woodlands, of which much less than 1 per cent is held by private owners.

There are large areas of public forest in the islands of Mindanao, Mindoro, Palawan, and Samar that are practically untouched and where deep, rich soil would amply repay any effort at cultivation.

The undersigned, in a recent trip across the island of Mindanao, was much impressed with the depth and richness of the soil in that region, where cut banks, more than 10 feet in depth, showed nothing but the rich, black decomposed lava, which is so wonderfully fertile. As a recent traveler recently remarked, the Philippine Islands are the richest, most fertile undeveloped regions in the Orient. These lands are awaiting cultivation, and this office will assist in any way any person or company desiring to begin operations.

Applications for licenses for the new fiscal year will be received during April, May, and June, and as all licenses are dated to begin July 1, I would suggest that your friends make an effort to take up this matter before the end of May.

Very respectfully,

George P. Ahern, *Director of Forestry.*

Copy respectfully furnished the honorable the secretary of the interior, for his approval.

Approved:

Dean C. Worcester,
Secretary of the Interior.

A FEW PERTINENT EXTRACTS FROM THE ABOVE NOTES.

CASTILLOA.

A continuously humid climate is not necessary to the growth and the productiveness of *Castilla*.

The percentage of rubber increases during the dry season and diminishes during the wet.

The gathering of rubber from trees less than 8 years old is not likely to be advantageous.

The rubber of *Castilla* is scarcely inferior to that of *Hevea;* the supposed inferiority is due to substances which can be removed from the milk by heat and by dilution in water.

Estimates from various American planters in Mexico: Yield, 6-year-old tree, 4 to 6 ounces; 7-year-old tree (bled to death), 1 pound; 8 to 10 year old tree, 1 pound.

It is believed that the size of the rubber tree has more to do with the amount of rubber it will produce than its age. Two and three-tenths pounds rubber milk produce 1 pound of rubber

Average yield.

Age.	Amount.	Number of trees.	Age.	Amount.	Number of trees.
	Ounces.			*Ounces.*	
7 years	9.3	257	10	17.5	4
8 years	14.25	14	12 years	28.9	12
9 years	18	7			

Acre at 12 years yields 314 pounds.

Three varieties of Castilloa: *Alba*, *negra*, *rubra*.

Alba is hardiest and best.

Requires very deep soil, of a rich, loamy character, with best of drainage.

Grows best at an elevation of 1,000 to 1,500 feet; at sea level refuses to grow well after reaching a height of 10 to 15 feet. The root is very deep. Robust tree; stands wind; likes drought. A rapid grower: in Ceylon has reached a height of 34 feet in four years, with a girth of 25 to 30 inches.

Seed hardy and easily packed; keeps well in charcoal.

Castilloa susceptible to weeds.

PARA.

A Para-rubber tree in the Botanical Garden at Penang, planted on poor, gravelly soil on a dry bank, was first tapped at the age of 11 years. The total yield from six tappings within the next five years yielded 16 pounds and 10 ounces of rubber.

Small amount of cultural skill required to successfully plant and cultivate Para rubber.

The tree has adapted itself to various climatic influences, and on the Gold Coast of West Africa found in Botanical Garden, Aburi, 1,500 feet above sea level; temperature, 81.5° F.; rainfall, 47 inches.

Para rubber will yield in paying quantities on different soils on hillsides to 2,700 feet elevation.

Does well at 500 feet elevation; better between 1,000 and 1,500 feet above sea level. Should be planted in fairly good soil; it will not do well in a fairly stiff soil. Temperature best suited for its cultivation, 74° to 94° F.; rainfall, 80 to 150 inches.

Distance apart to plant, 15 by 15 feet, 200 trees per acre. Holes, 2 by 1½ feet, and should be filled with top soil.

Seed should be packed in damp, powdered charcoal; may be kept a month, and 75 per cent germinate. Seed should be washed in a solution of sulphite of copper just before packing. Seed above ground in ten days; twenty days, 10 inches high. Five thousand seed packed weigh 50 pounds. Seeds begin to ripen about the last of July.

Nursery, good piece of land, broken to 15 inches, well cleared and worked. Beds 20 by 4 feet, drain between 1 foot deep and wide. Cover seed with one-half inch of soil. Lay seed on its side. Seed planted 6 by 6 inches will grow 6 feet in 10 months. Nursery should be protected from insects and rats. Plants should be protected from the sun until 2 feet above bed; should be watered twice daily. Cover should be gradually removed and at the end of two months will be found to grow better in the open.

Taproot should be put in straight and not curled up. Plants require care until 6 feet high.

Tapping.—Latex does not flow freely through the middle of the day. It is usual to tap from 4 to 7 a. m. and from 3.30 p. m. to dark. Trees are tapped when they show a girth of 2 feet without regard to their age. Not found profitable to tap higher than a coolie can reach standing on the ground.

The outer bark is scraped off to stimulate and increase flow. The bark is shaved off about two weeks before tapping it again. On some estates the whole trunk up to 6 feet is shaved; on others just where tapped.

The sharper the implement the better the flow and the less the loss by coagulation and cuts.

The best season for tapping is between June and November. The latex seems to exude most freely in wet weather.

Hevea dislikes wind and flourishes in sheltered positions; seems to grow best in roughest, rockiest positions.

Para trees develop poorly in the swampy districts of Ceylon, but prosper excellently in higher, drier locations.

Three grades of Para—fine, medium, coarse. Governed by amount of transparency and care in preparation for the market.

During the season 1896–97 the planting of Para rubber was taken up seriously in the Federated Malay States. The first tapping in this region began in 1904.

Total acreage planted in Para rubber in the Far East in 1904, 70,000 acres. Will be in full bearing in 1911, and may yield 14,000,000 pounds, hardly more than 10 per cent of present world's consumption.

The accompanying map is taken from Dr. Penoyer L. Sherman's Bulletin on "The Gutta-Percha and Rubber of the Philippine Islands."

The samples of rubber and gutta-percha gathered personally by Doctor Sherman, and the samples of rubber gathered by him and by Governor Offley, of Mindoro, and others, show that there is a wide distribution of high-grade native rubber in the Philippine Islands. The gutta-percha gathered by Doctor. Sherman was found to be of high grade.

The Para, *Castilloa*, Ceará, and Assam rubber trees have grown well in a number of places in these islands. The oldest of the three first-mentioned varieties is not over 4 years of age and not ready for tapping, but all show good growth.

There are extensive regions of unoccupied public land, from sea level to 6,000 feet elevation, awaiting the settler or company, where rich, well-drained soil, ample rainfall, and other conditions combine to make the prospect attractive to rubber planters.

HOW PUBLIC LAND MAY BE ACQUIRED.

The public-land laws allow homesteads to citizens of the islands and of the United States; the amount of land that may be taken up under the homestead act is 16 hectares (2.47 acres per hectare).

Individuals may purchase 16 hectares of land. Individuals or companies may lease 1,024 hectares of public land for twenty-five years, with privilege of renewal for the same period. Cost of lease is 50 centavos to ₱1.50 per hectare per year.

Incorporated companies may purchase 1,024 hectares of public land at a minimum charge of ₱10 per hectare. One-quarter of the purchase price is paid at time of purchase; the balance may be paid at any time within five years.

LITERATURE OF INDIA RUBBER.

Brannt, Wm. T. India Rubber, Gutta-percha, and Balata, 1900. Publishers, Henry Carey Baird & Co., 810 Walnut street, Philadelphia, Pa. Price and postage, $3.25, United States currency.

Ferguson, J. (compiler). All about Rubber and Gutta-percha, 3d ed., 1899. Publishers, John Little & Co., Singapore. Price and postage, rupees 5.

Johnson, W. H., director agriculture, Gold Coast, West Africa. The Cultivation and Preparation of Para Rubber, 1904. Publishers, India Rubber Journal, 37 and 38 Shoe Lane, London, England. Price and postage, 8s.

Pearson, Henry C. Crude Rubber and Compounding Ingredients, 1899. Publishers, India Rubber Publishing Company' 150 Nassau street, New York, N. Y. Price and postage, $5, United States currency.

PERIODICALS.

The Indian Forester, Pioneer Press, Allahabad, India. Annual subscription, Rs. 12. Single copies, Rs. 1. (3 Rs. equal $1, United States currency.)

The India Rubber World, 150 Nassau street, New York, N. Y. Annual subscription, $3, United States currency. Single copies, 35 cents, United States currency.

India Rubber Journal, London, England. Annual subscription, 16s. Single copies, 6d.

The Tropical Agriculturist, A. M. and J. Ferguson, Colombo and Ceylon. Annual subscription, $5, United States currency.

Agricultural Bulletins of the Straits and Federated Malay States, Kelly & Walsh, 194 Orchard road, Singapore. Annual subscription for European countries, 7s. To United States, not stated. Single copies, 50 cents, local currency.

The Preparation of Rubber at Mergui, Tenasserim. (Experiments at a government station in Burma.) The Indian Forester, Allahabad. XXXI, 9 (September, 1905). Pp. 530–534.

The Gutta-percha and Rubber of the Philippine Islands. By Penoyer L. Sherman, jr., Ph. D. (Published by Bureau of Science, Manila, P. I.)

Para Rubber. By Herbert Wright, Colombo, 1905.

L'Hevea brasiliensis. By G. Vernet, Hanoi, China,

O

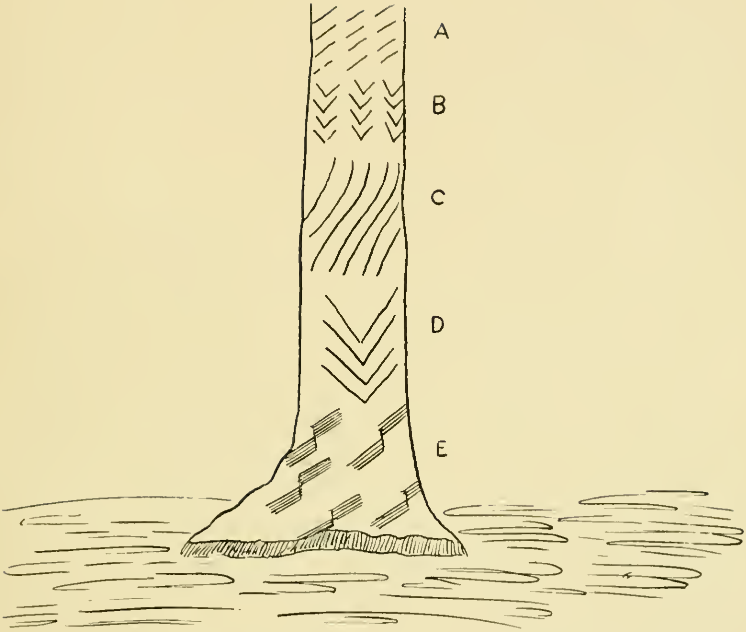

FIG. 1.—DIAGRAM SHOWING METHODS OF TAPPING HEVEA BRASILIENSIS (PARA), CEYLON.

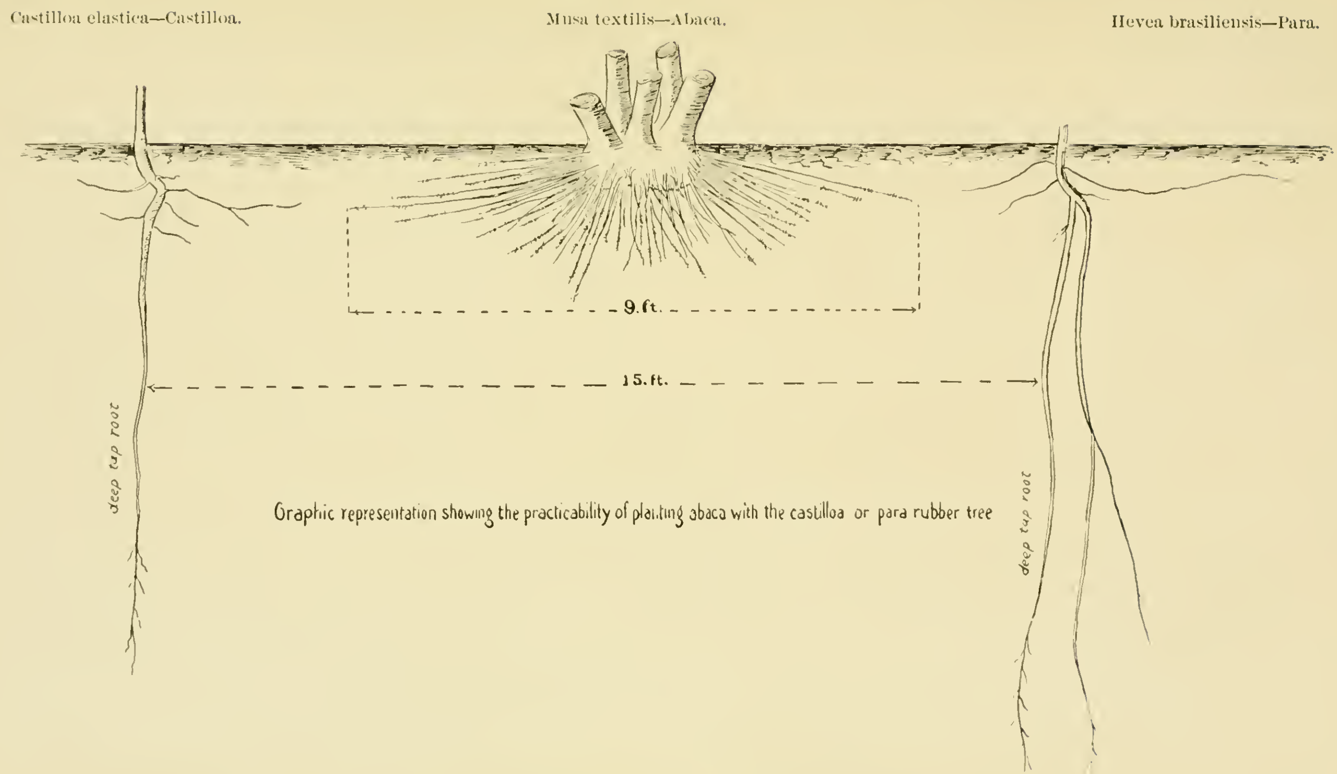
Castilloa elastica—Castilloa.
Musa textilis—Abaca.
Hevea brasiliensis—Para.
9. ft.
15. ft.
deep tap root
deep tap root
Graphic representation showing the practicability of planting abaca with the castilloa or para rubber tree

FIG. 2.