ROYAL BOTANIC GARDENS, KEW.

BULLETIN

OF

MISCELLANEOUS INFORMATION.

ADDITIONAL SERIES, VII.

SELECTED PAPERS

FROM THE

KEW BULLETIN.

III.—RUBBER.

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE.
By DARLING & SON, Ltd., 34-40, Bacon Street, E.

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PREFACE.

The object of the volumes of "Selected Papers from the Kew Bulletin," to which the present one belongs, has been explained in the preface to the first selection of the kind, which deals with "Vegetable Fibres" and was issued eight years ago.

The practical value of previous selections has been so great that the issue of the present volume, which deals with "Rubber," requires no explanation.

The arrangement of the papers here reprinted from the pages of the *Kew Bulletin* is that adopted in the selection which deals with "Fibres"; the notes and papers regarding individual rubber-yielding plants are given in the sequence adopted in the *Genera Plantarum* of Bentham and Hooker, of the natural families to which the various species belong. Those few papers, of a general character, which cannot in their entirety be allocated to particular natural families, and at the same time cannot conveniently be divided into sections, precede the more special articles.

D. P.

Royal Gardens, Kew,
August, 1906.

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ROYAL BOTANIC GARDENS, KEW.

SELECTED PAPERS

FROM THE

KEW BULLETIN.

III.—RUBBER.

I.—SOURCES OF RUBBER SUPPLY.

[*K.B.*, 1892, pp. 67–71.]

Para rubber is the produce of *Hevea brasiliensis*, Muell. Arg., a tree belonging to the natural order *Euphorbiaceae*. The rubber is obtained from incisions cut through the bark, from whence the sap trickles into small bowls and is finally cured by being ladled on to a paddle-shaped implement and held over a stove in which Urucury Nuts (*Maximiliana regia*) are burnt as the fuel. In Museum No. 1, Case 94 [now Case 105], will be found a fine series of articles used in collecting and preparing this rubber for export, and also numerous samples of the rubber. In 1891 the estimated export of Para rubber amounted to 17,700 tons, of which 6,000 tons were imported into this country.

A sample of rubber from *H. brasiliensis*, grown at Mergui, India, was reported upon in this country in 1889 as worth 1*s.* 11*d.* per lb.

Ceara rubber or "Ceara Scrap" is afforded by *Manihot Glaziovi*, Muell. Arg., a tree native of South America and belonging to the natural order *Euphorbiaceae*. The imports of this rubber into this country amounted to 180 tons in 1891. In Case 96 [now Case 106], Museum No. 1, will be found samples from Brazil, and also from plants introduced into Ceylon, Zanzibar, and Natal.

Mangabeira or Pernambuco rubber is extracted from a small tree (*Hancornia speciosa*, Gomez) of the natural order *Apocynaceae*. Specimens of this rubber are shown in Case 72 [now Case 76], Museum No. 1.

The principal source of Central American rubber is *Castilloa elastica*, a large forest tree of the tribe *Artocarpeae* of the natural order *Urticaceae*. It affords the Ule of British Honduras as well as Nicaragua, Guatemala, Mexico, and Guayaquil rubbers. The total imports of Central American, West India, Colombian, Carthagena, and Guayaquil rubbers during the year 1891 amounted to 100 tons. *See* Case 100 [now Case 115], Museum No. 1.

Esmeralda of Guiana may perhaps be afforded by *Hevea* sp. or *Sapium* sp. of the natural order *Euphorbiaceae*.

Colombian india-rubber and "Carthagena" are one and the same thing, as is pointed out in the *Kew Bulletin*, 1890, p. 149 [p. 132]. The tree yielding this rubber is *Sapium biglandulosum* of the natural order *Euphorbiaceae*, a widely spread and variable species; it is also the source of Touckpong or Cumakaballi rubber of British Guiana. Case 96 [now Case 108], Museum No. 1, contains specimens of these rubbers.

Assam rubber is the produce of *Ficus elastica*, a large tree of the *Artocarpeae* tribe of *Urticaceae*. The imports of Assam and Rangoon rubber (also from *F. elastica*) amounted to 350 tons in 1891. Specimens may be seen in Case 99 [now Case 114], Museum No. 1.

Borneo rubber is afforded by species of *Willughbeia* and *Leuconotis*, allied genera of the natural order *Apocynaceae* (*see* Kew Report, 1880, p. 43); 200 tons of this rubber were imported into this country during the year 1891. Samples will be found in Case 71 [now Case 75], Museum No. 1.

African rubber is furnished by several species of the genus *Landolphia*, woody climbers of the natural order *Apocynaceae*. The best quality from the Zanzibar coast is derived from *L. Kirkii*; two other species, viz., *L. florida* (the chief source of Mozambique rubber), and *L. petersiana* are also sources of the East African supply.

On the west coast *L. owariensis*, which has a very wide distribution, is the principal species furnishing Congo and Sierra Leone rubbers. *L. florida*, which occurs on the east coast, and *L. Mannii* also afford part of the West African supply. Liberian rubber is perhaps in part afforded by the "Abba" tree (*Ficus Vogelii*), of the *Artocarpeae* tribe of *Urticaceae*, which has already been fully discussed in the *Kew Bulletin* for November 1888 [p. 141] and May 1890 [p. 150].

Messrs. Hecht, Levis, and Kahn give the following statistics concerning these rubbers for 1891, viz.:—African imports, 4,350 tons; Mozambique, 380 tons; Madagascar, 300 tons. Case 71 [now Case 75], Museum No. 1, contains samples of these rubbers.

The following review of the sources of rubber supply from the commercial side has appeared in *The India Rubber and Gutta Percha and Electrical Trades Journal*, January 8, 1892:—

There are merchantable in New York between 30 and 40 different sorts of india-rubber, the variations determining the selection by manufacturers in the purchase of stocks, says I. A. Sherman in the *India-Rubber World*. Of course, rubber in all its variations is essentially the same, differing somewhat in the same degree as the pumpkin in South Dakota from that in New England—one large and another small, one with little flavour and the other richer in food qualities. The difference between sorts of rubber, however, is due in large measure to the methods employed in gathering the sap. It happens that the natives of the

Amazon Valley have always taken pains in the curing of rubber. While climatic conditions in that country may have had their influence upon the character of "Para," the condition in which this rubber is exported has become a prime factor in making it a favourite with manufacturers. On the other hand, some of the African sorts are so full of bark and stones as to make them almost unfit for use. At one time "Assams" were almost unmarketable in New York, the price sinking as low as 10 cents per pound, and not wanted at that. One firm, after long experimenting, discovered a chemical solution in which the rubber was washed, the process being that the bark and other impurities absorbed the chemicals, making them so heavy that they separated from the gum and fell to the bottom and away. This company made a fortune in a moderate space of time; but they put up gradually the price of Assams, from the fact of their creating a demand for that sort of rubber, until the profits became comparatively small, when they disposed of the privilege of washing to some leading rubbermen, who use the process at the present day.

Para rubber is more largely consumed in the United States than any other. It may be noted, also, that the larger share of the rubber exported from Para comes to this country. There are three grades—fine, medium, and coarse. Fine Para is the standard by which all other grades are measured; it brings the best price, and probably is more used than any other. Should it become irregular in quality in the operation of curing over the smoke of palm nuts—as when little strips of virgin gum occur in the grain—it is called "medium," and its price is lessened by a cent or two per pound.

The "coarse" is imperfect, being composed of the scrapings and refuse of the fine sorts, and sells for about two-thirds of the price of the better grade. It shrinks considerably, having much water in it, and the importer generally is in a hurry to turn it over to the manufacturer. There are again many variations in Para rubber coming from different localities on the Amazon. This subject is involved in some obscurity; but the best rubber is supposed to be found on the River Purus, a tributary of the Amazon, having its source in the Andes. Brazilians, however, are apt to believe that the locality of the best sorts is unknown to Americans, and possibly the Purus may not be the locality.

There comes from Peru, at the sources of the Amazon and its tributaries, a rubber resembling the Nicaragua sheet, and called Caucho. This rubber is very wet, and consequently shrinks very much, which is a serious drawback. It is considered a good strong rubber, and it is utilised to a considerable extent by the boot and shoe manufacturers.

Of Ceara rubber, there are three grades, numbered one, two, and three respectively. It is called a "mule gum," the significance being that it is neither one thing nor the other, it being so deficient in elasticity as to cause some to argue that it is not rubber. It is a very dry rubber, its gathering being peculiar. The tree is incised at the beginning of the dry season, and as the gum oozes from the wound it forms on the outside of the bark, to be pulled off at the end of the season. The gathering of this

rubber seems to be on the wane, for every year there is an extensive migration of Ceara people to Para, bound for the forests of the Amazon.

From Bahia and Pernambuco, in Brazil, comes a rubber of a different grade from that of Para. It is cured with alum and salt water. The Pernambuco comes in sheets, and is of a yellowish-white tinge. That from Bahia is not so good, and comes in round balls. The principal objection to it is that it is very damp, entailing a large loss to the importer from shrinkage.

Of Mangabeira rubber, there are three grades, very similar to the Bahia and Pernambuco sorts. A grade that has a red look is considered superior, and sells for 5 or 10 cents per pound higher than the others.

From Central America comes a variety of rubbers, distinctive in name theoretically, but owing to the lines of transportation centering at Greytown, and the trans-shipment at that point to New York, there is much confusion, one sort often getting substituted for another. The Pacific mail steamers gather also different varieties at Panama with the same confusion. That which comes from Nicaragua is called Nicaragua "sheet" and "scrap." The latter comes in pieces about $2\frac{1}{2}$ feet long, weighing from 10 to 40 pounds. In the gathering of rubber in the forest, around the cuts in the tree a residuum is left, which is given to the man as a perquisite, and this forms "scrap." As in the peculiar mode of gathering, it is very dry, there is little loss in shrinkage, and this quality makes it a favourite with manufacturers. It contains some bark, but not so much as the "sheet." The sheet, after it is milled and washed, is the same rubber as the "scrap." Both are cured by the use of a vine from which a soapy [? alkaline] substance is formed.

There is another grade which comes from Central America, containing a considerable amount of ashes, due to its being smoked over the latter. It comes in thin sheets $\frac{1}{2}$ to $\frac{3}{4}$ inch thick. It is a dry rubber, there not being so much loss in shrinkage; but it is not so firm as the other grades, and it is difficult to work. There also comes from Central American ports a rubber which is chiefly grown in New Granada, and is called "Carthagena strip." It is from $1\frac{1}{2}$ to 2 inches thick, and there is a great deal of sand and dirt in it. It is a black, tough rubber.

Honduras furnishes a great deal of rubber of the Tuno sort, which is found in many other sections of Central America. Guatemala ranks low in the American varieties, containing a resinous substance which gives it a tarry appearance. It comes in sheets pressed together. There is a rubber which comes from Angostura as good as Para. When cut it is found to contain little spots of white as large as a pea. Tuxpan, Mexico, once sent a fine grade of strip rubber; but as the trees have been destroyed by cutting them down instead of tapping for rubber, the imports from there are now very small. The rubber is gathered by scraping from the bark.

Guayaquil comes in large flakes or lumps of a whitish colour in the best sorts, the inferior sorts being porous and exuding a black liquid which stains the knife and hands. As in a great many "Centrals" the name is often confounded with the sorts.

Esmeralda comes from Guiana, is a strip rubber, and is also made into "sausages." Some brokers are of the opinion that very little of the real Esmeralda finds its way to America, it being almost indistinguishable from other grades. It brings a high price. Certainly little of it finds its way to Europe, brokers not quoting it there. A great deal of the rubber gathered in Colombia finds its way to the Amazon and Para.

In rubber from Asia the Assams probably take the lead, and are rated above coarse Para in price. There are three or four grades, the lower ones being very dirty and all of them requiring much washing.

There are two grades of rubber coming from Borneo. The rubber from that source was first called a gutta, on account of its geographical location, but this error was a palpable one, and soon corrected. It is a white, soft, porous or spongy rubber, the pores being filled with salt water or whey. The better grade is a fair rubber, but the second grade is often when cut almost as soft as putty and practically worthless.

Of Africans there are many varieties. The favourite sorts come from Madagascar. The pinky sort comes in the shape of round balls, weighing $1\frac{1}{2}$ to 4 pounds. It is not so strong as fine Para. There is always a good demand for it, and it is rarely found in store, being sold "to arrive." This sort comes from Tamatave. There are two or three variations in quality of Madagascars, but the grade called "black" comes from Majunga, is exported in small balls, and has a dark colour when cut.

From the West Coast of Africa there are many varieties, the best coming in the shape called "thimbles," which are square pieces 1 inch each way. The rubber is very dry, and is in good demand by mechanical goods manufacturers. It is very strong rubber, and naturally has little shrinkage. Tongues are shaped as their names indicate. There is considerable shrinkage, but it is a very good rubber. There is also a small ball rubber about $1\frac{1}{4}$ inches in diameter. It cuts white, and is fairly firm.

Congo ball is made from small strips of rubber and rolled into balls, from 1 to $2\frac{1}{2}$ inches in diameter. It is a firm and very elastic rubber, but there is more or less bark in it, and as manufacturers do not always have proper machinery to exclude it, they do not buy readily.

Sierra Leone comes in balls 3 to 4 inches in diameter, and is a very fair grade of rubber. It has a considerable demand from boot and shoe and mechanical goods men. Like all West Coast rubbers it reaches us by way of Hamburg or Liverpool.

The finer grade of Mozambique is called "white ball." It resembles Congo ball in appearance, and comes in about the same shape. The "red ball" is mixed with a reddish bark, and gets its name for that reason. Oftentimes both varieties of "ball" will be found filled in the centre with bark. The rubber is then called "unripe Mozambique," and sells for 10 cents less per pound.

From Liberia comes a lump rubber. There are three rivers in Liberia from which rubber is gathered, but it is all assembled at

the common mouth, and the grades are not kept separately, making a class of rubber which is very variable, and therefore disliked by manufacturers.

There is, on the whole, a growing tendency toward the use of Africans, and in this is a true check on the price of Para. In Centrals there seems to be a falling off in the production consequent upon a scarcity of labour, which has been from time to time drawn into internal enterprises. In Europe the stocks of Africans are always larger than of Para, and a steady growth is very noticeable.

II.—FOREST PRODUCTS OF SIERRA LEONE.

[*K.B.*, 1897, pp. 318–320.]

The following interesting account of the forest products of Sierra Leone and their possible development is taken from the *U.S. Consular Reports* for November, 1896 (pp. 442–444). It is an extract from an address made by the Governor of Sierra Leone (now Sir Frederic Cardew, K.C.M.G.) to the Legislative Council of Sierra Leone, on the 21st April, 1896.

Some portions of the forests described have been referred to in the report made by Mr. Scott-Elliot, already noticed in the *Kew Bulletin* (1893, pp. 167–169) :—

There are large tracts of forests with abundance of rubber and valuable timber awaiting exportation. They have been in no sense explored, and they only require intelligent and systematic methods for gathering the rubber to yield their wealth to the first comer who has the necessary enterprise.

For instance, the forest to which I have already referred as lying between Makali and Kruto may be roughly estimated to cover the greater portion of the district between the Seli river on the west and the Bagwe on the east, and an east and west line drawn through Kruto in the north, and a similar line drawn through Makali in the south.

This area comprises portions of the Kuniki and Koranko districts, and the extent of forest land within it may, on the most moderate calculation, be computed at about 600 square miles.

Along a great portion of the route taken by my party the forest is of some eight to ten years' growth, but in many parts of the district there is, I have no doubt, the virgin forest ; but even in the forests of recent growth there is abundance of rubber, and three kinds of such plants were pointed out to me. Two were vines called, respectively, in the Timni language "lilibue" and "nofe," and the third a tree called in the same language "kewatia." The "lilibue" yields the choicest rubber in the protectorate. In gathering it, incisions are made in the bark of the vine, which is not, however, always cut down. In the case of the "nofe" vine it is invariably cut up into small pieces of about 6 inches in length, and thus completely destroyed. The "kewatia," *i.e.*, the rubber tree, appears to grow rapidly, and in eight or ten years to

attain a girth of from 2 to 3 feet, but the tree, however, like the "nofe," is also destroyed in the process of gathering its rubber; it is felled, and the bark ringed at intervals of about 6 inches along the trunk. The rubber appears to be treated in a different way to that of the vines; the latter is, as you know, coagulated with lime juice, but the rubber which exudes from the rings cut in the tree is placed in hot water, on the surface of which it coagulates, and is then cut into strips, which are formed into balls for the market.

I have ventured, at the risk of being tedious, to go into detail in describing the manner in which the rubber is gathered.

I think we must all admit that the native processes are crude and wasteful in the extreme, and it is evident if more intelligent and economical methods were adopted, as I understand is the case in the Brazils and other parts of South America, there would be a far larger yield, and every probability that the West African rubber would command as high a price as South American. But if some steps are not taken to teach the natives better methods of extracting rubber than they now use, it may safely be predicted that with the increasing demand for rubber, in a few years the plant will become extinct, and an industry which should be one of the most thriving in the colony will be ruined.

In the forests I am speaking of the rubber is gathered by Susu traders in the crude and wasteful manner I have described. The natives in the Koranko and Kuniki districts, especially in the former, appear to be very ignorant of its value and the methods of gathering it. I feel quite convinced that if traders were to either go themselves or send as agents into these parts men well experienced in the industry, they would be rewarded for their trouble and expense with rich harvests.

The methods which prevailed in South America should be studied and adopted if found practicable here. A short account of the preparation of the Para rubber, which is the premier rubber of the world and is obtained from a large tree which forms extensive forests in the lowlands of the Amazon, was published at the recent Agricultural Exhibition, and the curator is now drawing up an account of other processes which may be suitable to the rubber industry of this colony.

The natives of the interior require to be trained in an intelligent way of working, not only in the preparation of rubber, but also in that of palm-oil. It is absurd to think that for the purpose of extracting a few ounces, or say, even pounds, of rubber, large trees should be felled, as is the case now, not to mention vines, and so completely destroyed. In the territory of the Amazon, each rubber tree is made to yield an annual crop, and the bark, instead of being ringed, has a number of incisions made in it as far up the trunk as the hand can reach, and the milk is caught in little hollowed-out lumps of clay which are placed below each incision. This work is done by the Indians, and there is no reason why the aborigines of the interior should not be taught to adopt similar methods. If the traders who purchase the rubber and other indigenous products would inform the Government in what

direction they consider reforms should be introduced in the prevailing systems of gathering such produce, the Government would, I feel sure, lend an attentive ear to their suggestions.

The forests in the Kuniki and Koranko districts are, relatively speaking, very accessible from here; Magbeli, from which place they can be entered, being distant about seven days' easy marching, and there is water carriage for light canoes from Benkia, two marches from Magbeli, down the Roquelle river.

But these forests are small compared to those on the Anglo-Liberian frontier, along the Morro and Mano rivers, which extend for 800 or 1,000 miles. Had it not been for the border raids which have been carried on for the last eighteen to twenty years, I have no doubt they would have been exploited long ago; but there is an opportunity, now that the raiding has altogether ceased, for opening up these forests, which abound in rubber and elephants, and the southern portions of which are within two days' journey of Sulima.

III.—RUBBER: GAMBIA BOTANIC STATION.

[*K.B.*, 1898, pp. 40, 41.]

There are four different species of rubber-producing plants growing in the station. The most common species are the native rubbers (*Landolphia owariensis* and *L. florida*). These abound on the Gambia, but owing to the ruthless manner in which the trees are tapped, it is feared they will soon disappear.

Hevea brasiliensis (Para rubber).—A few plants of this are at the station, but they do not appear to be growing very well, owing to the long dry season.

Castilloa elastica (Central American rubber).—Several plants were brought out by me as already mentioned from Kew. They are now growing well, and are about two feet high. These plants are said to grow well in a deep warm soil, composed of loam and sandy clay; a dry or rainy climate seems equally suitable, but a high and equal temperature, which does not sink below 60° F. at any time is essential.

Manihot Glaziovii yields the rubber known in commerce by the name of Ceara rubber. This plant grows well in the Colony. The only difficulty up to the present has been to procure the rubber from the tree. The sample of rubber collected from a tree growing at the station is free from impurity, but though small, it is quite large enough to show that the method of collecting I have practised is the correct one and the one which should be impressed on the local rubber collectors. The plant is very hardy, and will grow almost anywhere. Its healthy appearance in this Colony shows that it may prove of great value.

IV.—FIJI INDIA-RUBBER.

[*K.B.*, 1898, pp. 164–166.]

In the *Kew Report* for 1877, p. 31, it is stated that a specimen of native caoutchouc had been received from Sir Arthur Gordon (now Lord Stanmore), Governor of Fiji. This is still in the Kew Museum. It was favourably reported upon at the time and described as a "strong, elastic, pure rubber of the same character as the higher grades of African rubber. If free from water admixture and impurity the value would be 1*s.* 6*d.* per pound." This was twenty-one years ago. At the present time the price would probably be 2*s.* or 2*s.* 6*d.* per pound. After so promising a beginning it was hoped that a successful rubber industry would be established in the Fiji Archipelago. So far, however, this expectation has not been realized.

It was stated that the tree from which the rubber was obtained "was very common in the islands." In 1878 Mr. John Horne, F.L.S., then Director of the Botanic Gardens at Mauritius, visited Fiji and paid particular attention to their economic resources.

A report on the Caoutchouc or India rubber plants is published as an Appendix to his "*Year in Fiji*" (London, Stanford, 1881), pp. 195–202.

The Fijian name for caoutchouc is "drega," and the term "drega kau" is generally applied to all trees that have a milky juice.

Mr. Horne found a species of *Tabernaemontana* (since named *T. Thurstoni*, Baker, *Journ. Linn. Soc.* XX., 368), with white flower and a reddish-yellow berry about ½ inch diameter. "When wounded a thin milk-white juice exudes which yields a small quantity of caoutchouc." Locally this is known as "Kau Drega," or "Talotalo." Mr. R. L. Holmes (in the enclosure to the Governor's despatch of the 15th April, 1898) speaks of it as "decidedly our best rubber-yielding tree." He adds: "It grows to a large size. Those that I saw were up to 18 inches or 2 feet through at the base. It is found scattered in the forest on the hills and valleys, but is not gregarious." The specimen of rubber from this tree recently received from Fiji was hard and gutta-like and without elasticity. In the condition in which it reached this country it was of little or no commercial value.

The most promising india rubber plant met with by Mr. Horne was *Alstonia plumosa*, Labill.; of this possibly, *A. villosa*, Seemann, is a hairy form. The account given of this tree is as follows:—

"The Fijian name," says Mr. Horne, "is 'Drega quruquru.' They collect the juice in their mouths, which makes the caoutchouc as adhesive as glue, and of about the consistency and colour of putty. To get the juice, the Fijians break off the leaves from the branches, and collect it as it flows from the petioles and the wounds on the branches caused by the breaking off of the leaves. The branches are next broken off the trees, and each branch is broken up into pieces from 6 inches to a foot long.

"As fast as the pieces are broken, first one end of them is placed in the mouth, then the other, till the mouth is full of

crude caoutchouc. Several mouthfuls are collected together and squeezed into a round mass or ball. This method of collecting the juice, with the ruthless manner of breaking the trees, somewhat surprised me when I first saw it done. Since then repeated trials in all parts of Fiji have convinced me that the sap or juice does not flow freely by wounding the bark on the trunk of the tree in any way whatever. This is the reason for breaking the branches. The youngest branches of the tree contain most juice. When the old or firm-wooded branches are broken very little sap flows from them. When the young branches are broken the sap flows rapidly for a few seconds. It soon coagulates when exposed to the air, and the wound has to be freshened to cause the sap to flow anew. When the branches are broken into pieces of about a foot in length the juice flows from the ends and the pieces are drained almost entirely. A little more may be obtained by breaking the pieces in the middle, but very little. The juice flows from between the bark and the wood, and from the pith, or from between the pith and the wood.

"The coagulated juice would seem to have some attraction for the juice in a semi-liquid condition. If a portion of the coagulated juice be applied to the semi-liquid juice adhering to the ends of a broken branch, the slightest touch makes them join firmly. The adhesion is so perfect that the portions will not be separated, and a slight pull takes the semi-coagulated juice clean out of the many fissures or cracks in the ends of the broken branch. To obtain crude caoutchouc from this tree the juice has simply to be collected and worked with the fingers. It requires no other preparation. The juice congeals so rapidly that when collected in dry weather it requires little if any drying. The caoutchouc may be sent to market in balls, or it may be pressed in moulds into long thin pieces, one or two inches broad and an inch in thickness (more or less) as may be required. Samples of it have been sent to England, and the quality was highly valued."

Nothing further was done in regard to Fiji rubber until last year, when, in response to an inquiry from Kew, efforts were made to obtain botanical specimens of all the plants yielding a milky juice.

This was followed by the receipt of two samples of rubber forwarded by the present Governor, Sir George O'Brien. The first samples proved entirely valueless. The second, received in March, 1898, were more promising.

Alstonia plumosa is known in Viti Levu as "Sarua." It is described as abounding in the forests and if carefully treated might prove a useful rubber-producing plant. Mr. Joske, the Commissioner for Colo North, states "the leaves are large and glossy: the gum is obtained from the petiole or stalk. As soon as the leaf is broken a thick milky juice exudes, which when exposed to the heat of the sun for a little while congeals. It is then detached with a bit of bamboo or knife and the different particles are pressed together into balls. That is the way it is produced when required as an article of commerce. It is also chewed by children as a pastime and made into plastic balls with which to play."

Mr. Joske adds, "I remember twenty years ago that it was collected on both of the above islands [Viti Levu and Vanua Levu] as an article of commerce. If I recollect rightly, it even then fetched a good price in the European markets. The export of it fell off owing to the difficulty of getting the natives to continue steadily at the industry, and owing to the fact also that settlers hoped to do better with what they then considered more important articles such as cotton, sugar and coffee."

It is possible that under the stimulus of higher prices rubber gathering in Fiji may be revived. It is evident, however, that the preparation has almost become a lost art, for the specimen lately received from Sir George O'Brien was "soft and viscid on the outside, with little or no elasticity, and practically without value."

A later specimen, received in June last, was not so viscid, but it gradually became hard and inelastic. Mr. Holmes confirms Mr. Horne that no milk is obtainable from the stem.

With the above was enclosed a sample of rubber from a tree known as "Baka" (*Ficus obliqua*, Forst. f.). According to Mr. Joske, this "yields quantities of rubber." Further, "it is used by the natives of the interior as birdlime with which at certain seasons of the year they catch wild pigeons; it is very easily procured. Incisions are made in the bark and underneath are placed bamboos which receive the sap as it pours out. It is coagulated by means of heat, ... the natives say they could get immense quantities of this without much trouble. Were it discovered that the rubber was of commercial value it would prove an estimable boon to the natives of these islands."

Although the specimens of "Baka" rubber received at Kew had not been sufficiently coagulated, it was regarded by Messrs. Hecht, Levis, and Kahn as suitable for mixing purposes, and its value to-day was placed at 1*s.* to 1*s.* 3*d.* per pound.

A substance obtained from the "Ban" tree, possibly a member of the *Sapotaceae*, but, in the absence of flowers, otherwise indeterminable, was slightly elastic and might command a sale at 10*d.* to 1*s.* per pound.

Other specimens, obtained from the "Wasalili" (*Carruthersia scandens*, Seem.) and the "Malawaci" (*Trophis anthropophagorum*, Seem.), were entirely deficient of elastic properties and reported to be of no commercial value.

V.—COAGULATION OF RUBBER-MILK.

[*K.B.*, 1898, pp. 177–181.]

The extensive use of India-rubber in the arts and manufactures, renders the production of this substance a matter of general interest. One of the most important problems that awaits solution is a simple and effective means for coagulating the rubber-milk and producing an article free from impurities and capable of being worked with as little preparation as possible. In the following paper, which has recently appeared in the

Annals of Botany (Vol. xii., pp. 165–171), Mr. R. H. Biffen, B.A., Demonstrator in Botany at the University of Cambridge, has given an admirable summary of what is already known on the subject. Mr. Biffen accompanied Mr. Esme Howard last year on a tour through the rubber-yielding countries of Tropical America. They visited Mexico, Central America, Brazil, and some of the West India Islands. Mr. Biffen has therefore had a favourable opportunity for becoming acquainted with the conditions under which rubber is at present prepared, and is in a position to suggest scientific methods for the improvement of the industry.

While engaged during the latter part of 1896 in studying the functions of latex, my attention was frequently called to its spontaneous coagulation when in contact with the air.

De Bary describes the phenomenon as follows* :—"As soon as latex comes in contact with the air, and still more quickly on treatment with water, alcohol, ether, or acids, coagula appear in the hitherto apparently homogeneous clear fluid itself, and independently of the aggregation of the insoluble bodies described by Mohl (*Bot. Zeit.*, 1843, No. 33). The coagula collect together and separate with the insoluble bodies from the clear fluid. These phenomena of coagulation which appear under the action of so various agencies point especially to a complicated composition of the fluid, and deserve further investigation."

An examination of the subject was therefore commenced with the small quantities of latex obtainable from plants grown for the purpose in the Cambridge Botanical Gardens. The results obtained were of some interest, and accordingly the experiments were continued, together with other researches on a larger scale, in Mexico, Brazil, and the West Indian Islands.

Rubber-yielding plants, which always have laticiferous cells, were for the most part chosen on account of the ease with which large quantities of latex could be obtained, and because the various processes used in the preparation of crude rubber seemed likely to throw some light upon the subject.

A microscopic examination of any of these latices shows that its milky appearance is due to the presence of innumerable small granules of caoutchouc, which in themselves are soft and sticky, for they readily cohere to form a small mass of rubber if the cover-glass is lightly rubbed on the slide.

Some of the processes employed to prepare this rubber may be described here.

In the preparation of Para rubber, a thin layer of the latex of *Hevea brasiliensis* (Muell. Arg.) or other species of *Hevea*, is exposed to the action of the smoke of burning "urucuri" nuts (*Attalea excelsa*, Mart.); coagulation is immediately brought about, resulting in the formation of a soft, curdy mass of rubber, which on drying becomes tough and elastic.

The same process is now being applied with good results to the preparation of Ceará rubber from the latex of *Manihot Glaziovii* (Muell. Arg.).

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* De Bary, Comp. Anat. of Phanerogams and Ferns, p. 184.

The usually accepted explanation of this is that the water contained in the latex is simply evaporated off ;* but as the coagulation is brought about in so short a time, and moreover as there is no loss of weight on its occurrence, this is obviously incorrect.

On passing the smoke of the burning Attalea nuts through a condenser, condensation occurs, and two layers of liquid are found in the receiver, one colourless and limpid, the other dark brown and oily. If these are separated by means of a pipette, or with a moistened filter paper, and analyzed, the former is found to consist mainly of acetic acid, and the later of creosote and traces of pyridine derivatives.

On adding acetic acid to the crude latex of *Hevea* coagulation occurs immediately. This process of smoking the latex may then be classed with those mentioned by De Bary under the heading of treatment with acids. As other examples, the preparation of Lagos rubber from the latex of *Ficus Vogelii* (Miq.), in which case lime-juice is added,† and Helfer's process of adding acetic acid to the latex of *Artocarpus Chaplasha* (Roxb.),‡ may be quoted.

It is worthy of note that the latex of *Hevea brasiliensis* is in itself alkaline, and that the addition of a solution of ammonia preserves it indefinitely from spontaneous coagulation. The addition of alkalis brings about coagulation, however, in the latex of *Castilloa elastica*. In Mexico and Nicaragua, where this tree abounds, a decoction is made of the stems of the Moonflower *Ipomoea Bona-nox* (Calonyction speciosum), and added to the latex§. The alkaline properties of this extract are well known to the native Indians, who frequently employ it in the manufacture of soap. The latex has an acid reaction towards litmus paper, and the addition of acids does not cause coagulation.

Another method of clotting latex is to add an excess of common salt. This method is almost invariably applied in the case of *Hancornia speciosa* (Gomez) to produce the "mangabeira" rubber It is also reported to have been employed at times to coagulate the latex of species of *Hevea* and *Manihot Glaziovii*.

Coagulation may also be brought about by boiling the latex, as, for example, in the preparation of "balata" from *Mimusops globosa* in Venezuela and Trinidad.

There are several other methods in general use besides the few that have been quoted, and many others have been suggested from time to time‖.

As the rubber exists in particles in the latex, it seemed possible that the centrifugal method of separation might be adopted in examining the phenomena of coagulation. A modified form of the ordinary centrifugal milk-tester was, therefore, designed capable of being rotated some 6,000 times per minute.

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* Ernst, Trinidad Bulletin, vol. iii., p. 235.
† Kew Bulletin, 1890, Art. 142, p. 89 [p. 152].
‡ Watt's Dict. Economic Products of India, vol. iv., p. 343.
§ Belt, Naturalist in Nicaragua, p. 33.
‖ For a complete account, see *Le Caoutchouc et la Gutta-percha*, Seeligman, Lamy, and Falconnet, Paris, 1896,

The latex was taken directly from the trees, strained through wire gauze to remove any pieces of bark, and then, if very thick, diluted to about the consistency of thin cream. The first experiments were made with the latex of *Castilloa elastica*. After centrifugalizing for from three to four minutes, the rubber-particles completely separated as a thick, creamy, white layer, from the deep brown solution containing tannic acid in which they had been suspended. This layer was taken off, shaken with an excess of water to thoroughly wash it, and again separated. The separated particles were then shaken with water, so as to form an emulsion, and alkalies were added. No coagulation now occurred, even though the mixture was allowed to stand for several days. The particles could, however, be brought into a solid mass by pressure, by gentle heating, or by drying off the water with a porous tile.

So prepared, the rubber formed a pure white mass, without any trace of its usually characteristic smell. On exposure to the air for several days, the surface became brown, probably owing to oxidation.

The percentage of rubber in the latex was estimated at the same time by separating 50 c.c. The weight of the dry substance was 12·5 grammes, which, as the specific gravity of *Castilloa elastica* latex is practically 1·0, gives a yield of 25 per cent.

On treating the latex of *Hevea brasiliensis* in the same way for a slightly longer time, a similar separation occurred. The same purely physical means as those employed in the case of the separated *Castilloa* rubber-particles caused them to coalesce to form a solid mass, while the addition of acetic acid and the action of the smoke of burning urucuri nuts had no effect.

The yield of rubber estimated as before, was from 28 to 30 per cent. The latex of *Manihot Glaziovii* also separated readily and gave results completely parallel with those mentioned above. This latex is interesting, as it is readily clotted by churning. A soft spongy clot is formed in a few minutes containing in its meshes the greater part of the solution in which the rubber-particles were suspended. If this clot is cut into slices while still soft and pressed between sugar-cane crushers, or in a heavy press, the bulk of the solution is extracted and a fairly pure rubber is found. On drying, it does not give off the putrid smell characteristic of the ordinary Ceará "scrap."

Other latices can also be clotted by churning, but the process is a long one.

The latex of *Hancornia speciosa* and of *Mimusops globosa* gave similar results on centrifugalizing. In the case of the latter, the pink colouring-matter which characterizes 'balata' was found to have separated as a thin layer at the bottom of the tubes.

Artocarpus incisa contains a very viscous latex employed by the Brazilians as a bird-lime or as a substitute for glue. When diluted and centrifugalized it separates readily, giving a creamy white layer which dries to a resinous mass somewhat resembling gutta-percha. At the ordinary temperature this is quite hard and brittle, but if the temperature is raised slightly it becomes plastic,

and at the temperature of boiling water it is soft and excessively sticky. The substance is soluble in carbon bi-sulphide, and insoluble in alcohol and water.

*Urostigma Gamelleira** yields a similar substance of a chocolate-brown colour.

We thus see that the mere action of centrifugal force effects the separation of rubber; and from the failure of the processes usually employed, involving the use of chemical reagents, to bring about the clotting of the separated and washed rubber-particles, we must infer that no chemical change occurs in the rubber itself, and that the cause of coagulation must be looked for in the medium in which they are suspended.

From our knowledge of the constitution of latex, it is evident that the proteids are the most likely substances to cause this when treated with acids, alkalies, excess of salt, &c., and when boiled.

Unfortunately few latices have as yet been examined for their proteid constituents, chiefly on account of the difficulty of obtaining them in their natural condition in European laboratories, owing to their coagulating and undergoing decomposition during the journey from the tropics.† The investigations so far made prove the presence of albumin, globulin, albumose, and peptone in several rubber-yielding latices.‡ In the clear solution left after separation of the rubber-particles the xanthoproteic reaction always showed the presence of proteid matters, but under the circumstances it was impossible to identify them.

Now albumins are characterized by the coagulation of their solution on heating, especially in the presence of dilute acids, and globulins by their ready precipitation with the salt-solution and their coagulation on heating.

Thus when the latex of *Hevea brasiliensis* is held in the smoke of the burning urucuri nuts, the albumin it contains§ is clotted by the action of heat in the presence of dilute acetic acid.

The globulin of *Manihot Glaziovii* latex coagulates on heating when the temperature rises to 74–76° C.‖

The acid latex of *Castilloa elastica* contains an acid albumin, which on neutralization forms a gelatinous precipitate.

These coagula on forming gather up the rubber-particles (and probably starch-grains also, in the case of starch-containing latices) in the same way as the white-of-egg gathers up particles in suspension when clotted for the purpose of clearing jellies. We may even push the old analogy of blood and latex further, and compare the formation of a rubber-clot, in many cases, to the formation of a blood-clot, the rubber-particles being bound together by coagulated proteids in the same way as the blood-corpuscles are bound together by fibrin. In this case, however, we must remember

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* Mart. Fl. Bras. 4. i. 93, Ficus doliarum of Mart. Sys. Mat. Med. Bras., p. 88.

† This does not apply to the latex of *Mimusops globosa*, or *Hancornia speciosa*, which may be kept for months without undergoing any change.

‡ J. R. Green, Proc. Roy. Soc., 1886, p. 28.

§ Faraday, *see* Le Caoutchouc et la gutta-percha.

‖ J. R. Green, *ibid.*

that the rubber-particles, owing to their being sticky bodies unprotected by any external film, as *e.g.*, the fat-particles of milk are, are capable of aggregating together of their own accord to form a solid mass.

Rubber then, as now prepared, contains among other substances proteid matters. To these must be ascribed the well-known 'fermentative change' which causes a considerable loss by converting the solid blocks of rubber into a foul-smelling spongy substance. In the Para rubber the creosote absorbed from the smoke of the burning nuts acts as an antiseptic and prevents this proteid decomposition.*

To test for the coagulated proteids is not an easy mattter; continued boiling with a concentrated solution of caustic potash will, however, extract small quantities of alkali-albumin. 'Balata' gives good results most readily. On extraction with caustic potash a flocculent precipitate is obtained, which is readily soluble in dilute nitric acid, and is reprecipitated on the addition of alkalis. Boiling precipitates it either in acid or alkaline solutions, and it gives no precipitate with acetic acid and potassium ferro-cyanide. The proteid is thus identical with the albumose, described by Green, from the latex of *Mimusops globosa*.

R. H. BIFFEN.

Botanical Laboratory, Cambridge.
February, 1898.

VI.—ARTIFICIAL PRODUCTION OF INDIA-RUBBER.

[*K.B.*, 1899, pp. 27, 28.]

India-rubber, or caoutchouc, is chemically a hydrocarbon. But what is called its molecular constitution is unknown. All that has been ascertained is that when decomposed by heat (distillation in closed vessels) it is broken up into simpler hydrocarbons, amongst which is isoprene.

Caoutchouc is found in a considerable number of plants in no way related by botanical affinity. But they are for the most part natives of tropical countries. As is well known, it occurs in the *latex*, a milky juice contained in the laticiferous vessels. It is not dissolved in the latex but is merely suspended in it.

All chemical substances of vegetable origin sooner or later yield to the art of the synthetic chemist, and admit, therefore, of being built up from simpler compounds. The methods of accomplishing this in individual cases may or may not lead to commercial results. In many cases they remain merely of theoretical interest as, though practicable, they are too cumbrous and expensive to be of actual utility.

The artificial production of every organic compound is, then, a scientific problem which may have commercial results. It is

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* *Cf.*, the smoking of fish, &c., for preserving purposes.

always a matter of interest to note and place on record the first step towards its solution, although the commercial application may be remote.

Such a first step has been achieved by Dr. Tilden, F.R.S., Professor of Chemistry in the Royal College of Science, South Kensington, in the case of india-rubber. He has kindly permitted the republication of his results in these pages with some more recent revisions. They have also been republished in the *Chemical News*.

"*Note on the Spontaneous Conversion of Isoprene into Caoutchouc.*

"[Read before the Birmingham Philosophical Society, May 18th, 1892.]

"Isoprene is a hydrocarbon which was discovered by Greville Williams many years ago among the products of the destructive distillation of india-rubber. Later, in 1884 (*Trans. Chem. Soc.*, vol. 45, p. 410), it was observed by myself among the more volatile compounds obtained by the action of a moderate heat upon oil of turpentine and other terpenes. It is a very volatile liquid, boiling at about 36°. Its molecular formula is $C_5 H_8$, and it forms a tetrabromide, $C_5 H_8 Br_4$, but no metallic derivatives like the two homologues of acetylene.

"Bouchardat (*Compt. rend.*, vol. 87, p. 654, and vol. 89, pp. 361 and 1117) observed that when isoprene is heated to a temperature near 300°, it gradually polymerises into a terpene, which he called diisoprene, but which is now called dipentene. This compound boils at 176°. A quantity of colophene, similar to that which is produced by the action of heat upon turpentine, is formed at the same time. When isoprene is brought into contact with strong acids, aqueous hydrochloric acid for example, a small portion of it is converted into a tough elastic solid, which has been examined by G. Bouchardat and by myself. It appears to be true india-rubber.

"Specimens of isoprene were made from several terpenes in the course of my work on those compounds, and some of them I have preserved. I was surprised a few weeks ago at finding the contents of the bottles containing isoprene from turpentine entirely changed in appearance. In place of a limpid colourless liquid, the bottle contained a dense syrup in which was floating several large masses of a solid of a yellowish colour. Upon examination, this turned out to be india-rubber. The change of isoprene by spontaneous polymerisation has not, to my knowledge, been observed before. I can only account for it by the hypothesis that a small quantity of acetic or formic acid had been produced by the oxidising action of the air, and that the presence of this compound had been the means of transforming the rest. The liquid was acid to test paper, and yielded a small portion of unchanged isoprene.

"The artificial india-rubber, like natural rubber, appears to consist of two substances, one of which is more soluble in benzene or carbon bisulphide than the other.

"A solution of the artificial rubber in benzene leaves on evaporation a residue which agrees in all characters with a similar preparation from Para-rubber.

"The artificial rubber unites with sulphur in the same way as ordinary rubber, forming a tough elastic compound.

"The constitutional formula of isoprene is now known to be:— Methyl-crotonylene, $CH_2 = CCH_3 - CH = CH_2$.

"It is obvious that compounds such as these, containing doubly-linked carbon, may polymerise in a variety of ways; and, in the present condition of our knowledge even of isoprene, it would be idle to speculate as to which out of the numerous possible arrangements would correspond to the constitution of caoutchouc."—(*Proc. Birm. Phil. Soc.* viii., Pt. 1.)

In a recent letter Professor Tilden states:—"As you may inagine, I have tried everything I can think of as likely to promote this change, but without success. The polymerisation proceeds *very* slowly, occupying, according to my experience, several years, and all attempts to hurry it result in the production not of rubber but of 'colophene,' a thick sticky oil quite useless for all the purposes to which rubber is applied."

VII.—GUTTA PERCHA FROM A CHINESE TREE.

(*Eucommia ulmoides*, Oliv.)

[*K.B.*, 1901, pp. 89–94.]

Between 1887 and 1890, from several localities on the middle Yangtze-Kiang river, Dr. A. Henry sent to Kew fruiting specimens of a peculiar Chinese plant, with the statement that its bark is a most valued medicine in China, where it is named "Tu-chung," and that the tree is cultivated for it. "I have never seen it wild," he adds, "but I was informed it occurs so in Fang and other districts to the north." Fang is the name of a region near the middle part of the Yangtze-Kiang in the province of Hupeh.

This plant Prof. D. Oliver described (*Hooker's Icones Plantarum*, t. 1950) as *Eucommia ulmoides*.

Flowers not being available, and what material he had so peculiar that its relationships were not obvious, Prof. Oliver left the determination of the order of *Eucommia* open, merely adding that the tribe Phyllantheae of Euphorbiaceae occurred to him as of probable affinity.

The interest to us lies not so much in this as in his indication of the presence in the tissues of gutta percha. The discovery he made known in the following words:—

"The most singular feature about the plant is the extraordinary abundance of an elastic gum in all the younger tissues—excepting perhaps the wood proper,—in the bark (in the usual sense of the word), the leaves and petioles, and pericarp; any of these, snapped across, and the parts drawn asunder, exhibit the silvery sheen of innumerable threads of this gum."

His account continues: "The morphological relations and general histology of the cells which give rise to the substance, we hope to have the opportunity of describing from specimens in fluid or living, which, through Dr. Henry's kind offices, there is probability we may soon receive."

When the promised specimens arrived Mr. (now Prof.) F. E. Weiss undertook the examination of them, and from the account of his investigations, published in the Transactions of the Linnean Society (Series 2, Botany, iii., p. 243), the following sentences are drawn :—

"The threads of *Eucommia* consist of caoutchouc, for they are insoluble in alcohol, acids and alkalis, though they become soft when treated with ammonia. They dissolve in chloroform and turpentine, and swell up in ether. When heated they melt, and they burn with the characteristic smell of burning rubber.

"From the bark the rubber can very readily be extracted. If the bark be broken in pieces and pounded in a mortar, the mass can be roughly separated into two parts, one consisting of the tangled elastic threads, with small bits of broken bark adhering to them, the other chiefly of bits of bark containing, no doubt, smaller pieces of the threads. From both parts chloroform will dissolve out caoutchouc, a larger amount naturally from the portion which consists chiefly of the threads. Thus a sample of the threads and bark weighing 443 mg. gave as much as 25 mg. of caoutchouc, while the remaining bark, weighing 607 mg., yielded only 6 mg. Taking the two quantities together, the yield of caoutchouc was 3 per cent. of the weight of the dry bark, and the same figure was arrived at independently by Prof. F. W. Oliver with another sample.

"The threads are clear and homogeneous, and the only impurity in the chloroform extract seems to be a little resin, which can be washed out with alcohol.

"Whether the bark can be made use of commercially I must leave to those who are more experienced in technical matters.

"The distribution of the caoutchouc-containing cells I had been able to determine from the dry material which I first examined, and these observations were confirmed by the examination of the material preserved in alcohol. They occur in the inner portions of the cortex, very much in the position in which the latex cells of *Euphorbia* are found, but are even more frequent in the secondary phloem, where they run between the companion cells, and in both cases present the appearance of very long narrow cells, attaining such a length that one only occasionally finds their ends.

"In the leaf a group of caoutchouc-containing cells accompanies the ramifying fibro-vascular bundles, running just below the phloem, while in the petiole and all along the bundle of the midrib they form two groups at the sides of the bundle, and do not run below it.

"The pericarp of *Eucommia*, which resembles in appearance that of the elm, is especially rich in these caoutchouc-containing

cells. Below the epidermis we find a few layers of large chlorophyll-containing cortical cells, which become very much compressed in the dry fruit. Within these are the fibro-vascular bundles, the main trunks running longitudinally, and connected by branching and anastomosing lesser bundles. The longitudinal bundles have a strong group of caoutchouc-containing cells accompanying them on their inner side, and immediately beneath them we find a large mass of circularly running cells of the same nature, forming quite a dense coat of hyphae-like thin-walled cells, showing their cell-walls very distinctly when the caoutchouc has been dissolved out by chloroform."

These investigations did not settle the position of the genus, and Mr. Weiss left the matter with the remark that perhaps the tribe Crotoneae might include *Eucommia* in preference to Phyllantheae of the same order—Euphorbiaceae.

Since these first researches, made on imperfect material, further knowledge has been due to the success of scientific and horticultural establishments in Paris in obtaining first dried flowering specimens and now living plants. From the museum of the Jardin des Plantes came the material whereby Prof. Oliver was enabled to publish a second figure (*Hooker's Icones Plantarum*, t. 2361), and Dr. Solereder's researches (*Berichte der Deutschen botanischen Gesellschaft*, xvii, 1899, p. 387) were made upon flowers sent to him from Paris and fruits supplied from Kew; while the living plants in cultivation at the Jardin Colonial, in the garden of the Faculty of Medicine, and by the firm of Vilmorin, Andrieux and Co., have supplied material for the anatomical investigations of M. Barthelat (*Journal de Botanique*, xiv., 1900, p. 55) and the economic inquiry of MM. Dybowski and Fron (*Comptes Rendus de l'Académie des Sciences, Paris*, cxxix., p. 558).

Examination of the dried flowering specimens which had been received in 1894 from a French missionary—Père Farges—and were taken from trees cultivated in Szechuen, caused Professors Oliver and Baillon to agree in placing *Eucommia* in the order Trochodendraceae. Solereder refers it to Hamamelidaceae. It is impossible to discuss here the cause of this difference of opinion; let it suffice to say that it indicates the difficulty experienced in assigning to its true position this peculiar genus. Wherever from external morphological characters we place it, the allied plants are not rubber- or gutta-yielding plants. Solereder observes this, and compares in justification of his view the Hippocrateaceae, in which caoutchouc cells are found in certain species.

There are great differences between the caoutchouc cells of *Eucommia* and of the Euphorbiaceae. In the latter the whole system is one complicated network arising from the branching of cells which are present in the embryo, which grow with the growing plant, ramifying and uniting, so that the outflow of one cut vessel is more than its contents, because other vessels feed it as it bleeds. In *Eucommia* the caoutchouc vessels do not branch and unite, nor are they present, according to Barthelat, in the embryo. Their contents, too, are more of the nature of gutta percha than indiarubber; and in structure they are much more similar to the

cells which yield the gutta percha in *Dichopsis* than to the laticiferous vessels of *Hevea*, *Manihot*, *Sapium*, and other Euphorbiaceous plants.

To Weiss' description of the anatomy Barthelat adds somewhat. He found that the cortical parenchyma of the young stem contained abundant caoutchouc cells, sometimes running singly, sometimes two or three together. In the roots he found the same cells in the phloem, and in the petioles both in and below the phloem; while in the leaf-blades they were very plentiful, running with the nerves and branching from them to end in a swollen extremity under the palisade parenchyma of the upper surface.

Caoutchouc is thus seen to be present in every part of the plant except the wood and the outer layer of parenchyma of the young roots.

We may now leave the anatomy of the plant to quote from the paper by MM. Dybowski and Fron of the economic possibilities which *Eucommia* may possess. The following statements are translated from pp. 559–560 of their paper :—

"Our attention was called to the similar way in which the contents of the laticiferous vessels of *Palaquium* and *Eucommia* become evident when the leaves are carefully broken; and so we were led to apply to the different organs of the latter plant the procedure recommended by M. Jungfleisch for extracting gutta-percha from the leaves of the former. We experimented first on some fresh leaves of a plant of *Eucommia* grown in the Jardin Colonial. The leaves are 3 to $3\frac{1}{2}$ inches long and $1\frac{1}{2}$ to 2 inches wide. They are oval, pointed at the end, finely dentate, have short stalks, and in length resemble those of our common elm. Operating upon 20 grammes of dried leaves, we obtained 0·45 gr. of products soluble in toluene, which corresponds to a return of 2·25 gr. per cent. This return is poor, remembering that the fresh leaves contain 70 per cent. of water. The bark is full of laticiferous vessels. But the plant which we possess being still very young, we have not been able to take any branches away for examination.

"A second series of observations was made upon the fruits. The fruit is a samara, the length of it being $1\frac{1}{8}$–$1\frac{3}{8}$ inches, and the width nearly $\frac{1}{2}$ inch. Two hundred fruits weigh about 13 to 14 grammes. The extraction of matter soluble in toluene has given us the following results :—

1st attempt, 15 grammes yielded 4·09 gr. soluble in toluene
2nd " " " " 4·12 gr. " "

i.e., 8·20 gr. from 30 grammes of matter, or a yield of 27·34 per cent. We worked with fruits not dried. The fruit contains a small proportion of water, equal to 7·4 per cent.

"The product obtained is of a brown colour with metallic reflections on the surface. Plunged into hot water it becomes soft again, stretches out in thin flakes like goldbeater's skin, and under pressure will take the impress of metal. In cooling it loses its suppleness and becomes quite hard.

"We have submitted the samples to M. Léauté, an authority on the subject, and he has been so kind as to authorise us to say that he considers the gutta percha of good quality. We have but one plant under observation in the Jardin Colonial, but experiments are being made as to the methods of propagating. As at present *Eucommia ulmoides* is only known to exist in China, it is not easy to get a quantity of seed; and, further, germination seems slow and irregular. One sowing produced a single seedling after the lapse of six weeks, a second after five months, and others later. Fortunately cuttings seem to give better results. They will strike root at any season, and give vigorous plants; but spring, when the branches are still leafless, seems to be the most favourable time for taking them."

Eucommia ulmoides promises to be hardy at Kew. In November, 1897, M. Maurice L. de Vilmorin presented a plant to the Royal Botanic Gardens, where it has been grown successfully in the open without protection.

In Paris, where the winters are more severe than at Kew, the plant has survived through them, as testified by the following answer dated November 13, 1899, kindly sent by M. M. de Vilmorin to a question from Kew:—

"Two plants of *Eucommia ulmoides* remained unprotected against a wall in our Paris garden during the two last mild winters, and stood uninjured through as low a temperature as 18° or 19° F."

The Jardin Colonial has already experiments in hand in Annam, Tonkin, and North Africa.

The bark of *Tu chung* had attracted attention long before the discovery of the tree to which it belonged. The following notice appeared in the Kew Report for 1881, p. 47:—

Chinese collections of Materia Medica often contain specimens of a drug consisting of blackened fragments of bark and small pieces of twigs. These when broken across are seen to contain an abundance of caoutchouc which can be drawn out in fine elastic threads as in the East African Landolphias. Specimens have reached the Kew Museum from the Paris Exhibition of 1878 (with the Chinese name *Tu chung*), and from the Smithsonian Institution, Washington. The botanical origin has been hitherto altogether uncertain. It seems, however, probable from a notice by M. L. Pierre, Director of the Botanic Gardens, Saigon (*Excursions et Reconnaissances*, No. 11, Saigon), that this drug is the produce of *Parameria glandulifera*. This is an apocynaceous climber, ascending to the summits of the highest trees; it is common in the forests of Cochin China. Specimens which M. Pierre has obligingly communicated to Kew prove that the plant is identical with a species which abounds in Southern India. M. Pierre states that "the sap which flows from the stem has exactly the appearance of milk, and may even be used as a substitute for it; it has a slight nutty flavour. In the liquid state it is often employed in medicine by the Annamites and the Cambodians. The bark, after being dried ordinarily in smoke, is sold at 20 to 25 francs the picul (= $133\frac{1}{3}$ lbs.), and exported to China. The bark is a medicinal product, esteemed by the Chinese."

The real source of the drug was cleared up when the specimen of *Eucommia*, collected in Hupeh in 1887 by Dr. A. Henry, was described in 1890 by Prof. Oliver in the *Icones Plantarum*. Dr. Henry's specimens were accompanied by the following note :—

The *Tu chung* tree, 20–30 feet. The bark of this tree is a most valued medicine with the Chinese, selling at 4*s*. to 8*s*. a lb.

Mons. Pierre concurred that the suggested identification with *Parameria* must be abandoned.

Subsequently further specimens were received from the Museum d'Histoire Naturelle, Paris. These had been collected in Szechuen in 1874 by Rev. Père Farges. They were accompanied by the following note :—

Lorsqu'on brise l'écorce les vaisseaux corticaux s'étirent comme des fils de soies; c'est pour cela qu'il est appelé aussi vulgairement *sè mien*. Écorce officinale usitée dans les maladies des reins et comme une charpie dans les blessures.

Eucommia is a tree of mountainous districts. The name *Tu chung* is, however, applied by the Chinese to a tree of the plains, which is almost certainly a *Euonymus*, and not improbably *E. hamiltonianus*, Wall. (See *Kew Bulletin*, 1899, p. 219).

VIII.—A HARDY INDIA-RUBBER TREE.

(*Eucommia ulmoides*, Oliver.)

[*K.B.*, 1904, pp. 4–6.]

In the *Kew Bulletin* for 1901 (pp. 89–94) [p. 18], under the title "Gutta-Percha from a Chinese Tree," some account is given of this interesting discovery.

The figure given by Professor Oliver in *Hooker's Icones Plantarum* (pl. 2361) is now reproduced.

To this may be added the following interesting note kindly furnished by Dr. Henry, the well-known Chinese Botanist :—

Tu Chung is the name given by the Chinese to the tree, which has been described by Prof. Oliver as *Eucommia ulmoides*. The bark is the only part used, and is much esteemed by the Chinese as a drug, tonic and various other properties being assigned to it. It is described in nearly all Chinese works on materia medica and botany, the earliest mention of it being given in the herbal of which the Emperor Shên-Nung is the reputed author, and which was committed to writing probably as early as the first century of our era.

The tree is cultivated in small plantations in the mountainous regions of Szechwan, Hupeh, and Shensi ; and from these districts it is brought to Hankow, the great mart for drugs that are produced in the western provinces. From this port about 100 tons are annually exported by steamer to the other treaty ports. The value of this export is put down in the Customs returns at about £18,000; the price varies much from year to year and with the quality of the bark.

In the Customs List of Medicines mention is made of a small export, about 100 pounds annually, from Pakhoi, and this is said to be produced in the province of Kwangsi.

On my trip to the mountains which lie north-west of Ichang, I was not fortunate enough to come upon the tree in the wild state, but the natives report that it is occasionally to be met with wild in the woods on the great mountain range that form the water parting of the Han and Yangtze rivers ; and I was regaled with a story of a lawsuit which had been brought by a man in the Fang district, against the purchaser of a tree which had been unwittingly sold as firewood, but turned out to be the valuable *Tu Chung* tree.

It was stated in the *Kew Bulletin* (l. c. p. 93) that "*Eucommia ulmoides* promises to be hardy at Kew." As will be seen from the following note by Mr. W. J. Bean, the Assistant Curator, this expectation has been fully realised :—

Eucommia ulmoides has been grown out of doors at Kew without any protection for the last six years. None of the winters during that period have been very severe, but on one or two occasions about 20° Fahr. of frost have been registered. The plants have never been in the least affected, and I have very little doubt but that the species will prove quite hardy in most parts of Great Britain.

It is a vigorous, free-rooting plant and bears transplanting well. It will, I believe, thrive in any soil of average quality, but seems to prefer a rich light loam. In such a soil at Kew, young trees struck from cuttings five years ago are now 6 feet high and make shoots 2 feet to 2½ feet long in one season.

It can be propagated easily by means of cuttings, and with these two methods may be adopted. The quickest method is to take pieces of the current season's growth, about 6 inches long, in late July or early August, insert them in pots of very sandy soil (the usual mixture for cuttings), and then place the pots in a house or frame where slight bottom-heat can be afforded. The cuttings should be made of shoots in what gardeners term a "half-woody" condition. They will take root in a few weeks and can then, after a "hardening-off" period, be planted in nursery beds. The second method is to make the cuttings of the leafless wood in November and dibble them in sandy soil in a cool frame or out of doors under a *cloche* cr hand-light. They will take root the following spring. This method is not so quick as the other, nor have we found it so sure.

We have had no experience with plants raised from seed, but we find that with plants raised from cuttings it is necessary, in order to make them assume a tree-like form, that they should be pruned for the first few years. This pruning consists in keeping the plant to a single leader by the removal of rival ones, the shortening back of side shoots that have become unduly vigorous, and the gradual removal of the lower branches as the tree increases in height till a clean trunk of (say) 6 feet has been formed. Unless the plants are pruned they assume a more or less bushy form.

IX.—COLORADO RUBBER.

(*Hymenoxys* sp.)

[*K.B.*, 1906, pp. 218–219.]

Early in 1904 a correspondent forwarded to Kew an extract from the *Denver Post* of 26th November, 1903, which gave a somewhat enthusiastic account of the discovery by a prospector in Colorado of a rubber-yielding plant. This was spoken of as occurring abundantly in the hills and mesas in the vicinity of Salida, the belt extending into the San Luis Valley, Gunniston County, and as far south as New Mexico. In June, 1905, Mr. E. Naylor, of Bradford, presented to the Museum at Kew a specimen of the dried plant, together with samples of crude and manufactured rubber obtained from it. Mr. Naylor subsequently also communicated seeds of the plant.

Mr. T. D. A. Cockerell, to whom the Museum is also indebted for specimens of the plant and of its rubber, published an account of the species in the *Bulletin of the Colorado Museum* for December, 1903. The plant, which is a member of the natural family *Compositae*, is there identified as *Picradenia floribunda*, *utilis*, which Mr. Cockerell considers to be part of the aggregate *Actinella Richardsoni*. Subsequently, in the *Bulletin of the Torrey Botanical Club* for 1904, p. 461, the same author has indicated that *Picradenia* may be considered a subgenus of *Hymenoxys*, Cass. If this view be correct the Colorado Rubber plant is therefore a species of *Hymenoxys*.

In July, 1906, Mr. Naylor forwarded to Kew a further supply of material. Accompanying this was the following extract from the letter which Mr. Naylor had received with the specimens :—

"I have obtained a sample of crude rubber from the experimental plant at Buena Vista; this is, of course, not vulcanised, and if kept in a warm place will become soft and sticky. The round piece is just as it comes from the plant; the flat piece is after its second trip through the machine, and in this form is shipped east to the refinery. The full size of the pieces as shipped is 10 to 15 feet long and 18 inches wide. The root of the native plant yields about 10 per cent. of rubber."

From the evidence thus obtained there is hardly room for doubt that this species of *Hymenoxys* yields a rubber-like product. This does not, however, compare favourably with many of the lower grades of rubber already on the market. It is therefore somewhat doubtful whether the expectations which have been formed regarding it in some quarters will be realised.

X.—SOUDAN PRODUCTS.

[*K.B.*, 1899, pp. 198, 199.]

Comparatively little is known at present as to the available resources of the Soudan. The following preliminary account appears in the *Board of Trade Journal* for July of the present year (pp. 30, 31) :—

On the White Nile, in the Bongo and Rohl districts, the india-rubber creeper (*Landolphia florida*) is found in great profusion. If the rubber yielded by this creeper be not of quite so good a quality as that obtained from the Assam india-rubber tree (*Ficus elastica*), it is still of sufficient value to be counted as an important asset in the future trade of the Soudan. This plant, which has large laurel-shaped leaves, and a white flower resembling a jasmine, requires several years to mature before yielding rubber in any quantity. The natives obtain what they require by tapping the stem, usually in such a reckless manner that the creeper dies under the operation. The Assam india-rubber tree should certainly flourish well in most parts of the Soudan, more particularly south of Khartoum. Although this tree takes from twenty to thirty years to arrive at a girth sufficient to permit of regular tapping, its yield is so valuable (about 3*l*. per tree per annum) that its introduction into the country is well worth attempting.

XI.—MADAGASCAR INDIA-RUBBER.

[*K.B.*, 1899, pp. 35–39.]

Enquiries are frequently made about the rubber-producing plants of Madagascar. This island has long been known to furnish a supply of india-rubber to commerce. (See *Kew Bulletin*, 1892, p. 70 [p. 5].) Hitherto it has been supposed to be yielded exclusively by species of *Landolphia*, the "rubber-vines" which are so widely distributed in Tropical Africa. Within the last few years it has been obtained, and apparently in abundance, from a number of other plants.

About 1892 an immense development of the rubber-trade took place in Southern Madagascar. The following account is borrowed from the *India-rubber and Gutta Percha and Electrical Trades Journal* (Nov. 3, 1893, p. 107) :—

The French Vice-Resident, writing from Nossi Vé (not to be confounded with Nossi Bé)—his report appearing in the *Moniteur Officiel du Commerce* of November 2nd—says :—"Caoutchouc has only been exploited in the southern regions since the first months of 1892, and the first operations, conducted with discretion, have given very brilliant profits ; since then the affair has been blazed abroad ; a veritable caoutchouc fever has raged with everyone, especially the natives. Everything has been neglected for the rich product, leading to great modifications in wages, in the recruitment of workers, and in the prices of food and goods, &c. But the exploitation of caoutchouc has been carried out with veritable vandalism ; the trees and shrubs producing it have been

savagely destroyed ; hence the diminution in the yield, as well as in the quality, because the natives have mixed other substances with the caoutchouc to increase the size and weight of the balls."

Some further information which has attracted a good deal of attention appeared in a letter from Mr. Abraham Kingdon which appeared in the *Standard* of Dec. 22, 1896.

I call your attention to the arid district of St. Mary's, the southernmost part of Madagascar, from which district an enormous amount of india-rubber has been procured during the last few years.

The india-rubber is procured from an almost leafless shrub with a large bulbous root. The discovery that this shrub produced india-rubber was made by a "fluke." Up to the time of the discovery, india-rubber had only been procured from *Landolphia*, which grows freely in all the low-lying parts of Madagascar, north of the arid district of St. Mary's. One day, however, a young native (who did not believe that india-rubber could be procured from anything but the *Landolphia*) brought two balls of india-rubber to Mr. Marchal, of Fort Dauphin. He said, "I have brought you two balls of something which looks like india-rubber ; but I do not think it can be india-rubber, because it was not procured from the vahy (*Landolphia*) ; but if you will buy some of it I will bring it to you." He added, "I saw some boys playing with these balls. They were made from the juice of a shrub, which coagulates as soon as it is exposed to the air."

Mr. Marchal said that he was not a chemist, and as he did not know whether it would turn out right in the process of manufacture he did not care to risk much. The natives offered to sell at five dollars (one pound) per hundred lbs., and Mr. Marchal accepted the offer. The rubber was brought in such large quantities that Mr. Marchal was very soon cleared out of goods and cash, but as he had been twenty-five years a resident of Fort Dauphin, and was trusted, the natives brought him large quantities on credit. He was able to load a small barque, and took the cargo to Mauritius, where he sold his india-rubber at twenty dollars (four pounds) per hundred lbs. For about eleven months Mr. Marchal had a monopoly, and during this period he cleared twenty-six thousand pounds net profit. The same kind of india-rubber is now sold at Fort Dauphin at forty-five and fifty dollars per hundred lbs. Unfortunately the natives destroy the shrub in the operation of collecting the india-rubber ; for, in order to take the milk from the bulb, they root up the shrub.

For the most recent information Kew is indebted to the following communication from the Foreign Office :—

FOREIGN OFFICE TO ROYAL GARDENS, KEW.

SIR, Foreign Office, September 3, 1898.

I AM directed by the Secretary of State for Foreign Affairs to transmit to you the accompanying copy of an article extracted from the *Dépêche Coloniale* respecting the cultivation of India-rubber in Madagascar.

I am, &c.,

The Director, (Signed) F. H. VILLIERS.
Royal Gardens, Kew.

EXTRACT from the *Dépêche Coloniale*, August 28, 1898.

The Exploitation of India-rubber in Madagascar.

The localities favourable for the cultivation of india-rubber in Madagascar are numerous, especially on the coast and lower levels of the Island.

It may be expected that the efforts which may be made in this direction will fully succeed if, in establishing plantations, the essential conditions for producing the best india-rubbers are properly studied. The best known rubber-trees are : the *Hevea*, *Manihot*, *Castilloa*, *Landolphia*, *Willughbeia* and *Ficus*.

Besides the vines (*Landolphia*) and the Euphorbiaceae of the south, there exists a tree met with on the east side of the Island which the natives designate *barabanja*. This tree, which furnishes an abundant and much-prized latex, appears destined to play an important role in the future. There are two varieties, the one, the more important, with large leaves, the other with small leaves. They belong to the family of the Apocynaceae, tribe Alstonieae.

The *barabanja* is abundant in the region comprised between Vohemar and the Bay of Antongil. The tree is found wild up to an altitude of 1,300 to 1,600 feet. It prefers the glades and borders of forests, and may attain to a height of 50 feet, with a circumference of 5 feet. Specimens of this size are, however, rare, for, about the age of eight or twelve years, the natives make excessive incisions, and very often even cut down the tree in order to gather the latex.

The tree propagates itself readily from suckers, and it is to this that the present abundance of the tree is due. Very fine specimens are reported from the neighbourhood of Antalaha, Sahambava and Soavinandriana.

The cultivation of india-rubber trees has already been tried in different parts of the Colony. The preference seems to have been given to plants of *Hevea*, from Para, which appears likely to give satisfactory results.

With regard to the production of india-rubber, certain regions of Madagascar have been specially favoured. In the province of Fort Dauphin, for example, where an increasing production has been most observed, there were only 12 to 15 tons a year of rubber taken up to 1890 from *Landolphia* vines (Vahea) and from species of *Ficus*. But the discovery of the Euphorbiaceous plant, commonly called "*intisy*," which gives a superior latex, has stimulated an important commercial movement towards this district ; the harvest has been collected more energetically, and this has resulted in the zone of the rubber production being reduced to a considerable extent.

For the last few months natives of the west of the province of Fort Dauphin have begun to bring a little rubber to the coast ;

but a European could not at present devote himself to regularly and systematically working the substance owing to the bad state of communication in the interior of the country.

During the journey from the forest to Fort Dauphin, the caoutchouc carried on the back, in loads of 65 lbs., loses from the heat of the sun a certain part of its weight. At the present moment, the production, together with the loss and cost of transport, comes to 1·05 fcs. per lb. If to this we add the expenses of packing, carriage to the sea, shipping charges, export dues at 0·10 fcs. per lb., the total price per lb. reaches 1·25 fcs. delivered on board the vessel in the Fort Dauphin Road. From Fort Dauphin Harbour alone there were exported in—

1896	...	...	...	167,857 kilos. (369,285 lbs.)
1897	...	...	...	64,222 „ (141,288 „)

In the province of Majunga, the india-rubber is one of the articles of export which occupy the largest place in the local commerce, and its importance increases each day. The rubber at Majunga comes from Morarano for the most part, from the bay of Mahajamba, from Namakia, Soalala, Marambitsy, and especially Maintirano and Morondava. Generally the rubbers from the west coast are produced from "vines," which the natives incise without any care, cutting even the roots in order to obtain the largest amount of sap. The most sought after is the "pink rubber," but one also finds the "*ambongo*," "*godroa*" and "*vea*." In the north the caoutchouc is generally prepared by the natives with sulphuric acid, lemon, salt, or juice of the tamarind; in the south, on the contrary, it is coagulated with salt only. The value of the latter in commerce is inferior to that of the north.

Rubber prepared with sulphuric acid is worth at the moment from 350 fcs. to 360 per 100 kilos. (220 lbs.), whilst other rubbers hardly fetch 300 fcs. per 100 kilos.

There were exported—

From Majunga, in 1896, 19,445 kilos.; in 1897, 41,448 kilos.
From Nossi Bé, in 1896, 11,340 kilos.; in 1897, 40,766 kilos.
From Nossi Vé, in 1896, 122,313 kilos.; in 1897, 122,129 kilos.

As soon as roads become more numerous in Madagascar, the colonists who wish to devote themselves to a rational cultivation and working of rubber will obtain good results; but they must act with judgment, and not take from the plant more latex than it can reasonably produce.

The botanical identity of the Madagascar rubber-yielding plants is obscure. It is much to be regretted that the French botanists do not investigate it and clear it up.

M. Henri Jumelle has devoted a chapter to the subject in his "*Les Plantes à Caoutchouc et à Gutta dans les Colonies Françaises*," pp. 104–116 (1898). Of the "vines" he states that the most valuable is the Vahy (*Landolphia madagascariensis*). Other forms of the native name are no doubt the Vahea and Vea men tioned above. It appears to yield "pink rubber."

Intisy is a small leafless Euphorbiaceous tree. It is certainly the shrub described by Mr. Kingdon. What he terms the "large bulbous root" is probably the fleshy stem.

Little appears to be known about the *barabanja* except that it is a tree of fifty feet in height. It may be conjectured that it is an undescribed *Tabernaemontana*.

The late M. Raoul sent to Kew a specimen of what he described as the "best rubber-yielding plant in South Madagascar," which appeared to be a new species of that genus, or possibly a *Mascarenhasia*.

The *Godroa* is a small tree, perhaps also Apocynaceous.

XII.—MADAGASCAR INDIA-RUBBER—*(Continued)*.

[*K.B.*, 1900, p. 30.]

Landolphia Perieri.—The following information supplements that upon Madagascar india-rubber in a recent number of the *Bulletin* (1899, pp. 35–39) [p. 26]. It is borrowed from three communications by M. Henri Jumelle, the first to the Académie des Sciences, Paris (*Comptes-rendus*, cxxix., pp. 349–351), the others to the *Revue des Cultures Coloniales* (v., pp. 104–109 and 154, 155).

Landolphia Perieri is a rather slender liane of the forests in Madagascar lying between the watershed and the north-west coast. Its stem attains 6 inches in thickness, but slowly, and the majority of stems met with are much smaller. The natives who apply the names of 'Piralahy' and "Vahealahy" to the plant, make rubber from it by cutting these stems into lengths, collecting the latex which drips from the ends and coagulating it with lemon juice or with bruised fruits of the tamarind. The latex is very thin and watery, so that a whole day's work results in but a little more than a pound of rubber selling on the spot at $6\frac{3}{4}d.$–$9d.$ The small return for the labour has caused the collectors to forsake their occupation for gold-mining.

M. Jumelle notes that better preparation would ensure a better price. Coagulated by being boiled or allowed to dry, the rubber is dark and of poor quality (cf. *K.B.*, 1892, p. 70); but a number of reagents precipitate a pinky-white caoutchouc. These reagents are notably acids—sulphuric, acetic, or citric—or salts; amongst the latter are common salt and Chili saltpetre.

It has not been customary for the Sakalavas to interfere with the root; and after the stem has been cut to the soil a number of shoots spring up which in two to three years may possibly be ready to cut again.

XIII.—WEST AFRICAN RUBBERS.

[*K.B.*, 1889, pp. 63–66.]

The information contained in the following correspondence and papers in respect to West African rubbers may be usefully perused in continuation of that already published in a recent number of the *Kew Bulletin* (November, 1888, p. 253) [p. 141] :—

FOREIGN OFFICE to ROYAL GARDENS, KEW.

SIR, Foreign Office, 17th June, 1887.

I AM directed by the Marquis of Salisbury to transmit to you herewith certain samples of india-rubber which have been obtained from a district under British protection to the west of the Rio del Rey, by Mr. H. H. Johnston, British Vice-Consul at Old Calabar, during an exploration made by him of that region, and I am to desire you to submit the samples in question to an examination by some specialist in order that their quality and value may be tested, and to report the result to this Department.

I am, &c.,
(Signed) T. V. LISTER.

W. T. Thiselton-Dyer, Esq., C.M.G., &c.,
Royal Gardens, Kew.

Mr. S. W. SILVER, F.L.S., to ROYAL GARDENS, KEW.

3, York Gate, Regent's Park, N.W.,
DEAR SIR, 27th July, 1887.

REFERRING to mine of the 29th ultimo, I have the pleasure to forward a copy of the report from our chemist at Silvertown, with samples showing the results, and to state that sample No. 2 has a market value of 1*s.* per lb.; No. 3 (dark), 1*s.* 6*d.*; No. 3 (light), 1*s.* 10*d.* and 2*s.*; No. 5, about 2*s.* 3*d.*

I am, &c.,
(Signed) S. W. SILVER.

D. Morris, Esq.,
Royal Gardens, Kew.

REPORT of the INDIA-RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Silvertown, 21st July, 1887.

Description, &c.—Four samples of india-rubber were received, marked respectively No. 2, No. 3, No. 3 (dark), and No. 5.

The samples marked No. 3 have been dealt with as duplicate samples of the same rubber. Sample No. 2 was black and sticky on the outside, due to oxidation; the freshly-cut surfaces were slate-grey colour. The rubber was firm and non-adhesive to the fingers. The samples marked No. 3 differed slightly in appearance, one was much darker than the other. The darker sample evidently would be more prone to decay than the lighter sample,

but still both samples are remarkably good for African rubber. Both these samples consisted of agglomerated tear-like masses, with red and pinkish particles strongly resembling rubber. Evidently, if these samples are from the same plant, the difference in colour of the tears must be due to the incision or puncture extending to different tissues. The light-coloured particles were very similar to good Ceara rubber. The freshly-cut surfaces of sample No. 5 were whitish in colour. It was very similar to the better specimen of No. 3, and as a raw article is quite equal to the best kinds of Brazilian rubber. On so small a sample, it would be difficult to say how it would behave in general manufacture. The behaviour of a specimen under manipulation is of primary importance in fixing its commercial value. However, this specimen is far above the best kinds of African rubber.

In Manufacturing, &c.—No. 2 lost 14·5 per cent. on washing and drying, becoming sticky and of course difficult to treat in the ordinary way. In quality it is very low, being inferior to flake African. Mixed with a suitable proportion of sulphur it vulcanized fairly well and free from sponginess. It would hardly be suitable for working by itself, but with firmer kinds of rubber it would mix well and yield a product suitable for many low class manufactures. The two samples marked No. 3 lost 5·6 per cent. on washing and drying. The samples were mixed together and behaved very well in grinding and mixing. It vulcanizes very well in being elastic, firm, and solid. In this stage it takes a dark colour, but is not offensive in smell.

No. 5 sample gave a loss of 8 per cent. on washing and drying. It vulcanizes very well, although dark in colour. Its smell is not offensive but strong.

Remarks.—As a rule the African rubbers give dark products on vulcanizing, and many of them have an offensive odour, which arises no doubt from the action of sulphur, in vulcanizing, on some principle contained in the natural sap of the plant yielding the rubber.

Messrs. Taylor, Laughland and Company, of Glasgow, recently forwarded specimens of West African rubber with a letter of which the following is an extract :—

One of our agents in Old Calabar, West Africa, has collected and sent us a few samples which he is very anxious to get classified, and thinking that you would help us in this, we have sent to-day to your address per Globe Parcel Express, carriage paid, a parcel containing these samples as per enclosed list. He is anxious to get the natives to cultivate the rubber vine and make rubber more freely. He says he has been up the country and finds the various kinds of rubber vines in great abundance, but no rubber is taken from them, as until quite recently the natives did not know that there was any value in it, and even now they do not know how to make the rubber from the juice. In order to teach them and secure the best plants, he has sent home specimens of the leaves of four common kinds of vines with the native names, and if you can give us the scientific names we shall feel much obliged. He

sends also the rubber from them, but, as you will see, it is very badly made. Can you say which is the most valuable of these four vines ?

Three of the four specimens sent were wholly inadequate for any determination. But one called Npok was identifiable as *Landolphia owariensis*, which is found from Sierra Leone to Angola and is no doubt the most important source of West African rubber. [*See* Kew Report for 1880, p. 38.]

An investigation into india-rubber milk received at Kew from the Niger delta is described in the following correspondence :—

38, Elthiron Road, Fulham, S.W.,
14th September, 1888.

DEAR SIR,

SEVERAL gentlemen to whom I have applied for information about india-rubber have recommended me to communicate with you. I therefore venture to ask if you can help me, and trust you will pardon me for intruding on your valuable time. To explain myself fully, let me say that I have for some years been trading on the West Coast of Africa, in the oil rivers (the deltas of the Niger). For some time past we have been endeavouring to introduce and foster the india-rubber trade, and have been partially successful. There are quantities of rubber trees and vines, but the natives of these districts, having hitherto never cultivated the article, are quite ignorant of the mode of preparing the milk obtained from these trees and vines to convert it into a commercial form. We are quite certain that this matter will open a wide field of commerce to the benefit of the native, the trader, and the consumer, if we could learn the mode of treatment. What I wish to ask you is if you can inform me of the best mode of congealing the milk as it is obtained from the tree. Accompanying this I send you a small sample of rubber milk in its natural state. Should you deem it worthy of your notice, I will most gladly furnish you with a larger sample for experimental or other purposes.

I am, &c.

(Signed) JAMES S. COCKBURN.

W. T. Thiselton-Dyer, Esq.,
Royal Gardens, Kew.

ROYAL GARDENS, KEW, to MR. JAMES COCKBURN.

Royal Gardens, Kew,
2nd November, 1888.

SIR,

I BEG to forward herewith a copy of a report received from S. W. Silver, Esq., F.L.S., on the sample of rubber milk from the delta of the Niger which you recently forwarded to this establishment.

2. I regret to notice that this substance is not of a character likely to be of use in commerce, and the results of the experiments are such as preclude any hope of solving the question of coagulating the milk in a satisfactory manner on this side.

3. If we had specimens of the leaves, flowers, and fruit of the tree from which the milk was obtained, we might then be in a position to suggest a treatment that would afford satisfactory results. At present we have no data upon which to work, and the matter cannot be carried any further.

4. We would suggest that steps be taken to procure specimens of leaves, flowers, and fruit of all rubber plants in the district in which you are interested, and we enclose instructions for collecting and preparing such specimens, so that they might arrive in this country in a suitable state for examination.

I am, &c.,
(Signed) D. MORRIS.

J. Cockburn, Esq.

[Enclosure.]

REPORT of the INDIA-RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, on SPECIMEN of INDIA-RUBBER MILK from WEST COAST OF AFRICA.

Silvertown,
October 26, 1888.

The contents of the tin were strongly acid ; on pouring out the same it was found that the tin contained a large quantity of already coagulated gum, which could only be removed by cutting off the lid. The part coagulated was treated by itself. The portion still liquid was emptied into open dishes, so as to cause a further separation of coagulum by evaporation. The portion which separated in this case was treated by itself. Both products were very sticky, and became more so as the washing process was continued ; they ultimately became quite unmanageable for the subsequent stages of drying, &c. ; the substance is quite unsuited for any ordinary india-rubber manufacture.

By destructive distillation it does not yield caoutchoucene, which is the principal characteristic of caoutchouc or india-rubber. The distillate more closely resembles in smell that of some principles, balsams, &c., which yield cinnamic acid. This is highly characteristic and of value in determining the suitability of a lactescent juice as a mercantile source of caoutchouc. The most suitable way of obtaining the coagulum from this juice is by leaving the same exposed in open vessels, and collecting what forms on the surface from time to time so as to increase the chance of further evaporation, &c. If it be intended to send these natural juices for examination, it will be best to add ammonia freely, so as to neutralise any acid which may be generated whilst in transit.

The Resident Manager adds : "We do not see our way to make use of this material We quite agree with your remarks to Mr. Morris as to the chemical change in these juices that takes place before they can arrive in this country."

XIV.—MANGABEIRA RUBBER.

(*Hancornia speciosa*, Gomez)

[*K.B.*, 1899, pp. 185–190.]

Beyond brief notices (1892, pp. 67 and 69 ; 1898, pp. 179, 180) [pp. 1, 4, 13, 14] no account of this rubber has been given in the pages of the *Kew Bulletin*. The following short notes appeared in the *Kew Reports* :—

Hancornia speciosa.—Our attention having been drawn to this plant as a source of Mangabeira rubber, steps were taken to obtain, through correspondents, a supply of seeds. These we have received, and the plants raised from them will in due course be distributed. The plant itself is well known (*see* Collins, *Report on Caoutchouc*, pp. 23, 24). The rubber appears to be of good quality, and the tree has also the merit of producing an excellent fruit about the size of an Orleans plum, and yellow in colour, speckled with red. The fruit, in fact, in Pernambuco, is more valued than the caoutchouc.

I extract the following information from Consul Bonham's *Report on the Trade of Pernambuco* (1879) :—

"Mangabeira rubber is obtained from the trees of that name, which are to be found in large numbers in the interior of this, as well as of the other northern provinces. The reports which I hear have been received from Liverpool of the reception of this article are far from favourable ; the price went up to 2*s*. 7*d*. per lb., but has fallen again, and it would appear that 1*s*. per lb. is about the price obtainable in England in ordinary times. An idea of the great value of this article having got abroad here, the price rose to an absurd figure, having during this last season varied from 8,000 reis, or 16*s*., to 26,000 reis, or 52*s*. per 15 kilos., or 33 lbs. The method employed in the preparation of the rubber is very primitive, and, I think, may easily account for the article not being well received ; if the milk were treated in a more careful manner, there seems no reason why the rubber should not be favourably received. At present the plan adopted is simply to mix alum with the milk, which causes it to coagulate ; the lumps of rubber are then placed in the sun, after which it is sent to the market ; from this defective mode of preparation a great loss of weight afterwards occurs, frequently as much as 40 to 50 per cent., some say even more." (1880, pp. 47, 48.)

A quantity of good seeds of this plant (*Hancornia speciosa*) were sent to Kew by Mr. C. Craven, of Pernambuco, and were distributed among the following Botanic Gardens :—Brisbane Calcutta, Ceylon, Demerara, Singapore, Java, and Jamaica. The seeds sown at Kew germinated freely, but owing to damp the plantlets all perished. Apparently this plant prefers a dry atmosphere and a sandy soil. (1882, p. 24.)

The following detailed account of the plant, and of the rubber obtained from it, is translated from a paper by Professor O. Warburg, in *Der Tropenflanzer*, *Zeitschrift für Tropische Landwirthschaft*, iii., p. 147 :—

"Mangabeira rubber is the product of *Hancornia speciosa*, a tree of the Natural Order Apocynaceae, found in those dry

regions of Brazil which lie to the south of the forests of the Amazon. It occurs on the so-called Campos cerrados, in the Provinces of Pernambuco, Bahia, Goyaz, Minas Geraes, Matto Grosso and São Paulo. In the Provinces of Bahia and Pernambuco the rubber is chiefly obtained. The tree is abundant in the Provinces of Goyaz and Minas Geraes, and, according to Edwall,* in such amount as to be a characteristic plant of their Campos cerrados. In the coffee-growing Province of São Paulo, the range of *Hancornia* crosses its northern limit, the Rio Grande, and extends to the Paranaparema on the south, *i.e.*, almost to the tropic of Capricorn, but seems to avoid the littoral zone and the coastal range known as the Serra do Mar: the chief places where it occurs are Serra Azul, Cravintras, São Simao, Araraquara, Casa Branca, Riberão Preto. While it is probable that as a wild plant it requires the well-marked dry period of its native campo, it can be grown in a more moist climate to a less luxuriant extent. Towards the west it spreads through Matto Grosso to the boundaries of Peru.

In Paraguay, at Jacuati, to the south-east of Concepcion, Balansa has collected a plant which, if not the same, is a very near ally. In the Gran Chaco, and in Paraguay, an abundant tree, known on the Guarani as Manga-icé, and probably identical, yields an excellent caoutchouc which is collected in considerable quantity by a primitive method about Villa San Pedro.

Description.

The Mangabeira tree of the Brazilians attains the size of an apple tree, *i.e.*, a height of 16 to 23 feet, but in the Province of São Paulo fails at scarcely 12 feet. It branches freely, forming a crown, the breadth of which often considerably exceeds the whole height of the tree. Its many rather pendulous branches bear short lateral branchlets, and are leafy only at the extremities. The young twigs are brownish and smooth, the old branches encased in a corky bark. The opposite paired leaves are elliptic or long-elliptic in shape, are contracted towards the rounded apex, 2–4 in. long and $\frac{1}{2}$–$1\frac{1}{2}$ in. broad. The leaf-stalks are short—as a rule but $\frac{1}{5}$ in. long. In nervation the leaf is well marked; it has a straight midrib from which on either side spring numerous veins parallel to one another, and sometimes forked to support the margin, close to which they end.

The flowers are shortly stalked, about $1\frac{3}{4}$ in. long, and grouped as many as seven together, on the ends of the branches. The calyx is small, about $\frac{1}{10}$ in. long, glabrous or hairy, with five small, ovate, obtuse teeth. The corolla is $1\frac{1}{3}$–$1\frac{3}{4}$ in. long, with a long, narrow cylindric tube blocked by hairs at the middle, and with five small lanceolate somewhat reflexed lobes, half as long as the tube. The five stamens are inserted on and enclosed within the corolla-tube, and have lanceolate acute anthers. The style is filiform, long, and bears at its apex a two-lobed stigma. The ovary is two-celled, with many ovules in each cell, of which but one cell and a few ovules mature in the ripening fruit.

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* Gustavo Edwall, "Die Mangabeira," in Deutsche Zeitung S. Paulo, No. 99, 1898.

This fruit is of the size of a plum, fleshy, with an agreeable taste, and contains the few matured seeds embedded in the flesh. When ripe it is yellow, with blotches and streaks of red. It keeps but a short time, yet is much prized as a food, being eaten fresh and cooked in many ways. While the Portuguese call it Mangába, the natives use the name Tembiú-catú, which means "good to eat." A drink as well as a conserve is made from it.

Climatic Requirements.

According to information from Mr. S. Woldern, British Vice-Consul in Ceará, the tree grows wild in all wooded districts, on sandy soil. For its culture sandy soil in the plains, especially toward the coast, is most suited. The statement that the tree grows from 3,000 or even 4,000 to 5,000 feet above the sea is, according to Marval Irmaos, of Bahia, incorrect, the plateaux on which it occurs being but of 500 to 600 feet elevation.

Cultivation.

But little positive information is to hand under this head. In most of the great gardens of Asia and the West Indies the tree seems not to be grown, although in 1880 steps were taken by the Botanic Gardens of Kew to cultivate it. Seeds were received and seedlings raised at Kew, but of the result we have no information.

At any rate, the tree needs no shade. Experiments are needed as to the best method of propagating it, which in the Province of São Paulo is done both by cuttings and from seed.

Yield.

Equally little is certain at present about the yield. When four or five years old, or, according to other trustworthy authorities, when six years old, the tree is mature enough to be tapped. This is done by cutting a spiral groove or, as is preferable, oblique incisions in the bark at some distance from one another, eight of such, perhaps, in the whole length of the trunk. Below the incisions, by the use of a little moist clay, a trough is made to catch the juice as it runs out. At the end of a quarter to half an hour the supply is exhausted. This may be 2 lbs. and upwards, though in the rich parts of São Paulo—the terra-roxa (red earth) district, celebrated for its coffee—as much as 11 lbs. of juice may be obtained. A colouring matter in the bark gives to the fresh juice a delicate rose tint.

The latex from the little clay collecting troughs is then poured into larger vessels, and mixed with alum (Stauss' method). This produces coagulation in two or three minutes. Two teaspoonsful of alum solution are sufficient for milk enough to fill two or three bottles. The caoutchouc is then pressed by hand, and hung on sticks in the sun for eight days to allow the water to exude and drain off. The product thus prepared is in the form of large cakes called biscuits ; it still contains much water, and belongs to the class of caoutchoucs known as moist rubbers.

It is obvious that the making of the rubber into thin "sheets," instead of biscuits, is of advantage, for it gives facilities for drying, and consequently adds to its value. This mode of procedure has recently begun to take a place in the preparation. Other changes are suggested by Biffen's method of obtaining pure caoutchouc by the use of a centrifugal machine. Cannot some method of collecting and preparing Mangabeira rubber be found which will yield more nearly such a product as the trade desires?

Trade.

"Pernambuco biscuits" are large rectangular cakes of a reddish-brown colour outside, but bright rose-coloured inside, with a peculiar sweet scent, full of cavities containing a solution of alum, and usually with marks of its exudation on the surface. In the working up of the rubber, a loss, sometimes of as much as 40 to 60 per cent., occurs. The caoutchouc is but little elastic, hardens with age, breaks and tears—faults attributed to the presence of the alum. The demand for such rubber is small, and due chiefly to its pleasing colour; and the price in consequence is but half that of Para rubber.

Recently, however, the price of Mangabeira rubber has advanced by reason of the improvement in the purity, and on account of its great suitability, when pure, for certain purposes. In consequence, the disparity between the price of the best sorts and that of Para rubber is much diminished. At the end of last year, a kilogramme (2 lbs. 3 ozs.) of the best Mangabeira rubber sold for upwards of 12 milreis (almost 8 shillings), a price not far short of that of Para rubber. An additional cause of the advance in price is to be sought in the change in making up the rubber; for, owing to the constant watch which is necessary to guard against adulteration by addition of iron or stones put in to make weight, pieces of rubber only $\frac{1}{2}$–$\frac{3}{4}$ in. thick and 2 ft. long by 10 ins. broad, the so-called "sheets" of commerce, are welcome in the trade.

Of recent years, the exploitation of this source of rubber has taken a considerable extension. And, while the intelligent collectors, who start from Bahia and work toward the interior, have only tapped mature trees, improvident itinerant collectors, making their own profit out of the pressing demand of the time, have in many places mischievously drawn on the supply and threatened its continuance.

The chief centres for export of Mangabeira rubber are Bahia and Pernambuco. A large supply is brought down the river São Francisco, and so to Bahia; and from this town, in 1889, 134 tons were exported; in 1892, 4,362 bales, to the value of £22,826; and in 1893, 3,293 bales, to the value of £20,362. From Pernambuco were exported, in 1896, 54 tons, to the value of £1,800.* A small amount of caoutchouc from the Province of Matto Grosso (probably Mangabeira rubber) is exported down the Parana through Paraguay, and great quantities from Minas Geraes are shipped through Rio de Janeiro.

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* Probably an error for £18,000.

Recently, the Province of São Paulo has begun to demand a place in the consideration of rubber export. Regions here, such as that through which the Mogyana railway runs, are exploited, even by persons coming from Bahia for the purpose, the owners of the land receiving, in return for the permission they grant, one-third of the clear profits. A worker can collect about 6½ lbs. of rubber per diem, and receives on the spot 75 milreis (£2 9*s.* approximately) per arroba (32⅓ lbs.). The arroba is sold in London for 200 milreis. In the first half of the year 1898, no less than 76,498 kilogrammes (approximately 78 tons) of rubber were passed over this railway, and yet the railways of Paulista and Sorocaba equally traverse the country where the Mangabeira tree grows. In consequence of the increasing trade, Santos has become an important centre for rubber, and there, as at the town of São Paulo, now exist mercantile houses whose principal concern lies in this business.

In this Province, an idea of the importance of cultivating and protecting the tree is arising. Many coffee-planters are turning their attention to the sowing of *Hancornia*, and seed is already hard to procure. The Government hoping, by means of the duty on rubber (now standing at 13 per cent. ad valorem), to recuperate its finances, which have become disordered by the depreciation of coffee, has instructed Dr. A. Uchoa Cavalcanti, Acting Director of the Agricultural Institute at Campinas, to inspect the territory in question ; and further, the Congress of the State has decreed that the Mangabeira tree shall be protected, and its cultivation extended, as is advisable.

This decree, in brief, runs as follows : —

Article 1. §i. A premium of 25 contos of reis (25,000 milreis, or about £784) shall be paid to him who, within four years from the passing of this decree, shall show that within a distance of 60 kilometres (37 miles) of a railway, he has planted and cultivated, for two years at least, the greatest number of Mangabeira trees, preserving between the trees enough room for their free development.

§ii. A premium of 15 contos (nearly £470) to him who shall have planted the second greatest number.

§iii. A premium of 15 contos to him who shall have fulfilled all the conditions of the first paragraph, excepting the requirement with regard to the distance from a railway.

§iv. A premium of 25 contos to him who, within the same space of time, and within the prescribed 60 kilometres of a railway, shall have cultivated, for two years at least, the greatest number of Mangabeira trees, provided that at the same time he shall have enclosed the ground, and removed all other trees.

§v. A premium of 15 contos to whoever shall have cultivated, etc., the second greatest amount.

§vi. A premium of 15 contos to whoever shall have fulfilled all the conditions of the fourth paragraph, except the requirement with regard to the distance from a railway.

§vii. A premium of 10 contos (about £313) to whoever shall prove that within the same lapse of time he shall

have acclimatised in a manner profitable from the agricultural standpoint any other species of rubber tree, *e.g.*, *Manihot Glaziovii.*

Article 2. A premium of 15 contos of reis to whoever shall show that within the same time he has devised the best method of extracting the latex.

Although but little is known so far of the cultivation of Mangabeira, it may be said that there is a considerable probability of it becoming an important tree in rubber-culture. The apparently easy accommodation of the tree to soil and climate, its early and considerable yield, together with the fact that even under the rough treatment of the Indians it preserves its fruitfulness, and also the facility with which it can be cultivated, promise a future. And, taking a wide view of its possibilities, from its presence in the red coffee-growing soils of the west of the Province of São Paulo, it appears suitable for the red-earths of the German Colonies of Africa, Usambara and Togoland alike, such, for instance, as occur at Misahöhe, in the latter colony. For these soils it promises to be considerably better suited than the Ceara rubber plant (*Manihot Glaziovii*), and the Para rubbers (*Hevea*), and will probably give better results than *Castilloa*, than which it is more hardy, earlier maturing, and smaller."

XV.—FORSTERONIA RUBBER.

(*Forsteronia gracilis*, Benth.)

[*K.B.*, 1888, pp. 69–71.]

The flora of British Guiana is in course of being carefully and intelligently investigated by Mr. Jenman, the Government Botanist and Superintendent of the Botanic Garden at Georgetown. The critical determination of the plants is carried on at Kew, where typical specimens are added to the collections of Guiana plants already existing in this establishment. Among the plants for which we are indebted to the zeal and sagacity of Mr. Jenman there are many of economic value. Recently we received from him dried botanical specimens and sample of rubber from a plant locally called Macwarrieballi, not hitherto known to yield caoutchouc. A botanical examination of the specimen by Professor Oliver proved that this plant was a species of *Forsteronia* (*F. gracilis*, Benth.), a genus of *Apocynaceae*. This family is extremely rich in india-rubber plants, and comprises all those which yield rubber of African and Malayan origin. The plant under notice appears from Mr. Jenman's account to be "a large twining plant, the stem of which trails on the floor of the forest, snake-like, and the head spreads over the tops of the highest trees above." He continues: "the flowers are not quite out. I send also a sample of the rubber, which, if you could obtain a report on, I should be greatly obliged. It is discoloured from the creek water in which it was washed, the only kind of water that was there obtainable. The fresh milk seems to be rich beyond any I have before found in caoutchouc. The only defect I experienced is that it dries slowly, remaining sticky for some time."

Through the kindness of Mr. S. W. Silver, F.L.S., to whose good offices in connection with the investigation of numerous samples of rubber this establishment is greatly indebted, we have been favoured by the India-rubber, Gutta-percha, and Telegraph Works Company, Limited, of Silvertown, with an interesting report, dated 20th January, 1888, upon the properties of this new kind of rubber from British Guiana. We are informed that the substance possessed "so many valuable properties, that it would be well to ascertain whether a larger quantity could be placed in our hands for further experimenting. The present quantity is far to small to enable anyone to say whether it would be practicable to extract or utilise the large quantity of caoutchouc which it contains, so as to give this substance a position of commercial importance.

"We note the remark as to its being 'discoloured by being washed in peaty water'; this treatment has in no way interfered with our being able to report upon it. One side of it is coated with a brownish substance of a resinous character, and is evidently produced either by oxidisation of the resin itself, contained in this substance, or from some other cause.

"The substance, as it is, cannot be worked at all with the present india-rubber appliances; this is due to its adhesiveness. This introduces the serious difficulty of removing water from it by any ordinary process of drying, which is *essential* with india-rubber.

On removal of the resin, the caoutchouc is recovered in a soft sticky condition, quite unfit for manipulating as india-rubber.

"When a substance of such promise is sent for examination, it is not only important that a larger supply should be available for the purposes of a preliminary examination, but for subsequent experiments; frequently an application has been found for a vegetable product by accident, from being able to fall back upon it, as it were, as opportunity presents itself."

So far, there appear good grounds for believing that if the plant from which the rubber was extracted exists in any quantity in the interior of Demerara, the collection of the rubber would be a very promising commercial undertaking.

In connection with this subject, it may be useful to draw attention to the fact that another species of *Forsteronia* (*F. floribunda*), called in Jamaica milk-wythe or green-wythe, has long been known to yield caoutchouc. In the Report of the Director of the Botanical Department, Jamaica, 1883, p. 17, it is stated that, "an indigenous plant, known as the 'green withe' of Jamaica, yields excellent rubber, a specimen of which was sent to me by the Rev. E. Bassett Key.

"This plant, probably a species of Echites [*Forsteronia*] is found only in the interior woods of Manchester and St. Elizabeth, and, so far, I have been unable to obtain specimens in flower or fruit."

In the Report for the year 1884, pp. 46–47, it is further stated that the "indigenous plant, known as the 'milk-withe,' found in the mountains of Manchester and St. Elizabeth, yields an excellent rubber.

"A specimen of what I believe to be the same rubber was presented some years ago to the Museum of the Pharmaceutical Society of Great Britain by Mr. John Sawyers, of Derry, in the parish of Manchester.

"The plant yielding this rubber has now (thanks to further specimens sent to me by Mr. Bassett Key) been determined at Kew as *Forsteronia floribunda*, G. Don."

XVI.—JAMAICA INDIA-RUBBER.

(*Forsteronia floribunda*, G. Don.)

[*K.B.*, 1888, pp. 292–294.]

Latterly attention has been drawn in the *Kew Bulletin* to more than one direction in which it may be hoped to enlarge our supplies of india-rubber, and correspondents of this establishment, at home and abroad, have suggested improved methods of tapping the trees and coagulating the milk, so as to produce the best qualities of commercial rubber.

The principal papers on these subjects are: Nicaragua, or Central American rubber (*Castilloa elastica*), *Kew Bulletin*, December, 1887, p. 13 [p. 170]; Macwarrieballi or Demerara rubber (*Forsteronia gracilis*), March, 1888, p. 69 [p. 40]; and Lagos rubber (*Ficus Vogelii*), November, 1888, p. 253 [p. 141].

To these may now be added a further note on a new rubber plant, native of Jamaica, which has already been referred to in the *Kew Bulletin* for March of the present year (pp. 70, 71) [p. 41] as *Forsteronia floribunda* (Grisebach's *Flora, British West Indian Islands*, p. 412). This plant is known locally as the milk-wythe or milk-vine. It appears to be entirely confined to the Island of Jamaica, and is found as a climbing shrub in the mountain woods of the interior in the parishes of Manchester and St. Elizabeth. It is closely allied to the Demerara rubber plant already mentioned, but the caoutchouc, judging by the results of experiments made by the India-rubber and Gutta-percha Company of Silvertown, appears to lend itself more readily to the requirement of manufacture.

Attention was first drawn to the Jamaica rubber plant in the Report of the Director of the Botanical Department, 1883, p. 17, and again in the Report for the year 1884, pp. 46, 47, from which the above particulars have been taken :—

ROYAL GARDENS, KEW, to COLONIAL OFFICE.

Royal Gardens, Kew,
26th October, 1888.

SIR,

I HAVE the honour to forward herewith the accompanying papers relating to an important india-rubber plant (*Forsteronia floribunda*, G. Don), native of Jamaica, which has been in course of investigation by this establishment.

2. The inquiry in regard to this plant was first taken up some time ago, but recently at the request of Kew, the Rev. E. Bassett

Key, who throughout has taken a warm interest in the subject, forwarded here a bottle of latex for the purpose of determining the commercial value of the rubber.

3. The report of the India-rubber, Gutta-percha, and Telegraph Company of Silvertown, obtained through S. W. Silver, Esq., F.L.S., proves that this native rubber of Jamaica is of high industrial value, and it might give rise to an important local industry if it were found possible to increase the plant by cultivation and to pursue the subject in a systematic manner.

4. On this latter point the Government of Jamaica will, no doubt, consult Mr. Fawcett, Director of the Botanical Department.

5. The supply of india-rubber as a forest product is destined to fall far short of the supply, and under these circumstances the Government of Jamaica might be glad to be placed in possession of information as regards a native rubber plant which stands so high in intrinsic value. Various samples of commercial rubber manufactured from the Jamaica plant are enclosed.

I am, &c.,

Edward Wingfield, Esq.,
Colonial Office.

(Signed) D. MORRIS.

[Enclosure.]

INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY to ROYAL GARDENS, KEW.

Silvertown, London, E.,
17th October, 1888.

The sample received with letter from Kew, dated 12th September, 1888, consisted of a lactescent juice partially coagulated, with a strongly acid reaction. Fortunately it was contained in a stout glass bottle, about 10 ounces capacity.

The portion which had coagulated in the bottle could be removed only by fracturing the same. It was rinsed out so as to free it from adherent non-solidified milk, &c., and treated subsequently by itself. It will be referred to hereafter as A.

The non-coagulated portion was mixed with about twice its volume of water, with about an ounce (fluid measure) ordinary acetic acid, British Pharmacopoeia strength, &c. After a few days' exposure the coagulum rose to the surface in a fairly coherent form, and was collected and squeezed. This portion will be referred to hereafter as B.

The residual liquid was evaporated to complete dryness (and yielded less than half-ounce of solid, principally saline, matter, gum, &c.) so as to ascertain whether the juice itself contained any principle likely to produce a detrimental effect on the product, by any subsequent process of coagulation or inspissation. So far as we can see, the portion of the juice or sap which is rendered insoluble by evaporation would give the rubber a dark colour, and render it short. The finest Para rubber contains the entire juice or sap of the tree; the aqueous portion evaporates during the process of coagulation. It is doubtful whether the juice of the *Forsteronia floribunda* could with advantage be treated in this

way. The juices of india-rubber producing plants are alkaline or neutral, never acid. By a process of fermentation which soon sets in, the nitrogenous or other constituents of the juice produce sufficient acid to cause a separation of caoutchouc. Whether the *Forsteronia floribunda* juice, if exposed in an open vessel, would part with the whole of the caoutchouc in this way would be worth trying, with the recently collected juices.

It is quite possible that it would be an advantage to recover the caoutchouc as it was coagulated without using any artificial means; the mother-liquor should not be thrown away, but should be continually worked up with fresh juice.

The method recently given by Mr. Alvan Millson for the recovery of caoutchouc from the "Abba" tree, is admirably adapted for the treatment of the juice of the *Forsteronia floribunda*.

The rubber from this plant is so remarkably good that no time should be lost in submitting samples prepared on the spot. The rubber cannot be seriously deteriorated by any process likely to be used in its recovery.

There is no doubt but that the examination of the natural juice of a plant will, in most cases, enable one to point out what precautions should be taken to ensure the best result; still, the fact must not be loss sight of that such an examination might lead one to suggest methods difficult of being carried out under surrounding circumstances.

The juice of the *Forsteronia floribunda* yields roundly one pound of dry and washed caoutchouc, or about 22 ounces of ordinary crude caoutchouc as generally met with, per quart.

A.—About $2\frac{1}{2}$ ounces of this product was recovered, the weight being that of the washed and dried article. In colour and strength it approaches more nearly to the better descriptions of Para rubber. Mixed with sulphur and treated it vulcanized perfectly, in being solid, firm, and strong. It is a light colour when vulcanized.

B.—About $1\frac{1}{2}$ ounce of this product was recovered when washed and dried. It was much darker in colour than sample marked A. This remark applies also to the washed product, but it is not nearly so tough as A.

XVII.—NEW RUBBER INDUSTRY IN LAGOS.

(*Kickxia africana*, Benth.)

[*K.B.*, 1895, pp. 241–247.]

In the *Kew Bulletin*, 1888, pp. 253–261 [p. 141], there is an account of rubber extracted at Lagos from the "Abba" tree (*Ficus Vogelii*, Miq.). A further account is given in the *Bulletin*, 1890, pp. 89–93 [p. 150]. This rubber, although promising, "could not be used by itself," and attention has since been devoted to other sources of supply. In West Africa it is well known there are numerous plants yielding commercial rubber. The chief of these are species of the Apocynaceous genus

Landolphia, consisting of climbing shrubs, with stems 4 to 6 inches in diameter dividing above into numerous branches, and supporting themselves on neighbouring trees. From these, and similar plants, a very important rubber industry was started at the Gold Coast by Sir Alfred Moloney, K.C.M.G., in 1882; and although previous to that year no rubber whatever was exported from that colony, it had attained in 1893 to the annual value of £200,000. This is a remarkable and striking instance of the creation of a new industry by official action, and it deserves to be recorded. In 1882 Sir Alfred Moloney addressed a letter to the "Lagos Times" (*Forestry of West Africa*, pp. 83–88) strongly recommending attention to the possibilities of a similar rubber industry in Lagos, and suggesting "the adoption of measures having for their object the addition of one more to the industries of the colony." The result of this was not immediately apparent. But in 1894 the present Governor of Lagos, Sir Gilbert T. Carter, K.C.M.G., issued the following notice, as appears from the *Report* on the Botanic Station for the quarter ending the 30th June, 1895:—

"His Excellency, the Governor, desires to notify to the mercantile community of Lagos that he has been able to induce a party of natives from the Gold Coast experienced in rubber collecting to come to Lagos, with a view to the development of this valuable and important industry. The men have already inspected certain districts, which they report to be rich in rubber-producing plants, and it is confidently hoped that Lagos will shortly be able to compete with the sister colony of the Gold Coast in the great export of the product."

Following this came the announcement that a new rubber-yielding plant had been discovered in the colony of Lagos, and that it was a large tree abundantly distributed in the interior forests.

In the report on the Botanic Station at Lagos for the quarter ending 31st December, 1894, the Curator states: The rubber industry of the colony is rapidly extending. Large quantities are collected around Jubi Ode. There is no doubt that the rubber supply of West Africa is not confined to species of *Landolphia* and *Ficus*. A large tree, probably belonging to the *Apocynaceae*, found abundantly in the interior lands, also yields rubber. Mr. Leigh, one of the assistants at the station, was away above a week collecting specimens of this rubber. When ready they will be submitted to the authorities at Kew for a report. The native name of the tree is "Ire." Mr. Millen adds, "It may prove very valuable to the colony."

In April 1895, Captain Denton, C.M.G., the Acting-Governor, communicated some specimens to Kew with the following remarks:—

"I send you by parcel post some specimens of the tree—native name Irai—from which the rubber which is sent from this part of the world is obtained. During the last six months it has become a valuable article of export, and there appears to be every chance of the quantity produced increasing. I obtained these specimens from the district between Ilogbero and Ilaso, where I saw the process of procuring the juice from the tree in course of progress. The Irai tree, at the base, is between 3 and 4 feet in circumference

and is some 30 to 40 feet high. The natives score the bark to a depth of five-eighths of an inch, and the men, who have had experience of the work in other places, contend that the tree can be tapped again with good results in about 18 months' time. If this is so, we have started what is likely to prove a valuable industry."

So far it had not been possible to identify this new rubber-yielding tree. The specimens hitherto received at Kew were imperfect, and in some cases even consisted of portions of totally different plants. The next contribution received was from Mr. Jonathan C. Olubi, F.R.G.S., who forwarded excellent specimens of the tree and samples of the rubber, accompanying them with the following interesting letter :—

Mamu Forest Station, Ibadan District,
Lagos, May 3, 1895.

DEAR SIR,

For identification, improvement on, and advice about the rubber tree discovered in this forest not quite a year ago by the energy of Governor Carter, I now send you the following parcels.

I have seen many foreign rubber trees and vines in the Botanic Station at Lagos, such as the Kosa rubber, Para rubber, and the *Ficus elastica*, but not this particular tree that I am going to describe. It was first discovered in Accra about the year 1883, and from its resources many Europeans and natives have made their fortunes. The native name of this rubber tree is Ire, Ireh, or Ereh.

The Ire tree is one of the most beautiful trees in the forest. From the ground it grows evenly in bulk and smoothly to the height of 60 to 70 feet. The average thickness of the tree is 12 to 14 inches in diameter. In the rainy season, when the trees are full of milk, a tree well tapped is capable of producing from 10 to 15 lbs. of rubber, which is worth about 1*s.* per lb. here if properly prepared, and 2*s.* 1*d.* to 2*s.* 4*d.* in English markets if made into biscuit.

The present method by which the milk is extracted is shown on the piece of stick enclosed, and this is said to be the most perfect way known to the natives. I have heard of an instrument by which one can easily extract the milk; can you give any help or direct me to where I can get a sample? There are many ways in which the milk is prepared: first by cutting a coffin-like hole in the trunk of a tree and throwing in milk daily until it is full, then the milk is well covered, airtight if possible, and within a month it is quite solid. Of course in the rainy season it may take two months before it is solid. This is known as the silk rubber.

The one gathered and cooked in water and whose appearance shows white after cooking (although the atmospheric influence causes it to get black after some days of exposure) is known as the first quality rubber. The rubber cooked as gathered and thickened by heat directly in the pot obtains varied prices. Can one improve on these methods? I know of one method, but it is difficult to follow, for one cannot get the fresh milk. The custom is to purchase already cooked milk. The preparation I speak of is to allow the milk to remain in cold water (about double the proportion of the milk) for twenty-four hours, then the milk floats. This is then gathered and put in a bag, which can be hung up for

perfect draining or the bag put in a box with so many holes for the water to escape. This fetches a good, and, I dare say, the best value; but unless one can command his own forest the fresh milk is hard to get. The sample of rubber sent is of the general preparation cooked as brought from the tree. If desirable I shall send you a two feet long log of the rubber tree. For any name appropriate for the tree and any improvement on the preparation of the rubber, also for collecting the same, I shall thank you very much.

I remain, &c.,

The Director,
Royal Gardens, Kew.

(Signed) J. C. Olubi.

The Rubber Plant.

The specimens sent by Mr. Olubi led to the identification of the new rubber plant as *Kickxia africana*, Benth. Of this plant we had very little previous information.

In May 1888, a sample of seeds marked "India-rubber seeds" from Winnebah, Gold Coast, West Africa, was forwarded to Kew by Messrs. J. Bowden & Co., Liverpool. The seeds were stated to be worth 72*s.* per lb. There was, however, no further reference made to the plant yielding them as a source of India-rubber. The seeds were determined as those of *Kickxia africana*, Benth., a tree of the order *Apocynaceae*, known to occur in West Africa, from Sierra Leone to the delta of the Niger, and in the island of Fernando Po. As the seeds were then in commerce as a substitute for *Strophanthus* seeds, it was inferred that the high price they fetched was due to this and not to their value as a means of propagating India-rubber plants. In fact, it seems that they were never suspected to have any other importance than that they lent themselves readily for the adulteration of *Strophanthus* seeds. Thus Mr. E. M. Holmes,* Mr. T. Christy,† Dr. J. Nevinny‡, and lately Mr. L. Planchon§ examined the seeds of *Kickxia africana* from this point of view, and they pointed out the characters in which they differed from the seeds of *Strophanthus*.

From Mr. Olubi's letter quoted above it would appear that the tree was known in Accra as early as 1883 as a rubber tree, and this evidently accounts for the sample of seeds sent by Messrs. Bowden & Co., to Kew, in 1888, being called India-rubber seeds.

The vernacular name of the tree is spelt Ire, Iré, Irai, Ireh, and Ereh. A similar name "Ere" occurs in Moloney's List of Timbers in *Forestry of West Africa*, p. 207, No. 6. It is there applied to a tree 25–33 feet high and 4 feet in diameter, but no further particulars are given.

The description of *Kickxia africana* drawn up by Bentham for *Hooker's Icones Plantarum* (t. 1276) was based upon rather scanty

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* Notes on false Strophanthus seed, in *Pharm. Journ.* Vol. XVII. (1887) 903, 904.

† New Commercial Plants and Drugs (1887), No. 10, p. 11, and fig. 7 on p. 10.

‡ Kickxia and Strophanthus, in Z. öst. Apoth. 1887, Nos. 20, 21, 22.

§ Produits fournis à la matière médicale par la famille des Apocynées (1894) pp. 80, 81.

material. Dr. Stapf who is engaged in the elaboration of the *Apocynaceae* for the *Flora of Tropical Africa*, has therefore prepared a more complete description from the fuller material now available.

Kickxia africana, Benth. in *Hook. Ic. plant.* t. 1276 (1877–79). A large glabrous tree, 50–60 feet high with terete branchlets which turn black in drying. Leaves 4–9 in. long, 1½–3 in. broad, oblong, shortly acuminate at both ends, coriaceous, with 8–10 nerves on each side and inconspicuous veins, petiole 2–6 lin. long. Flowers in shortly peduncled, bracteate, often many flowered and much contracted cymes, originally terminal but afterwards apparently axillary, being overtopped by a branch from the axil of one of the uppermost leaves; peduncle short, to 3 lin. long; bracts small, ovate, acute; pedicels to 2 lin. long. Calyx about 1¾ lin. long, 5-partite, segments ovate, with several glands at the base. Corolla salver-shaped, yellow, tube fleshy, constricted at or just below the middle, 3 lin. long; lobes 5–6 lin. long, oblong, overlapping to the right, nearly erect in bud, then spreading. Stamens 5, inserted above the constriction of the tube and enclosed in it, filaments short and broad having a gibbous swelling on the back; anthers conniving in a cone around the stigma, to which they adhere by a glutinous secretion from the base of the anther cells, sagittate, acuminate, tipped with a few minute hairs, basal tails solid, destitute of pollen. Disc fleshy, of 5 free or more or less comate lobes closely surrounding the ovary to ⅔ of its height. Ovary of 2 free minutely hairy carpels; style filiform; stigma capitate, slightly grooved, constricted into a broad, conical apex; ovules pendulous, numerous in each cell. Follicles about 4–6 in. long, spreading, thick, spindle-shaped, with two sharp longitudinal ridges, woody. Seeds 6–7 lin. long, spindle-shaped, compressed, brown, with a long basal awn (pointing towards the base of the follicle), and a fine point on the other end; awn naked at the base, otherwise covered with long reversed silky hairs; albumen forming a thin or rather thick coat around the embryo; cotyledons contortuplicate and much longer than the superior radicle.

The laticiferous vessels are found in great numbers in the inner bark within a zone of hardened tissue and accompanied by cells containing crystals.

The habitat of *Kickxia africana* was stated in the *Icones* to be "West Tropical Africa, Bagroo River, and Fernando Po, Mann No. 817, Bonny, Kalbreyer." It is evident that it has a very wide distribution, extending from Sierra Leone to the Gold Coast and beyond the mouths of the Niger to the Bight of Biafra. How far it may extend inland it is impossible to say.

In September last Kew received from Captain Denton, C.M.G., two pieces of the trunk of the Lagos rubber tree, each about 10 inches to a foot in diameter, scored with the marks of the rubber gatherers. These will be placed in the Kew museums. They were sent as the "female" rubber tree, a name we learn that is applied locally to the *Kickxia africana*, Benth. It is thus distinguished from *Holarrhena africana*, quite a different plant, which is fancifully called the "male" rubber tree. The latter is a Rubiaceous plant not known to yield any rubber.

As showing the remarkable development which has taken place in the rubber industry at Lagos during the last six months, the Acting Governor has furnished Kew with the following particulars :—

RETURN of RUBBER exported from LAGOS during the half year ended June 30, 1895.

Month.	Weight.	Value.
	lbs.	£ s. d.
January	21,131	1,213 10 3
February	15,888	777 0 11
March	26,316	1,419 7 8
April	39,763	2,078 16 6
May	216,916	11,700 0 7
June	268,619	12,577 2 6
Total	588,633	29,765 18 5

E. A. LOVELL, Collector of Customs.

July 12, 1895.

EXTRACTING THE RUBBER.

The following information respecting the mode of tapping the Ire trees and preparing the rubber is taken from the *Report* of the Botanic Station at Lagos for the quarter ended 31st March, 1895. This Report was prepared during the absence of Mr. Millen on leave by Mr. F. G. R. Leigh, the acting-curator.

In tapping the trees the bark is first cut in a vertical direction from the bottom to the top. This single line is about $\frac{1}{2}$ to $\frac{5}{8}$ of an inch broad, and deep enough to reach the inner bark. This forms the main groove. On each side of this, two series of oblique grooves, about two feet apart, are cut, each running into the main groove. The side grooves are made, beginning at the top and gradually reaching the base of the tree. All the milk exuding from the lateral grooves will find its way into the main groove, and so ultimately reach the bottom, where a vessel is placed to receive it. When sufficient milk has accumulated it is then collected and made into rubber.

The methods adopted for coagulating the milk are then described. These are at present of two kinds, viz., "the cold process" and "the heat process." The cold process is chiefly practised by the Fanti men introduced from the Gold Coast. A cavity is excavated in the trunk of a fallen tree so as to form a cistern of the capacity necessary for holding the milk collected during several days. Into this the rubber gatherers pour the milk, after straining it, from day to day until it is quite full. It is then covered with palm leaves and left for 12 to 14 days, and sometimes much longer, depending on the season, until most of the watery portions have either evaporated or sunk into the wood. After being kneaded and pressed together, the rubber thus obtained has a dark brownish colour, with the inner portions of a slightly lighter colour. Such rubber is known locally as "silk rubber."

The local price is from 10*d.* to 1*s.* 2*d.* per pound.

The heat process is the one generally adopted by the natives of Lagos. This is much simpler in working, as it disposes of all the milk collected at the close of each day. After being strained, the milk is placed in a vessel and boiled. The rubber begins to coagulate almost directly the heat is applied, and after the boiling is over is removed in a somewhat sticky condition, owing to being burnt, and of a blackish colour. The local price of this rubber is from 9*d.* to 1*s.* per pound. It is pointed out that the heat process, though simpler, impairs the quality of the rubber, and is calculated to injure the industry. It is probable that if the heat process were somewhat modified the results would not be so injurious. An experiment was tried at the Botanic Station to coagulate the milk by heat, but not applied directly to it. The result was much more satisfactory. The rubber came off of a milky white colour, and after being pressed it was clean and firm without being sticky. A sample of this received at Kew was reported upon by Messrs. Hecht, Lewis, and Kahn. It the sample referred to below as No. 2.

Messrs. HECHT, LEVIS, and KAHN to ROYAL GARDENS, KEW.

21, Mincing Lane, London, E.C.,
September 13, 1895.

DEAR SIR,

WE have your yesterday's lines, and also two samples of Lagos rubber.

We have had, both in Liverpool and in Hamburg, for the last six months, large imports of rubber from Lagos, and this description seems to have been favourably received by consumers.

Your sample No. 2 is of very fine quality, and would be worth, if sent in the same clean and dry condition, from 2*s.* 3*d.* to 2*s.* 4*d.* per lb. Your sample No. 3 is also good, but less close in texture and much damper, which seriously detracts from its value. Still, the rubber is cleaner than the average arrivals from Lagos, and to-day's value would be about 1*s.* 5*d.* to 1*s.* 6*d.* per lb.

From what we hear the production of rubber in Lagos is likely to increase largely, and we only hope that the producers will keep the rubber as clean and free from impurities as possible.

Always at your service,

We remain, &c.,

(Signed) HECHT, LEVIS, & KAHN.

John R. Jackson, Esq.,
Royal Gardens, Kew.

The history of this new rubber industry in Lagos is full of interest, and illustrates the wonderfully rich resources of the vast forests of West Africa. It shows also very clearly how largely these resources can be developed by judicious and intelligent action on the part of the Government.

Should the new *Kickxia* rubber continue of commercial value, there is no doubt that it will eventually be possible to establish regular plantations, and thus make the industry a permanent one. It has always been seen that owing to the climbing habit of the

species of *Landolphia* which have hitherto yielded African rubber, it was not practicable to cultivate them in regular plantations as they required the support of other plants, and when once tapped many years would have to elapse before they would be fit to yield another crop. With the *Kickxia* these practical difficulties disappear.

The important position now occupied by the rubber industry in British Possessions in West Africa may be gathered from the following table compiled from the Supplement to the *India Rubber Journal* of August 12, 1895 :—

RETURN of RAW CAOUTCHOUC received in the UNITED KINGDOM from BRITISH WEST AFRICA, including the GOLD COAST and LAGOS.

Year.	Weight.	Value.	Average price per Cwt.
	Cwts.	£	s.
1890...	33,876	297,453	175
1891...	48,164	408,646	169
1892...	41,967	357,133	170
1893...	54,357	452,799	166
1894...	47,466	393,990	166
Total	225,830	1,910,021	169

XVIII.—NEW RUBBER INDUSTRY IN LAGOS—

(Continued).

(*Kickxia africana*, Benth.)

[*K.B.*, 1896, pp. 76, 77.]

The rubber industry at Lagos of which an account was given in the *Kew Bulletin*, 1895, pp. 241-247 (with a plate) [p. 44], affords one of the most remarkable instances of the rapid development of an industry that has taken place in recent years in any British Colony. It owes its existence to a wild plant which was only discovered in Lagos within the last two or three years. It was found to be new as a source of rubber, although there is now reason to believe it had yielded some of that formerly exported from the Gold Coast. At the present time *Kickxia* rubber from Lagos has established itself as a commercial article in great demand. The exports in January 1895 were 21,131 lbs. of the value of 1,214*l*. This was practically the beginning of the industry. In December 1895 the exports had increased to 948,000 lbs. of the value of 51,488*l*. 9*s*. 4*d*. From a recent return, communicated to Kew by the Government of Lagos, the total exports during the year 1895 amounted to 5,069,504 lbs. (2,263 tons) of the value of 269,892*l*. 13*s*. 10*d*. This considerable industry has therefore been called into existence within 12 months. The rubber is purely a forest product, and the collection and preparation of it have been effected by means of native labour. The success of the industry is another indication

of the undeveloped resources of our West African Colonies. It is only a few years ago that a somewhat similar though more gradual, rubber industry was called into existence at the Gold Coast. The origin of this is given in the following extract from a Colonial Office Report on the Economic Agriculture of the Gold Coast in 1889 (C. O., 110, 1890) : "Although the youngest of our industries, the preparation of india-rubber is now only second in importance to that of palm-oil. Attention was first drawn to this valuable product by Sir Alfred Moloney (now Governor of Lagos) when administering the government of the Gold Coast Colony in 1882, by letters to the local press. The first practical experiments were made by Mr. F. C. Grant, of Cape Coast, whose example was quickly followed by others, and the undertaking proving remunerative, the collection of rubber began in every part of the colony. The quantity now produced annually ranges from 30,000*l.* to 40,000*l.* in value."

During the year 1893 the Gold Coast exported rubber to the extent of 3,395,990 lbs., and of the value of 218,162*l.*

The following details respecting the exports of Lagos rubber have been received from the Government of the Colony :—

Colonial Secretary's Office, Lagos,
January 13, 1896.

DEAR THISELTON-DYER,

I ENCLOSE a return showing the export of rubber during 1895. Tremendous, is it not ? It seems to be the general opinion that there will be a considerable falling off this year, but I question if anyone can speak with any degree of certainty on this point.

We have had a good year on the whole ; revenue, 142,000*l.*, the largest on record.

Believe me, &c.,

(Signed) GEORGE C. DENTON.

EXPORT of RUBBER from the Colony of LAGOS from 1st January to 31st December, 1895.

Month.	Weight in lbs.	Value.
		£ s. d.
January	21,131	1,213 10 3
February	15,888	777 0 11
March	26,316	1,419 7 8
April	39,763	2,078 16 6
May	216,916	11,700 0 7
June	268,619	12,577 2 6
July	461,765	22,593 13 3
August	354,990	19,951 18 3
September	673,160	36,172 19 9
October	1,059,158	57,117 1 10
November	983,394	52,802 13 0
December	948,404	51,488 9 4
Total	5,069,504	269,892 13 10

E. A. LOVELL, Collector of Customs.

XIX.—RUBBER IN LAGOS.

[*K.B.*, 1897, pp. 414, 415.]

The following extract taken from the Annual Report for 1895 on the Colony of Lagos, West Africa (*Colonial Reports*, Annual, No. 185, 1896), contains interesting information respecting the progress of the rubber industry lately developed in that dependency.

The rubber industry was discussed in these pages two years ago (*K.B.* 1895, pp. 241–247 with plate; and 1896, pp. 76–77) [pp. 44, 51].

"By far the most important factor is the extraordinary development of the rubber industry, the statistics of which are almost incredible. On the Gold Coast we are told that the export of rubber, which in 1882 was *nil*, had attained in 1893 to the annual value of £200,000. Lagos, in 1894, shipped 5,723 lbs. of rubber to Great Britain, and 144 lbs. to Germany, in all 5,867 lbs., of the value of £324 6*s.* 4*d.* In 1895 these figures rose to no less than 5,069,576 lbs., of a total sterling value of £269,893.

"So far back as 1882, Sir Alfred Moloney, K.C.M.G., to whom is due the credit of starting the industry on the Gold Coast, had suggested the possibility of a similar industry in Lagos, but it was not until 1894 that any progress became apparent. In that year the Governor of Lagos, Sir Gilbert Carter, K.C.M.G., issued the following notice :—

"'His Excellency the Governor desires to notify to the mercantile community of Lagos that he has been able to induce a party of natives from the Gold Coast, experienced in rubber collecting, to come to Lagos, with a view to the development of this valuable and important industry. The men have already inspected certain districts, which they report to be rich in rubber-producing plants, and it is confidently hoped that Lagos will shortly be able to compete with the sister Colony of the Gold Coast in the great export of the product.'

"This confident hope was quickly justified. Merchants took up the idea with enthusiasm. With startling suddenness the easy-going native awoke to the fact that wealth abounded in the forests round him, and learnt for the first time that in sitting under his own fig tree he had been unconsciously reposing in the shade of the family bank.

"There is, unhappily, reason to fear that the usual result may follow this sudden discovery. Already there seem to be grounds for the belief that, in so far as the term 'rubber industry' implies the intelligent growth and cultivation of the plant for profit, it conveys a false impression of the methods in vogue in the interior.

"Judicious tapping with due regard to the life of the tree, and its future usefulness, is the exception; rubber-bearing trees are ruthlessly sacrificed by irresponsible seekers after wealth, and dead trunks are becoming a too familiar feature in the landscape of the productive districts. Sooner or later a purely destructive policy of this kind must exhaust the richest country; adventurers will have to stray further afield, and the cost of transport will equal or exceed the value of the article."

XX.—LAGOS RUBBER INDUSTRY.

[*K.B.*, 1899, pp. 29–35.]

In the *Kew Bulletin* for 1895 (pp. 241–247) [p. 41] an account is given of the important commerce which had resulted in Lagos from the collection of rubber from the Ire tree (*Kickxia africana*). It is, however, to be feared that this source of wealth to the Colony will be short-lived, owing to the reckless way in which the rubber trees had been exhausted by the rubber collectors.

The reports given in the following correspondence depict a state of things which, unless arrested by some remedial measures, can only lead to the extinction of the industry. These reports are highly creditable to the two young Africans, Messrs. Leigh and Dawodu, by whom they were drawn up. As stated in the *Kew Bulletin* (1893, p. 365) they have had the advantage of training in the Botanical Department of Jamaica and subsequently at Kew.

The Ire tree, or, as it is locally called, the "female Ire tree," is *Kickxia africana*, an Apocynaceous tree. The "male Ire tree" appears to be *Holarrhena africana*, also Apocynaceous. In the *Kew Bulletin* for 1895 (p. 245) it is described by an oversight as Rubiaceous. It yields rubber oil apparently of little commercial value.

The *Ficus* referred to in the reports is probably *Ficus Vogelii*, discussed in the *Kew Bulletin* for 1888 (pp. 253–261) [p. 141] and 1890 (pp. 89–93) [p. 150], the extraction of rubber from which appears to have met with little success. It was first indicated as a source of rubber in the *Kew Report* for 1878, p. 39.

Governor McCallum to Mr. Chamberlain.

Government House,
Lagos, 24 June, 1897.

Sir,

In despatch "Interior," dated 9th February, 1897, paragraphs 5 and 6, Captain Denton referred to the wholesale destruction of rubber trees in the Hinterland, and the consequent injury to a most important industry of the Colony. He reported that he had sent Messrs. Leigh and Dawodu of the Botanical Department to Ibadan, with a view to the protection of this industry, and he recommended the establishment of a small Forest Department.

2. I have now the honour of forwarding copy of report received from Messrs. Leigh and Dawodu, from which you will observe that Captain Denton's fears have been more than realised, and that the destruction is very widespread, extending to the Ekiti-Parapo Confederacy as well as to Ibadan and Jebu. I also enclose return for the last six months from the Acting Collector of Customs, showing that there is a falling off in export of rubber amounting to 33 per cent. compared with 1896.

3. This falling off is serious, for—*cæteris paribus*—it means a corresponding diminution of imports, and therefore of revenue.

I do not, however, anticipate any serious reduction of revenue, for, from other causes, the total amount which has been collected for five months is not below that estimated.

4. I, moreover, entertain hopes that the present visit, for the first time in history, of kings and chiefs of the Hinterland, with their numerous followers, will be of the greatest benefit to the Colony, and be the means of securing a marked increase of trade with the interior.

5. It is important, however, to take steps which will protect the forests from being ruthlessly destroyed, and which will allow young rubber trees to mature before they are tapped by irresponsible collectors. I therefore cordially endorse Captain Denton's recommendations as to the necessity of a Forest Department.

* * * * *

7. I hope also to organize some system by which the native chiefs will exercise more control over the collectors, but this I can scarcely do until I visit the country myself, and see what promises to be the best means of securing permanence of supply.

8. In the meanwhile, I have thought it desirable to give you some idea as to how the question stands, for you will probably have its importance represented to you by the merchants of Liverpool and Manchester, who will suffer from the falling off in the supply of rubber which has taken place during the current year.

9. Had the collection been entrusted to the chiefs of Yoruba and their men, it is probable that our controlling influence would have checked the destruction which has taken place, but Fantees from the Gold Coast have not had permanency of supply in their minds when they have destroyed trees in all directions, and imperilled the constant supply of a material for which there is now so much demand.

I have, &c.,
(Signed) HENRY MCCALLUM,
Governor.

The Right Honourable
Joseph Chamberlain, M.P.,
Secretary of State for the Colonies.

[Enclosure.]

SIR, Ife, May 25th, 1897.

WE beg respectfully to report to you our work and progress since we left Ibadan.

We should state that before leaving Ibadan we had an interview with His Excellency the Acting Governor.

In this interview we informed His Excellency of the ruined state and condition of the Jebu and Ibadan forests which we had then just visited; and also conveyed to him the information we had gathered from those interested in the industry to the effect that there was no rubber forest in the neighbourhood of these two countries that has not been spoiled by overworking.

We were then instructed by His Excellency to go to the Ekiti country, where, we told him, as we were informed ourselves, rubber working was going on then. Accordingly we left Ibadan on the 21st of March for the Ekiti countries, and went as far as Owo, which town, we understand, is the limit of the Protectorate of the Lagos Colony on that side.

But we regret to say that all the rubber forests through which we have passed and visited during the whole tour have all been spoilt by over-tapping ; consequently, we thought it our best plan to make it understood to the kings and chiefs of the different towns we visited, that it is the wish of his Excellency the Governor to improve the quality of the rubber, and to make the industry a permanent one ; that his Excellency desires this, not only in the interest of trade, but also for the lasting benefit of themselves and children ; and that for this purpose we had been sent out by the Government. In order to effect the wish of His Excellency, four important things were impressed on their minds :—

1. Considering the present state of the forests, we strongly advised them to leave off tapping for two years, when all the trees in their forests which have been almost stripped of their barks shall have healed up, and be in a fit state for extracting fresh supply of juice.

2. That after the trees shall have healed up the process of tapping should only have one season in a year, and this should be during the rainy season. We explained that by so doing the trees would be allowed ample time to heal up and thus be in a good state for the next year's tapping.

3. That in tapping the trees the rubber collector should be very particular in making his lateral incision; these should be 2 feet apart. This we explained is very important as on it depends the life of the trees.

4. In places where juice is available we have seized the opportunity of teaching those who are interested in this industry the proper mode of preparing rubber.

Our present plan is to go round to the Yoruba forests to teach these facts as has been done in the other districts.

We are, &c.,

(Signed) F. G. R. LEIGH and
T. B. DAWODU.

The Acting Resident,
Ibadan.

ACTING GOVERNOR CAPTAIN G. C. DENTON TO MR. CHAMBERLAIN.

Government House,
Lagos, 28th June, 1898.

SIR,

I HAVE the honour to forward a report by Messrs. Leigh and Dawodu, Assistant Curators of the Botanic Station, giving the results of their mission to the interior upon which they were sent by me in February, 1897.

2. I still hold to the view I expressed in my despatch of the 9th February, 1897, on the subject of a Forestry Department, and I think that, though it may not be possible to put in force a drastic Forestry Ordinance, much may yet be done to preserve the rubber and other trees if the Government, acting through the authorities of the country, will take upon themselves the supervision of all the forests.

3. I beg to suggest that Messrs. Leigh and Dawodu's report be transmitted to the Director of the Royal Gardens, Kew.

I have, &c.,
(Signed) GEORGE C. DENTON,
Acting Governor.

The Right Honourable
Joseph Chamberlain, M.P.,
Secretary of State for the Colonies.

[Enclosure.]

Botanic Station, Ebute Meta,
July 28, 1897.

SIR,

WE have the honour to submit for the information of His Excellency a general report of the work done during our absence in the interior.

Leaving Lagos on the 8th February we proceeded to Ibadan, *viâ* Epe, where we arrived on the 13th instant. Here we received definite instructions as to the exact nature of our mission.

During our stay at Ibadan, and before we received instructions to proceed further up country, we took the opportunity of visiting the Ibadan and Jebu forests, which are so rich in rubber and timber trees. We regretted to find that though both forests abound in Ire trees (rubber trees) the latter have all been over-tapped, and the forests have in consequence been ruined. Large numbers of trees have died from sheer exhaustion, and those that survived were in a very poor condition, and would take a couple of years to recover themselves.

As all rubber-working had practically ceased in the Ibadan and Jebu forests owing to the destruction of the trees, we were instructed by His Excellency to proceed further up country where rubber-working was still going on, and teach the people the best methods of working and preparing rubber, so that the trees may be preserved and the industry made a permanent one.

We accordingly left Ibadan on the 21st of March, and proceeded first to the Ekiti countries, where we understood rubber-working was still going on. We found the forests of all these countries to abound, more or less, in Ire rubber trees; but we discovered that all rubber-working had practically ceased even in these far off countries, a consequence due entirely to the overworking of the trees.

As far as we could inspect them all the trees had been over-tapped, and consequently many of them were dying, as is the case with the Jebu and Ibadan forests.

We thought it therefore our best plan, seeing the condition of their forests, to call together the kings, chiefs, and townspeople of the different towns we visited, and conveyed to them the wishes of the Lagos Government with regard to the rubber industry.

We called their attention to the ruined condition of all the rubber trees in their forests, and pointed out to them the folly and short-sightedness of the system of " killing the goose for the golden eggs."

We made them to understand that it is the earnest wish of the Lagos Government to make the rubber industry permanent, and to improve the working of it; and that for this purpose we had been sent up to them, but that it is impossible for the industry to last another five years with the present system of working the trees, and that we would strongly advise them, therefore, in accordance with the wishes of the Government, to stop all rubber-working in their forests for the next two or three years, so that the surviving trees might have sufficient time to recover themselves with bark, and to allow young ones (in which their forests abound) to attain tapable sizes. After this period of time every proprietor should then begin to work his bush on quite a different system. That in this way the industry would be permanent, and they would derive yearly income from their forests.

We pointed out to them the great commercial value of this tree, and its financial superiority over cola and palm trees, and therefore strongly urged them to devote as much, if not greater attention to the rearing and cultivation of this tree as they do to the latter ones.

They were made to understand that by doing this they would not only be carrying out the wishes of the Lagos Government, which is a duty incumbent on them, but that they would also be promoting the interest of trade and be benefiting themselves and children.

Finally we told them that it is their duty to stop all intruders in their forests, as it was strangers who had ruined their forests more than the inhabitants themselves.

We regret to report that all over Yorubaland, beginning from Iwo, and as far as we went in this direction, the forests are sparse and there are more fields than anything else. Consequently there are few rubber trees in those parts, and a good deal of what there are are what the natives call the male Ire tree [*Holarrhena africana*]; it produces a similar juice to the female Ire tree, but this coagulates only to the consistency of the soft Ire rubber (*Landolphia* sp.; this deserves investigation as it is very plentiful in some parts and yields abundance of juice).

The only parts where good bits of forest were found were Osogbo, Ila-Oke, Ilobu, Ejigbo.

All over Yorubaland, therefore, we strongly urged the people to take to planting Ire trees, as they do cola and palm trees, where suitable lands are available, explaining how they should be

planted, and what a great source of income such an undertaking will be to them in the future. We are pleased to report that the people seemed to fall in readily with this suggestion.

We furthermore impressed on them that the process of tapping should only be done once a year, and during the rainy season, so that sufficient time be allowed the trees to rebark themselves against the next season.

We explained to them the advisability of their allowing fully 2 feet between the oblique lateral grooves: this is just the point where the native tappers destroy the trees; they do not allow more than from 6 to 9 inches between the lateral grooves, thus leaving a very limited amount of bark between the grooves, subsequently the trees all wither (especially during the dry season) and die.

The mode adopted by the Fantees, who are to be found in good numbers at Owo and its vicinity, for extracting the juice is the one most suitable and convenient. The first point is for the tapper to make a vertical groove ($\frac{1}{2}$ to $\frac{5}{8}$ in. wide) from the bottom to the top of the tree, and in such a way as to gouge out a bit of the true bark; after this is done, and as the tapper is descending, two series of oblique lateral grooves converging towards the main vertical groove are made, of the same width; thus all the exudation of the lateral grooves flows into the main groove which, together with its own exudation, finds its way down to the base of the tree where a receptacle of some kind is placed to receive the milk.

The method the natives adopt for coagulating the juice is a very dirty and improper one, but a better and simpler way of producing a whiter and superior quality was shown them. This is done by adding twice the quantity of water as there is juice (strained), and then gradually heating; by so doing the rubber becomes coagulated, and does not burn up as in the case with the native system. This kind of rubber comes out milky white, and when pressed (to get rid of water), has an agreeable smell and a superior quality. We pointed out to them the advantage gained in taking a little trouble in the preparation, as on it depends the value of their produce.

As there was no more rubber milk to be obtained in several towns (save few) through which we passed, we were obliged to give oral lessons to those interested in this industry. The Ire tree (*Kickxia africana*) is the only tree from which our present rubber supply is obtained, although in some parts about the Ekiti forests we observed other rubber-yielding trees, such as species of *Landolphia*, *Ficus*, &c.

The species of *Landolphia* yielding the soft rubber is found plentifully in the Ekiti forests, but owing to its softness, and the low prices offered by merchants, the people do not consider it remunerative enough.

The other species of *Landolphia* (probably *L. owariensis*) which produces the harder and superior rubber is much preferred, but as it is very scarce and not so common in the interior as the soft one, very few balls have been brought down and sold at very lucrative prices. During all our tour the only place where it was

observed to exist (but not in a very large quantity) is in the Isoya forests. We advised them to search for this particular species, which is commonly known under the native name of Ibo Akitipa, and to collect rubber of it, which, we assured them, will be readily sold at as good a price, if not better, than that offered for the Ire rubber. The tapping of this species of *Landolphia* will not take so much time as the Ire. The operation is simple enough, and can be successfully done by intelligent and careful natives. The stem of the vine (which is as thick as a man's arm) is detached from all its supports and stretched out on the ground, but its roots are not at all disturbed, so that the vine is still supported by its roots. After stretching out the vine on the ground, incisions of 6 in. × 2 in. are made at distances of from 6 to 8 ft. apart, under these incisions vessels are placed to receive the milk, which easily and readily coagulates, and is then balled or wound up. This kind of rubber has no water whatever in it.

The species of *Ficus* noticed are several, but owing to the insignificance and inferiority of its rubber (specimens have been sent to England and valued at a very low price) we did not recommend these to them.

On the whole we are compelled to say that the Government was rather too late in taking up this matter, and that unless our suggestions and recommendations are followed by the people we very much fear for the permanency of the rubber industry.

Rubber collectors have now to go 15 or 16 days off Ibadan for rubber beyond the Protectorate of this Colony. The countries where active rubber-working is going on are the Benin and Akoko forests. Unfortunately we could not proceed to these parts which, we understand, are outside the Protectorate of this Colony, consequently we did not go further than Owo (a place only three days off Benin) which, we understood, is the limit of our Protectorate on that side.

* * * *

We have, &c.,

(Signed) F. G. R. LEIGH,
T. B. DAWODU,
Assistant Curators.

EXTRACT from LAGOS ANNUAL REPORT for 1897.

"As was anticipated, the falling off in the production of rubber, due to the reckless way in which it was collected, has come to pass, the amount shipped in 1897 being 4,458,327 lbs. as against 6,484,365 lbs. in 1896. It is early to talk pessimistically of the 'extinction of the industry,' inasmuch as the opening up of fresh country to peaceful commerce cannot fail to revive the production. At the same time the greed and guile of the small minority that collects and adulterates rubber, coupled with the apathy of the large majority that only looks on, must inevitably deal a severe blow to the trade. Steps are, however, being taken to encourage the native chiefs to have the rubber collected in a thrifty and systematic manner, which, it is hoped, will show good results in the near future" (pp. 6, 7).

XXI.—ON KICKXIA AND FUNTUMIA.

[*K.B.*, 1905, pp. 45–59.]

The genus generally known as *Kickxia*, was originally described as *Hasseltia* by Blume in 1825 (*Bijdr. Fl. Ned. Ind.* p. 1045) from a tree indigenous in Java. Finding subsequently that this name had already been given by Kunth (*H. B. & K., Nov. Gen. et Spec.* vii. p. 231) to a Tiliaceous plant, he changed it into *Kixia* (*Fl. Java*, Praef. p. vii., 1828), in dedication to the Dutch botanists Jean Kickx (latinised Kixius), father and son. This mode of spelling was generally in use (*see* Endlicher, Meissner, De Candolle, etc.) until Blume himself in 1848 altered it into *Kickxia* (*Rumphia* iv. p. 25). Lindley used the form *Kixia* as late as 1853 (*Veg. Kingd.*, 3rd ed., i., p. 601); but with his exception, *Kickxia* has been so universally adopted that it would be pedantry to fall back on the original form *Kixia*, although this is no doubt more pleasing to the eye of a scholar. So much as to the name *Kickxia*.

A second Malayan species, *K. Blancoi*, a native of the Philippines was added to the genus by Rolfe in 1884 (*Journ. Linn. Soc.* xxi. p. 313), and a third species by Koorders from Celebes in 1898 (*Mededeel. 's Lands Plantent.* xix. p. 528). If we further add a species from Sarawak, in Borneo, which I described and figured in *Hooker's Icon. Plant.* t. 2693, as *K. borneensis*, the number of Malayan species of *Kickxia* is brought up to four.

Previous, however, to the discovery of these last three species, Bentham and Hooker recorded in 1876 (*Gen. Plant. ii.* p. 721) a species from West Africa which was subsequently described and figured by Bentham in *Hooker's Icones Plantarum* t. 1276 (1879) as *K. africana*. Quite recently six more species have been described under *Kickxia*, namely *K. latifolia*, Stapf (*Kew Bull.* 1898, p. 307) from the Congo, *K. elastica*, Preuss (*Notizbl. Bot. Gart. u. Mus. Berlin*, ii. 1899, p. 353), from the Cameroons, *K. Scheffleri*, K. Schum. (*Notizbl. Bot. Gart. u. Mus. Berlin*, iii. 1900, p. 81) from German East Africa, *K. Zenkeri*, K. Schum. (l. c.) from the Cameroons, *K. Gilletii*, De Wild. (*Rev. Cult. Colon.* vii. 1900, p. 744) from the lower Congo, and *K. congolana*, De Wild. (l. c. p. 748), also from the lower Congo. Of these, however, the four last named species have, on closer examination, been found to be identical with *K. africana* and *K. latifolia* respectively.

Taken in the sense of the Genera Plantarum and all the modern authors, the genus *Kickxia* would therefore appear to inhabit two widely remote areas—one in the Malayan region, with four species, and the other in tropical Africa, with three species. Cases of similar discontinuous distribution are not altogether unknown in *Apocynaceae*; but they are rare. Of the 100–105 Apocynaceous genera which inhabit the tropics of the Old World, only 12 are common to Africa and Asia, and of these five do not extend from the Indo-Malayan region farther west than the Mascarene Islands or the East Coast of Africa, whilst one (*Wrightia*) is known to occur in Africa only in Natal. The remaining six

genera (*Carissa*, *Rauwolfia*, *Alstonia*, *Voacanga*, *Holarrhena* and *Strophanthus*) may be said to range fairly continuously over the greater part of tropical Africa; they are found in the Mascarene Islands and again (excepting *Voacanga* which is not known from India proper) in Ceylon and Western India, whence they spread more or less into the Malayan region. One of them is, moreover, represented by numerous species in the New World, namely, *Rauwolfia*. This distinct differentiation of the genera of *Apocynaceae* in the African and the Indo-Malayan region suggests an independent evolution of the order in the two areas for a very long time.

A glance at the Malayan species of *Kickxia* is sufficient to show that the case of *Kickxia* is no exception to this theory. In fact, the geographical separation of the two groups coincides with an equally conspicuous morphological differentiation. I stated this very summarily before the Linnean Society more than five years ago (*Proc. Linn. Soc.* December 7, 1899), and a little more fully in *Hooker's Icones Plantarum*, sub tt. 2694–2695. To make, however, the matter perfectly clear, I will place side by side the diagnoses of the two groups, as drawn from the material in the Kew Herbarium.

Malayan Group.	African Group.
Calyx ad basin 5-partitus, intus glandulis munitus, persistens; segmenta imbricata, anguste vel late ovata, acuta vel obtusa; *glandulae* numerosae, *annulatim dispositae, fimbrilliformes, aut singulae cum unoquoque segmento eique arcte appressae, applanatae.*	Calyx ad basin 5-partitus, intus glandulis munitus, persistens; segmenta imbricata, lata, magis minusve obtusa; *glandulae* numerosae vel paucae, *semper applanatae, segmentis, appressae.*
Corolla *infundibuliformis, magna vel majuscula; tubus ad vel supra medium constrictus, infra e basi subventricosa cylindricus vel gradatim attenuatus, supra cupulae vel campanulae modo ampliatus, ad constrictionem magis minusve incrassatus et annulo intus prominente munitus*, lobi oblongi, magis minusve obliqui, praefloratione dextrorsum obtegentes.	Corolla *hypocraterimorpha, parvula; tubus brevis, medio vel paulo supra medium ventricosus, superne crassissimus, carnosus, ore annulo crasso prominente cincto poriformi;* lobi lineares vel oblongi, praefloratione dextrorsum obtegentes.
Stamina 5, *annulo tubi inserta, in conum circumcirca liberum in tubum ampliatum projectum* conniventia; filamenta brevissima, crassa; antherae sagittatae, intus basi glandula viscosa munitae, cruribus duris solidis filamentis aequilongis, loculis angustissimis brevibus.	Stamina 5, *in medio tubo inserta, in conum os vix attingentem arcte inclusum* conniventia; filamenta brevissima, crassa; antherae sagittatae intus basi glandula viscosa munitae, cruribus duris solidis quam filamentis sublongioribus; loculis angustissimis brevibus.
Discus breviter tubulosus, subinteger vel 5-lobus, tenuiter carnosus.	Discus breviter tubulosus, 5-lobus vel 5-partitus, carnosus.
Carpella libera, *ovato-lanceolata, sensim in stylum attenuata, e disco exserta, glaberrima*; styli filiformes, supra coaliti; stigma ovoideo-clavatum, ope antherarum glandularum cono staminali adhaerens; *placentae* ad basin bipartitae, *lamellis liberis patulis* facie dorsali ovulis multiseriatim obsitis.	Carpella libera, *brevia truncata, lateraliter abrupte in stylum constricta, e disco exserta vel ab eo paulo superata, vertice puberula;* styli filiformes supra coaliti, incrassati; stigma ovoideo-clavatum, ope antherarum glandularum cono staminali adhaerens; *placentae* ad basin bipartitae, *lamellis carpelli lateri ventrali plane adnatis* facie dorsali ovulis multiseriatim obsitis.

Fructus folliculi distincti, *elongati*, *reflexi*, *paralleli*, *coriacei*, secundum suturam dehiscentes; placentae maturae *fragiles vel facile separatae*, *inflexae*.	Fructus folliculi distincti, *breves vel elongati*, *divaricatim patentes*, *coriacei vel lignosi*, secundum suturam dehiscentes; placentae maturae *tantum zona angusta rugulosa utrinque secundum suturam percurrente indicatae*, *caeterum a folliculi pariete haud distinctae*.
Semina plurima, elongato-fusiformia, subsemiteretia, sicca quidem ventre canaliculati, basi coma stipitata reverse plumosa ornata; raphe filiformis, prominula; testa tenuis; albumen carnosum strato tenui embryonem circumdans.	Semina plurima, fusiformia, subsemiteretia, basi coma stipitata reverse plumosa ornata; raphe filiformis, prominula; testa tenuis; albumen carnosum strato tenui embryonem circumdans.
Embryo elongatus, subsemiteres; radicula supera, longiuscula; cotyledones foliaceae, longitudinaliter contortuplicatae.	Embryo elongatus, subsemiteres; radicula supera, longiuscula; cotyledones foliaceae, longitudinaliter contortuplicatae.
Arbores vel frutices.	Arbores.
Folia *membranacea et decidua vel magis minusve coriacea*.	Folia *sempervirentia*, *coriacea*.
Flores *magni vel majusculi*, 3·75-10 *cm.* (1½–4 *poll.*) *longi*, in cymas axillares *pauciforas vel ad florem solitarium reductas* dispositi, *longe vel brevissime pedicellati*, albi vel inferne virescentes vel flavescentes.	Flores *parvuli*, 12–20 *mm.* (6-10 *lin.*) *longi*, *numerosi* in axillis foliorum, *cymoso-congesti*, *breviter vel brevissime pedicellati*, albidi vel flavescentes.

A comparison of these two descriptions shows most convincingly that the differences in the characters of the two groups are as great as those of any two genera in the tribe of *Echitideae*, and that they have every claim to be considered as two distinct genera. Hence the name *Kickxia* will have to be kept for the Malayan group. For the African species, referred hitherto to *Kickxia*, I have proposed the name *Funtumia*—from "Funtum" or "O'Funtum," a vernacular name of the rubber-yielding species of the Gold Coast, Lagos, and the Cameroons (*Proc. Linn. Soc.*, Dec. 7, 1899).

The two genera are so different that it would be difficult to understand how they could ever have been united if it were not for one very peculiar character which is common to both, namely the presence of a "basal" awn to the seeds. That feature is unique in the order, and it seems to have outweighed all the considerations which must have tended towards the separation of the genera. The authors of the Genera Plantarum may have hesitated to separate the African "*Kickxia*" from the Malayan for want of sufficient material; at any rate, their diagnosis of *Kickxia* agrees very well with Blume's description of his genus, but scarcely fits the African plant referred to it. The latter, indeed, appears rather as a kind of appendix to the former, no better place having been available for it at the time.

The development of a flying apparatus in the shape of a tuft of hairs or a plumose awn attached to the seeds is a universal contrivance in *Echitideae*. The tufts spring either from the chalazal end of the seed, and then they are termed basal, or from the micropylar end, when they are styled apical, or they originate from both ends. Sometimes they are transformed into plumose awns by the lengthening of the axis of the tuft, and often also by the intercalation of a naked stalk between the seed proper and the

plume. The commonest form is an apical tuft. Basal tufts without apical ones are characteristic of *Wrightia;* basal and apical tufts occur together in *Isonema*, *Adenium*, and *Haplophyton;* apical awns and basal tufts together are found in all the numerous species of *Strophanthus;* basal awns alone in *Kickxia* and *Funtumia*. Where two tufts or a tuft and a plumose awn occur simultaneously, the basal tuft is often early deciduous and does not leave the follicle with the seed; nevertheless its occurrence proves that there is a more general disposition towards developing the flying contrivance from the chalazal end of the seed than is generally assumed. At the same time we see that the presence of this peculiar disseminative organ is not confined to genera which are admittedly close allies, as a glance at the different attempts to group the genera of *Echitideae* will show. To summarise briefly, the basal awn of the seeds of *Kickxia* and *Funtumia* is unique in the order in so far as in no other case known, the evolution of the basal flying contrivance has been carried to this peculiar modification, but it has its homologue in several not closely allied genera, and therefore cannot be considered as a character in itself indicative of close relationship.

What is true of the basal awn may be said of the apical plumose awn of *Strophanthus*, *Laubertia*, *Stipecoma*, *Urechites*, etc. It is the homologue of the usual apical tuft of the majority of *Echitideae*, and occurs also in genera otherwise not closely linked together.

It is quite conceivable that the basal awns in *Kickxia* and *Funtumia* have been evolved from the basal tufts of two types which had little else in common than those characters which bind *Echitideae* together. Hence, to solve the question as to the relationship of the two genera and their place in the natural system of *Echitideae* we must look out for other characters. Both genera possess an embryo with contortuplicate cotyledons, a feature almost as unusual in the order as the basal seed-awn, flat foliaceous or planoconvex cotyledons being the rule. So far as I know, the genera *Wrightia* and *Holarrhena* are the only ones in the order which have cotyledons of the same description, but here again we have a character which, taken by itself, points to two different lines of descent, as *Wrightia* and *Holarrhena* have otherwise so little in common that *Wrightia* has been placed in *Echitideae* and *Holarrhena* in *Plumerieae* where it occupies a somewhat anomalous position. We should not fare better with any other character if taken alone, although anyone might form a convenient basis for a purely artificial arrangement. *Echitideae*, like the majority of *Tubiflorae*, are rich in ill-defined genera, and in instances of parallelism which makes it so difficult to trace their phylogenetic relations. To do this satisfactorily is beyond the scope of the present paper, as it would involve a critical revision of the whole tribe of *Echitideae*; for it is only from a thorough and comprehensive investigation into the structure of the genera composing the tribe that we may hope to solve the intricate problem of their mutual relationship.

If I may venture to suggest a place for *Kickxia*, it would be near *Wrightia*. The suggestion is not new; it was made by Blume in *Rumphia*, iv. p. 26, on account of general resemblances,

and by Miers in his essay "*On the Apocynaceae of South America*," p. 9, on account of the great similarity of the fruits and seeds. I have already pointed out the homology of the basal tuft of the seeds of *Wrightia* and of the basal awn of *Kickxia*, and the practical identity of the structure of the embryo in both genera. Neither of these characters by itself is of very great taxonomic importance; but when they appear combined, and coincide besides with a general parallelism in the structure of the flower and fruit, they become indicative of a closer relationship of the genera. This is, indeed, to a certain degree the case with *Wrightia* and *Kickxia*. Certain Malayan species of *Wrightia* approach *Kickxia* rather closely in general appearance, and Blanco was actually misled to enumerate *Kickxia Blancoi* as a species of *Anasser*, a synonym of *Wrightia*. Still there remain these differences:—the aestivation of the corolla lobes is in *Wrightia* the reverse of that in *Kickxia*; the corolla is divided down to the insertion of the stamens and (with, I believe, a single exception) provided there with variously shaped appendages, instead of surrounding the staminal cone with a cup or bell-shaped widening of the tube; and, finally, there is in *Wrightia* no disc surrounding the gynoeceum. Pierre has described lately two new genera from Cochin-China, *Microchonea* and *Paravallaris*, which belong possibly to the same stock as the Asiatic species of *Wrightia* and *Kickxia*, so far as I can judge from flowering specimens. As to *Funtumia*, however, the resemblance with *Kickxia* ends with the homology of the seminal appendage and the practical identity of the structure of the embryo. I have, so far, sought in vain for another genus in *Echitideae* to which it is obviously and closely related. We may place it provisionally near *Kickxia* if we lay more stress on the character of the seed in our at present rather artificial arrangement of *Echitideae*, or among *Eu-Echitideae* on account of the structure of the flower. In either case it will occupy an isolated position.

DESCRIPTIONS OF GENERA AND SPECIES.

KICKXIA, *Blume*.

Calyx ad basin 5-partitus, intus glandulis munitus, persistens; segmenta imbricata, anguste vel late ovata, acuta vel obtusa; glandulae numerosae, annulatim dispositae, fimbrilliformes, aut singulae cum unoquoque segmento eique arcte appressae, applanatae. *Corolla* infundibuliformis, magna vel majuscula; tubus ad vel supra medium constrictus, infra e basi subventricosa cylindricus vel gradatim attenuatus, supra cupulae vel campanulae modo ampliatus, ad constrictionem magis minusve incrassatus et annulo intus prominente munitus; lobi oblongi, magis minusve obliqui, praefloratione dextrorsum obtegentes. *Stamina* 5, annulo tubi inserta, in conum circumcirca liberum in tubum ampliatum projectum conniventia; filamenta brevissima, crassa; antherae sagittatae, intus basi glandula viscosa munitae, cruribus filamentis aequilongis duris solidis, loculis angustissimis brevitus. *Discus* breviter tubulosus, subinteger vel 5-lobus, tenuiter carnosus. *Carpella* libera, ovato-lanceolata, sensim in stylum attenuata,

e disco exserta, glaberrima : styli filiformes, supra coaliti ; stigma ovoideo-clavatum, ope antherarum glandularum cono staminali adhaerens ; placentae ad basin bipartitae, lamellis liberis patulis facie dorsali ovulis multiseriatim obsitis. *Fructus* folliculi distincti, elongati, reflexi, paralleli, coriacei, secundum suturam dehiscentes ; placentae maturae fragiles vel facile separatae, inflexae. *Semina* plurima, elongato-fusiformia, subsemiteretia, basi coma stipitata reverse plumosa ornata ; raphe filiformis, prominula ; testa tenuis ; albumen carnosum, strato tenui embryonem circumdans. *Embryo* elongatus, subsemiteres ; radicula supera, longiuscula ; cotyledones foliaceae, longitudinaliter contortuplicatae.—*Arbores* vel frutices. *Folia* membranacea et decidua, vel magis minusve coriacea. *Flores* magni vel majusculi, in cymas axillares paucifloras vel ad florem solitarium reductas dispositi, longe vel brevissime pedicellati, albi vel inferne virescentes vel flavescentes.

Species 4, in archipelago Malayano et in insulis Philippinis.

Key to the species.

Glandulae intracalyculares numerosae, fimbrilliformes, annulatim dispositae.	
Folia membranacea, elliptica : flores 6 cm. ($2\frac{1}{2}$ poll.) longi	1. *arborea.*
Folia pergamacea vel coriacea, lanceolata vel lanceolato-oblonga ; flores ad 10 cm. (4 poll.) longi	2. *Wigmannii.*
Glandulae intracalyculares singulae cum unoquoque segmenta eique appressae.	
Flores distincte pedicellati, 6 cm. ($2\frac{1}{2}$ poll.) longi ; calycis segmenta obtusa	3. *Blancoi.*
Flores brevissime pedicellati, $3\frac{1}{2}$–4 cm. ($1\frac{1}{2}$–$1\frac{2}{3}$ poll.) longi ; calycis segmenta acuta	4. *borneensis.*

1. **K. arborea,** *Blume, Rumph.* iv. 26, t. 179, fig. 1. *Arbor* mediocris (*Blume*) ad 42 m. (140 ped.) alta (*Koorders*). *Truncus* erectus, cylindricus, basi exalatus, ad 62 cm. (25 poll. dimetiens ; coma parva a basi admodum remota, irregularis, laxa ; rami primarii pauciores, tenues ; ramuli juveniles magis minusve compressi, exsiccando atri ; cortex extus nigro-cinereus, laevis, medio fuscus, intus albidus ; latex albus, copiosus. *Folia* breviter petiolata ; lamina elliptica vel oblongo-elliptica, utrinque breviter acuta vel subacuminata vel rotundata, 12–22 cm. ($4\frac{3}{4}$–9 poll.) longa, 7–12 cm. ($2\frac{3}{4}$–$4\frac{3}{4}$ poll.) lata, integerrima vel subrepanda, magis minusve undulata, supra glaberrima, intense viridis (exsiccando nigrescens), infra pallidior (exsiccando fusca), imprimis in nervis minute pubescens vel tandem glabrata, membranacea, nervis secundariis utrinque 14–16 patentibus vel oblique ascendentibus sub margine arcuato-connexis, tertiariis venisque tenuibus ; petiolus 5–10 mm. ($2\frac{1}{2}$–5 lin.) longus. *Cymae* numerosae, pauciflorae, brevissime pedunculatae ; bracteae minutae, ovatae, acutae, atro-purpurascentes ; pedicelli graciles, 4–5 cm. ($1\frac{1}{2}$–2 poll.) longi. *Flores* nutantes, ultra 6 cm. ($2\frac{1}{3}$ poll.) longi, flavescenti-albi, odorati. *Calyx* 5 mm. ($2\frac{1}{2}$ lin.) longus ; segmenta ovato-oblonga, acuminata, crassa, basi extus gibba ; glandulae inaequales, fimbrilliformes, in annulum dispositae. *Corollae* tubus glaber, e basi ventricosa ad constrictionem cylindricus, viridis, deinde campanulatus, parte inferiore 14–16 mm. (7–8 lin.) longa, ubi

angustissima 3 mm. (1½ lin.) lata, superiore 12 mm. (6 lin.) longa, ore 10 mm. (5 lin.) lata; lobi obtusi, 3·5–4 cm. (1⅓–1⅔ poll.) longi, 12–15 mm. (6–7½ lin.) lati, superne extus subvelutini, caeterum glabri. *Staminum* filamenta viridula, extus glabra, intus basi excepta dense tomentella; antherae 6 mm. (3 lin.) longae, flavidae, glabrae. *Discus* cupuliformis, crenulatus, albidus. *Fructus* folliculi reflexi, paralleli, cylindracei, 60 cm. (25 poll.) longi, extus longitudinaliter striati, diu virides, tandem fuscescentes. *Semina* 3 cm. (1¼ poll.) longa, arista circa 15 cm. (6 poll.) longa, ad 10 cm. (4 poll.) nuda, pilis ad 7 cm. (2¾ poll.) longis.—A. DC. Prod. viii. 408; Hasskarl in Flora, 1845, 299 (267, err. typ.); Miq. Fl. Ned. Ind. ii. 435; Koord. & Valet. in Mededeel. 's Lands Plantent. xi. 110; Koord. l.c. xix. 529; Boerl. Handl. Fl. Ned. Ind. ii. 400; non Nav. & Vill. *Hasseltia arborea*, Bl. Bijdr. 1046. *Kibatalia arborea*, Don. Gen. Syst. iv. 86.

JAVA. *Tejsmann! Lobb!* According to Junghuhn (*Java*, i. 236, 237), characteristic of the woods of the dry hot hills of his first zone (upwards to 2,000 ft.), whilst Koorders & Valeton l.c. say that it is rare in the heterogeneous, evergreen primeval forest from 50–350 m. (160–1160 ft.). They quote the following localities from Central and West Java:—Pekalongan, near Soebah; Banjoemas, near Tjilatjap op Noesa-Kambangan; South Preanger, near Palobaehan; Southwest Banten, near Pgr. Tjemara. *K. arborea* sheds its leaves according to Blume in October, immediately before the flowers come out; Koorders & Valeton indicate, however, June and July as the season when it loses the leaves, and flowers.

2. **K. Wigmannii**, *Koord. in Mededeel. 's Lands Plantent.* xix. 528. *Arbor* 12–15 m. (40–50 ped.) alta. *Truncus* erectus, cylindricus, basi exalatus; coma laxa, irregularis; rami primarii horizontales, tenues; cortex extus niger, laevis, rimis longitudinalibus, medio fuscus, intus albescens, inodorus; latex albus, sapore amarissimus. *Folia* breviter petiolata; lamina lanceolata vel lanceolato-oblonga, rarius oblonga, basi angustata, symmetrica vel asymmetrica, apice abrupte breviter acuminata, 23 cm. (9½ poll.) longa, 6 cm (2⅓ poll.) lata, integerrima, subundulata, margine exsiccando revoluta, adulta utrinque glaberrima, juvenilia puberula, viva subcarnoso-pergamacea, exsiccata coriacea vel pergamacea, supra nitida obscure viridia, infra opaca pallidiora, nervis secundariis 8–14 parallelis fere marginem attingentibus, tertiariis venisque tenuibus; petiolus 5 mm. (2½ lin.) longus. *Cymae* axillares, pauciflorae (2-florae); pedicelli 15 mm. (7½ lin.) longi. *Flores* 10 cm. (4 poll.) longi, albi. *Calyx* 10 mm. (5 lin.) longus; segmenta ovata, acuta; glandulae numerosae, inaequales, magis minusve per paria vel plures connatae, in annulum dispositae. *Corollae* tubus 32 mm. (16 lin.) longus, ore 10–11 mm. (5–5½ lin.) latus, intus villosus, extus glaber; lobi anthesi patentes, 7 cm. (2¾ poll.) longi, 22 mm. (11 lin.) lati, glabri. *Staminum* filamenta glaberrima. *Discus* cupuliformis, minute 5-denticulatus, dentibus truncatis crassis apice 2-foveolatis. *Fructus* folliculi 22–29 cm. (9–11½ poll.) longi, 3·5 cm. (1½ poll.) lati. *Semina* 30–34 mm. (15–17 lin.) longa; arista 6 cm. (2½ poll.) longa, ad 2–2½ cm. (¾–1 poll.) nuda, pilis ei aequilongis.—Boerl. Handl. Fl. Ned. Ind. ii. 400. *K. Valetonii*, Koord. l.c. 67, 169 (nomen).

NORTHEAST CELEBES. Minahassa, rare in very heterogeneous tall primeval forest, near Paku-ura and Kajoewatoe, between 150 and 500 m. (500–1650 ft.). *Koorders*, 16,045 ! 16,048 ! 16,067 ! Flowering from February to April and maturing the fruits at the same time.

The description of the flower is copied from Koorders. There is only one detached and badly preserved corolla with the specimens of *K. Wigmannii* at Kew, and its dimensions are considerably below those given by Koorders. The corolla tube is scarcely 24 mm. (1 in.), and the lobes 42 mm. ($1\frac{3}{4}$ in.) long. The larger of the two calyces (also detached) at Kew is about 7·5 mm. ($3\frac{3}{4}$ lin.) long. The stamens are inserted near the base of the corolla tube, which appears to have been cylindric throughout its length, with the exception of a slight constriction below the insertion of the stamens. It is therefore probable that the specimens of *K. Wigmannii* at Kew are either made up of portions belonging to two different plants or that they represent a new genus, or at least a very marked subgenus of *Kickxia*.

3. **K. Blancoi**, *Rolfe in Journ. Linn. Soc.* xxi. 313 (nomen tantum). *Arbor* (?). *Ramuli* juniores graciles, exsiccando nigrescentes. *Folia* breviter petiolata ; lamina lanceolata vel lanceolato-oblonga, utrinque acuta vel acuminata vel apice obtusa, 5–10 cm. (2–4 poll.) longa, 2–$3\frac{1}{2}$ cm. (10–17 lin.) lata, integerrima, utrinque glaberrima, exsiccando plus minusve fuscescens, subtus pallidior, pergamacea, nervis secundariis utrinque 5–7 tenuibus obliquis sub margine arcuato-connectis, tertiariis venisque inconspicuis ; petiolus 5 mm. ($2\frac{1}{2}$ lin.) longus. *Cymae* axillares, brevissime pedunculatae, plerumque ad florem 1 redactae, rarius 2-florae ; bracteae minutae, obtusissimae ; pedicelli circiter 12 mm. (6 lin.) longi, graciliores. *Flores* ad 6 cm. longi, albi. *Calyx* 5 mm. ($2\frac{1}{2}$ lin.) longus ; segmenta lata, ovata vel rotundata, obtusa, basi extus gibba, intus glandula solitaria applanata rotunda appressa munita. *Corollae* tubus e basi ventricosa ad constrictionem sensim attenuatus deinde cupuliformis, glaber, parte inferiore 15–18 mm. ($7\frac{1}{2}$–9 lin.) longa, ubi angustissima 3 mm. ($1\frac{1}{2}$ lin.) lata, superiore 5–6 mm. ($2\frac{1}{2}$-3 lin.) longa, ore 7–8 mm. ($3\frac{1}{2}$–4 lin.) lata ; lobi oblique patentes, obtusi, ad 4 cm. ($1\frac{2}{3}$ poll.) longi, 12–14 mm. (6–7 lin.) lati, intus basin versus sparsim papilloso-pilosuli, caeterum glabri. *Staminum* filamenta glabra ; antherae 5 mm. ($2\frac{1}{2}$ lin.) longae, dorso linea pilosula ad apicem percurrente notatae. *Discus* subinteger. *Ovarium* cum stylo et stigmate 20–22 mm. (10–11 lin.) longum. *Fructus* ignotus.—Koorders in Mededeel. 's Lands Plantent. xix. 529. *Kixia arborea* Vill. in Naves & Vill. Nov. App. Fl. Philipp. 132, t. cdxxviii bis, non Blume. *Kickxia* sp. Vidal Sin. Gen. Filip. 118. *Anasser* " otra especie con las flores axillares solitarias " Blanco, Fl. Filip. ed. 1, 114 ; ed. 2, 81 ; ed. 3, 149 (in nota).

PHILIPPINES : Luzon, *Lobb !* Prov. Albany, *Vidal*, 3277 ! Panay, Ilo-Ilo, S. Joaquim, *Vidal*, 3289 ! Guimaras, *Vidal* teste *Villar*, l.c.

Naves's figure quoted above, agrees exactly with Vidal's specimens, but for the very crudely drawn analyses and the corolla-tube which is much more slender than represented.

K. borneensis, *Stapf in Hook. Icon. Plant.*, t. 2693. *Frutex* 2 m. (6 ped.) altus. *Ramuli* juniores exsiccando nigro-fuscescentes, teretes, subgraciles. *Folia* brevissime petiolata ; lamina lanceolato-oblonga, basi subacuta, apice acuminata, 10–11 cm. (4–4½ poll.) longa, 3–5 cm. (1⅓–2 poll.) lata, integerrima, glaberrima, supra exsiccando nigro-fuscescens, subtus pallidior, coriacea, nervis secundariis utrinque circiter 9 subpatulis sub margine arcuatim connectis, tertiariis venisque inconspicuis ; petiolus 3–4 mm. (1½–2 lin.) longus. *Cymae* axillares brevissime pedunculatae, pauciflorae vel ad florem solitarium redactae ; bracteolae minutae, obtusae ; pedicelli brevissimi. *Flores* 3¾–4 cm. (1½–1⅔ poll.) longi. *Calyx* 5–6 mm. (2½–3 lin.) longus ; segmenta ovata, acuta, basi extus gibba, intus glandula solitaria oblonga applanata appressa munita. *Corollae* tubus e basi subventricosa ad constrictionem cylindricus, deinde campanulatus, parte inferiore 12 mm. (6 lin.) longa, ubi angustissima 3 mm. (1½ lin.) lata, glabra, superiore 10 mm. (5 lin.) longa, ore 6–7 mm. (3–3½ lin.) lata, intus sparsim papilloso-pilosula ; lobi oblique porrecti, obtusi vel subacuti, 12 mm. (6 lin.) longi, 3–4 mm. (1½–2 lin.) lati, intus basin versus sparsim papilloso-pilosuli, caeterum glabri. *Staminum filamenta* glabra ; antherae 5 mm. (2½ lin.) longae, apicem versus in dorso sparse pilosulae. *Discus* inaequaliter 5-partitus. *Ovarium* cum stylo et stigmate 14 mm. (7 lin.) longum. *Fructus* folliculi 15 cm. (6 poll.) longi, coriacei, extus longitudinaliter striati. *Semina* ignota.

BORNEO. Sarawak, *Lobb !*

FUNTUMIA, *Stapf.*

Calyx ad basin 5-partitus, intus glandulis munitus, persistens ; segmenta imbricata, lata, magis minusve obtusa ; glandulae numerosae vel paucae, semper applanatae, segmentis appressae. *Corolla* hypocraterimorpha, parvula ; tubus brevis, medio vel paulo supra ventricosus, superne crassissimus, carnosus, ore annulo crasso prominente cincto poriformi ; lobi oblongi vel lineares, praefloratione dextrorsum obtegentes. *Stamina* 5, in medio tubo inserta, in conum vix os attingentem arcte inclusum conniventia ; filamenta brevissima, crassa ; antherae sagittatae, intus basi glandula viscosa munitae, cruribus duris solidis quam filamentis sublongioribus, loculis angustissimis brevibus. *Discus* breviter tubulosus, 5-lobus vel 5-partitus, carnosus. *Carpella* libera, brevia, truncata, abrupte lateraliter in stylum constricta, e disco exserta vel ab eo paulo superata, vertice puberula ; styli filiformes, superne coaliti, incrassati ; stigma ovoideo-clavatum, ope antherarum glandularum cono staminali adhaerens ; placentae ad basin bipartitae, lamellis carpelli lateri ventrali plane adnatis facie dorsali ovulis multiseriatim obsitis. *Fructus* folliculi distincti, breves vel elongati, divaricatim patentes, coriacei vel lignosi, secundum suturam dehiscentes ; placentae maturae tantum zona angusta rugulosa utrinque secundum suturam percurrente indicatae, caeterum a folliculi pariete haud distinctae. *Semina* plurima, fusiformia, subsemiteretia, basi coma stipitata reverse plumosa ornata ; raphe filiformis, prominula ; testa tenuis ; albumen carnosum, strato tenui embryonem circumdans. *Embryo* elongatus,

subsemiteres, radicula supera, longiuscula ; cotyledones foliaceae, longitudinaliter contortuplicatae.——*Arbores* saepe peraltae. *Folia* sempervirentia, coriacea. *Flores* parvuli, numerosi, in axillis foliorum in cymas densas congesti, breviter vel brevissime pedicellati, albidi vel flavescentes.

Species 3 in Africa tropica.

Key to the species.

Alabastra cylindrica, 14–20 mm. (7–10 lin.) longa ; corollae lobi oblongo-lineares, tubo distincte longiores ; folia in axillis inter costam et nervos secundarios subtus magis minusve pubescentia, efoveolata ; seminis arista basi nuda... 1. *africana.*

Alabastra conica, 6–12 mm. (3–6 lin.) longa ; corollae lobi oblongi, tubo distincte breviores vel ei aequilongi.

Corollae tubus extra glaberrimus, prope basin constrictus ; discus ovarium excedens, 5-crenulatum ; folia in axillis inter costam et nervos secundarios subtus glabra, foveolata ; seminis arista basi nuda ... ... 2. *elastica.*

Corollae tubus extra minutissime pubescens, infra medium ipsum constrictus ; discus ovario brevior, 5-lobus ; folia in axillis inter costam et nervos secundarios subtus glabra, efoveolata ; seminis arista ab ipsa basi plumosa 3. *latifolia.*

1. **F. africana,** *Stapf in Proc. Linn. Soc.* 1900, 2. Arbor 4·5–24 m. (15–80 ped.) alta. *Truncus* erectus, cylindricus ; cortex extus cinereus, sublaevis, medio fuscus, intus albidus ; ramuli teretes vel sub nodos compressi, exsiccando plerumque nigricantes ; latex copiosus, albus, coagulando viscosissimus. *Folia* petiolata, forma et magnitudine admodum variabilia ; lamina oblonga, rarius ovato-oblonga, basi attenuata vel interdum rotundata, apice breviter et abrupte acuminata, 12–23 cm. (5–9 poll.) longa, 4–9 cm. ($1\frac{1}{2}$–$3\frac{1}{2}$ poll.) lata, integerrima, margine undulata et exsiccando revoluta, supra glaberrima, sicca plerumque fusca, infra in axillis inter costam et nervos secundarios plerumque pubescens, efoveolata nervis secundariis utrinque 9–10 (raro 11), subpatulis sub margine arcuato-connexis, tertiariis venisque inconspicuis ; petiolus 4–8 mm. (2–4 lin.) longus. *Cymae* breviter pedunculatae, multiflorae, congestae, glabrae ; pedunculus 6 mm. (3 lin.) longus ; bracteae parvae, ovatae, acutae vel subacutae ; pedicelli ad 4 mm. (2 lin.) longi. *Flores* flavescentes ; alabastra subcylindrica, paululo curvata, 14–20 mm. (7–10 lin.) longa. *Calyx* 3·5 mm. ($1\frac{3}{4}$ lin.) longus ; segmenta late ovata vel elliptica, margine minute ciliolato excepto glabra ; glandulae plures cum unoquoque segmento, lobulatae. *Corollae* tubus medio vel paulo infra constrictus, 6–8 mm. (3–4 lin.) longus, glaber ; lobi oblongo-lineares, 10–12 mm. (5–6 lin.) longi. *Stamina* medio tubo vel paulo supra inserta ; filamenta intus minute tomentella ; antherae acuminatae, apice minute pilosulae. *Discus* 5-lobus vel ad basin 5-partitus, ovario $\frac{1}{3}$ brevior. *Fructus* folliculi fusiformes, acute acuminati, semiteretes, ventre applanati, in lateribus utrinque longitudinaliter angulati, ad 20 cm. (8 poll.) longi, angulis 3–4 mm. a sutura ($1\frac{1}{2}$–2 lin.) distantibus. *Semina* glabra, 12–16 mm. (6–8 lin.) longa ; arista 3–4 cm. ($1\frac{1}{4}$–$1\frac{3}{4}$ poll.) longa, basi nuda, pilis 6–7 cm. ($2\frac{1}{2}$ poll.) longis.—Schlechter, West-Afr. Kautschuk Exped., 236 ; Stapf in Hook. Icon. Plant. tt. 2696–2697, and in Fl. Trop. Afr. iv. 190 ; De Wild. in Rev. Cult. Col. x. 74. *Kickxia africana,* Benth. in Hook. Icon. Plant. t. 1276 ; Henriques in Bol. Soc.

Broter. x. (1892) 141 ; Stapf in Journ. Linn. Soc., xxx. (1894), 90, and in Kew Bull., 1895, 244 cum icone* ; K. Schum. in Notizbl. Bot. Gart. und Mus. Berlin, i., 217–221 cum icone* ; Warb. in Zeitschr. f. trop. Landwirthsch. (Tropenpfl.) i. 99–103, cum icone* and Kautschukpfl. 110 ; Lecomte in Rev. Cult. Col. i. 12–19, 41–47, figs. 1, 2 and 14 ; Preuss in Tropenpfl. iii. 65–71 ; Jumelle, Les Plantes à Caoutchouc, 68–73, fig. 10* ; Preuss in Notizbl. Bot. Gart. und Mus. Berl. ii. 353–360, t. ii. ; Schlechter in Tropenpfl. iv. 326–330, et West-Afr. Kautschuk Exped. 41, 158, 160, 194, 202, 206, 235, 236, 307, fig. on p. 238 ; De Wildeman in Rev. Cult. Col. vii. 633, 634, 747. *K. Zenkeri*, K. Schum. l. c. iii. 81. *K. Gilletii*, De Wildeman, l. c. 744 . . .

West Tropical Africa. Sierra Leone, without precise locality, *Scott Elliot! Haydon* (follicles and seeds)! near Kukuna on the Scarcies River, *Scott Elliot*, 4506 ! (fruit-bearing branch, with almost bright green and quite glabrous leaves) ; Bagroo River, *Mann*, 817 ! Liberia, Grand Basa, S. John's River, *Dinklage*, 835 ! Sinô Basin, *Whyte!* Ivory Coast, Dobou, *Jolly*, 174 ! 1691 ! Gold Coast, Sehwhi and Wam District, *Armitage!* (barren branches). Koforidua, *Johnson*, 434 ! E. Akim, *Johnson*, 692 ! (flowering branches). Prah River, *Johnson*, 925 ! Togoland, Amedjohve Mountain, *Schlechter*, 12,979. Misahohe, *Baumann*, 555 ! Dahomey, Adja Were, according to *Hua*. Lower Nigeria, Bonny, *Kalbreyer*, 82 ! (detached leaves, open follicles and seeds ; the follicles are rather less coriaceous than in the other specimens). Opobo, *Holland*, 157 ! Adiabo, *Holland*, 224 ! between Ekuke and Abaragba, together with F. elastica, according to *Holland*. Cross River, at Itu, *Holland*, 5 ! Ekure, *Holland*, 160 ! Cameroons, virgin forest near Victoria, *Preuss*, 1382 ! Bipinde, Buli, *Zenker*, 2280 ! 2534 ! Gaboon, Libreville, *Klaine*, 662 ! Fernando Po, *Mann !* Lower Congo, Kisantu, *Gillet !*

Flowers were collected in December in the Cameroons, in January in Sierra Leone, in January and February in Gaboon, early in April (in a very young state) on the Cross River. The fruits of the previous year seem to ripen at about the same time. This tree appears to be common in the hill forests of the Agome Mts. and in the Boëm Country, Togoland (Schlechter), in the coast region of the Cameroons (Dr. Preuss), and in the basin of the Upper Mungo as far as the Bakossi Mts. (Schlechter), and on the slopes of the hills near Libreville (Chalot in *Le Jardin*, xi., 199). Lecomte claims to have discovered a plant identical with *F. africana* of Libreville, still farther south, at Kakamoeka, on the Kouila River ; but he remarks that the fruits are rather longer and the stamens somewhat differently shaped.

K. Zenkeri was supposed to differ from *Funtumia africana* in the longer corolla-lobes and the shape of the disc ; there is, however, in my opinion, no difference whatever in these respects. *K. Gilletii*, on the other hand, was distinguished from *F. africana* on account of the flowers being smaller ; but here again, I find that the size of the corollas comes well within the range of variation exhibited by the flowers of *F. africana*. There is also

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* Descriptione et figuris fructuum exceptis.

no difference in the foliage, and unless the fruits should be found to afford more tangible characters, we shall have to consider *K. Gilletii* as identical with *F. africana*.

The rubber obtained from this species is sticky like bird-lime, and therefore worthless.

2. **F. elastica**, *Stapf in Proc. Linn. Soc.*, 1900, 2. *Arbor* ad 30 m. (100 ped.) alta. *Truncus* erectus, cylindricus; cortex extus pallidus, maculatus; ramuli teretes, exsiccando nigricantes; latex copiosus, coagulando massam elasticam haud viscosam reddens. *Folia* petiolata; lamina oblonga vel lanceolato-oblonga, basi attenuata, apice in acumen angustum plerumque acutum contracta, 12–21 cm. (5–9 poll.) longa, 3–6 cm. ($1\frac{1}{4}$–$2\frac{1}{2}$ poll.) lata, integerrima, margine conspicue undulata et exsiccando revoluta, glaberrima, sicca fusca, subtus pallidior, in axillis inter costam et nervos secundarios distincte foveolata, nervis secundariis utrinque 7–11 (10 in specimine "*Preuss*, 1381," in caeteris plerumque 8–9) subpatulis sub margine arcuatim connexis, tertiariis venisque inconspicuis; petiolus 4–10 mm. (2–5 lin.) longus. *Cymae* breviter pedunculatae, multiflorae, congestae, glabrae; pedunculus ad 6 mm. (3 lin.) longus; bracteae parvae, late ovatae, obtusae vel subacutae; pedicelli 3–5 mm. ($1\frac{1}{2}$–$2\frac{1}{2}$ lin.) longi. *Flores* albi vel flavescentes; alabastra conica, brevia, ad 12 mm. (6 lin.) longa. *Calyx* 4–$4\frac{1}{2}$ mm. (2–$2\frac{1}{4}$ lin.) longus; segmenta latissima, ovata vel rotundata; glandulae plerumque 2 cum unoquoque segmento. *Corollae* tubus supra basin constrictus, 7–8 mm. ($3\frac{1}{2}$–4 lin.) longus, glaber; lobi oblongi, obtusi, 5–6 mm. ($2\frac{1}{2}$–3 lin.) longi. *Stamina* infra medium tubum inserta; filamenta intus minute tomentella; antherae acuminatae, apice minute pilosulae. *Discus* 5-partitus, segmentis crenatis, ovarium paulo superans. *Fructus* folliculi clausi oblongo-claviti, apice obtusi vel rotundati, sectione transversa elliptica, plane aperti oblongo-elliptici, ad 5 cm. (2 poll.) lati, lignosi, in lateribus vix longitudinaliter angulati, 8–14 cm. ($3\frac{1}{4}$–6 poll.) longi. *Semina* glabra, 12–18 mm. (6–9 lin.) longa; arista 3·6–5·4 cm. ($1\frac{1}{2}$–$2\frac{3}{4}$ poll.) longa, ad medium nuda, pilis ad 6 cm. ($2\frac{1}{2}$ poll.) longis. Schlechter, West-Afr. Kautschuk Exped. 236; Stapf in Hook. Icon. Plant. t. 2694–2695, and in Fl. Trop. Afr. iv. 191; De Wild. in Rev. Cult. Col. x. 74–76, xii. 193–196; Moeller in Tropenpfl. ix. 509–511. *Kickxia elastica*, Preuss in Notizbl. Bot. Gart. u. Mus. Berlin, ii. 353–360, t. i. Schlechter in Tropenpfl. iv. 109–120, 141, 143, vi. 308, 423, 636, vii. 93, and in West-Afr. Kautschuk Exped. 16–19, 96–101, 103, 112, 113, 151–160, 236–247, 257, figs. on p. 99 and opp. pp. 164 and 176; Warburg, Kautschukpfl. 110-112, 153; De Wildeman in Rev. Cult. Col. vii. 633, 634, 743–747. *K. africana*, Stapf in Kew Bull. 1895, 244 cum icone*; K. Schum. in Notizbl. Bot. Gart. und Mus. Berlin, i. 217–221, cum icone*; Warb. in Zeitschr. f. trop. Landwirthsch. (Tropenpfl.) i. 99–103, cum icone,* Kautschukpfl. 110-112, and Plantes à caoutch. 200–205, partly; Lecomte in Rev. Cult. Col. i. 12–19, 41–47, fig. 2*; Jumelle, Les Plantes à Caoutchouc, 68–73, fig. 10*; Thonner in De Wild. and Durand, Plant. Thonner. Congol. xii.; Henriques, Der Kautschuk, 18;

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* Quoad fructus.

tabelle iii.; Reintgen in Tropenpfl. vi. Beih. 2–3, 163–168; Zitzow in Tropenpfl. viii. 228–250, with fig. on p. 232; Stein in Tropenpfl. viii. 597–611; Soskin in Tropenpfl. x. 32–39; non Benth.

WEST TROPICAL AFRICA. Liberia, about 40 miles up the Sinô River, *Sim!* Gold Coast, Mampong Hills, *Johnson*, 255! Sehwhi and Wam District, *Armitage!* (barren branches and a branch bearing very young fruits). Ashanti, Kumassi, *Cummins*, 217! (flowering branch, flowers young and partly deformed). Lagos, Jebu District, *Millen*, 178! 180! and without precise locality, *Denton!* (fruits and seeds, also flowering branches from plants grown in the Trinidad Bot. Garden, raised from those seeds, comm. *Hart!*) *Punch!* Yoruba, Ibadan, *Olubi!* (open follicle and seeds); dense forests between Shagamo and Ibadan, *Schlechter*, 12319. Lower Nigeria, Old Calabar, *Lloyd!* (follicle with seeds); between Ekuke and Abarogba, *Holland*, 158! 159! 161! 162! (flowering and fruiting branches, some of the latter with remarkably small follicles); between Insofan and Obeyon, *Holland*, 243! Cameroons, right bank of Mungo River, between Malende and Nyoke, and between Nyoke and Moyoka, *Preuss*, 1381! Mundame, *Preuss*, 62! between Kumba Ninga and Mokonje, *Preuss*, 6! forests on the upper Mungo River as far as the Bakossi Mts., *Schlechter*. S.E. Cameroons, plentiful in the basin of the Ngoko and Dscha, *Schlechter*, 12746! French Congo, Ubanghi basin, Libengi, *Mardulier*! (leaves and follicles). Congo Free State, Bangala, *Laurent*, 3036! (leaves); Ngali, *Thonner*, 13! Upper Ituri River, *Arnold!* Uganda, Mabira Forest, *Dawe*, 146!

The rubber tree observed by Dr. Preuss near Barombi Station in the Cameroons Hinterland (Tropenpfl. ii. 206) is, according to him, probably also identical with *F. elastica*. It is the same tree which was mentioned by him in Danckelmann's Mittheilungen aus den Deutschen Schutzgebieten, ii. 48, as a species of *Ficus*. *F. elastica* flowers in December and January, and matures the fruits from the previous year about the same time. Vernacular name:—Funtum (*Johnson*); Female Funtum (*Armitage*). Ire (*Denton*, *Millen*). Fishunga (*Schlechter*, Balunda Language).

Dr. Preuss says (Notizbl. Bot. Gart. und Mus. Berlin, II. 355) that the Lagos specimens which he saw differed from those collected by himself in the Cameroons in having smaller and less wavy leaves with fewer lateral nerves and narrower fruits. I can confirm this so far as the size of the leaves and the number of nerves are concerned. The same applies also to all the specimens which I have seen from outside of the Cameroons with the exception of Captain Armitage's and some of Holland's, which have leaves up to 21 cm. (9 in.) by 9 cm. ($3\frac{3}{4}$ in.) and usually 9 (rarely 10 or 11) nerves on each side. A specimen grown in the Royal Gardens from seeds sent from the Gold Coast, exhibits a similar approach to the Cameroons plant. As the flowers and fruits are absolutely identical in both forms, it does not appear at present expedient to distinguish them by varietal names.

This species is one of the most important sources of West African rubber.

3. **F. latifolia,** *Stapf* ex Schlechter, West-Afr. Kautschuk-Exped., 236. *Arbor* 15–30 m. (50–100 ped.) alta. *Truncus* erectus, basi ad 1 m. (ultra 3 ped.) dimetiens; coma circiter 10 m. (35 ped.) a solo remota; ramuli superne magis minusve compressi, caeterum teretes, minutissime pubescentes vel subglabri, exsiccando nigricantes. *Folia* petiolata; lamina oblonga vel lanceolato-oblonga vel elliptica, basi rotundata vel acuta vel cuneata, apice abrupte acuminata, 14–24 cm. (6–10 poll.) longa, 6–9·5 cm. (2½–4 poll.) lata, in gemma sparsim minutissime pubescens, mox glaberrima, margine integerrima, undulata, exsiccando vix revoluta, subtus in axillis inter costam et nervos secundarios efoveolata, nervis secundariis utrinque 10–15 (plerumque 12), tertiariis venisque inconspicuis; petiolus 6–10 mm. (3–5 lin.) longus. *Cymae* breviter pedunculatae, multiflorae, congestae, minutissime puberulae; pedunculus 4–6 mm. (2–3 lin.) longus; bractae parvae, ovatae, acutae vel subacutae; pedicelli 2–4 mm. (1–2 lin.) longi. *Flores* albi; alabastra brevia, elongato-conica, circiter 12–14 mm. (6–7 lin.) longa, extus magis minusve minutissime velutina. *Calyx* 2½–3 mm. (1¼–1½ lin.) longus; segmenta ovata, obtusa vel subacuta, margine minute ciliolata, dorso sparsim minute pubescentia; glandulae 2 vell, cum unoquoque segmento. *Corollae* tubus ad ⅓ supra basin constrictus, 6–8 mm. (3–4 lin.) longus; lobi oblongi, obtusi, 5–8 mm. (2½–4 lin.) longi. *Stamina* medio tubo inserta; filamenta minute tomentella, antherae acuminatae, apice puberulae. *Discus* 5-lobus, lobis integris vel crenulatis late rotundatis, ovarii ⅔ aequans. *Fructus* folliculi divergentes, clausi lanceolati, acuti 12–14·5 cm. (5–6 poll.) longi, aperti 3–4 cm. (1¼–1⅔ poll.) lati, dorso acute bicarinati, carinis a sutura 6 mm. (3 lin.) distantibus, tenuiter lignosis. *Semina* sparse longe sericeo-pilosa, 18–20 mm. (9–10 lin.) longa, arista 22–24 mm. (11–12 lin.) longa, a basi plumosa, pilis ad 5 cm. (2 poll.) longis. Stapf in Hook. Ic. Pl. sub tt. 2694–2695. *Kickxia latifolia*, Stapf in Kew Bull., 1898, 307, in Ann. Mus. Congo, sér. 2, I. i. 42, and ii. 41, and in Fl. Trop. Afr. iv. 192; Preuss in Notizbl. Bot. Gart. u. Mus. Berlin, i. 353–359, fig. A–H on p. 356; Schlechter in Tropenpfl. iv. 30 and West-Afr. Kautschuk-Exped. 63, 64, 236, 307, fig. on p. 125; De Wildeman in Rev. Cult. Col. vii. 633, 634. *K. Scheffleri*, K. Schum. in Notizbl. Bot. Gart. u. Mus Berlin, iii. 81. *K. congolana*, De Wildem. l. c.

West Tropical Africa: Congo Free State, Lower Congo, Kisantu, *Gillet*, 387 ! near Nouvelle-Anvers, *Duchesne*, 14 ! near Coquilhatville, *Gentil! Schlechter*, 12,596 ! Bangala, *Dewèvre*, 867 ! Lake Leopold II. District, Kutu Ibali, valley of the Kiri, *Bollé!* Mission Delhez, *Delhez!* Kassai Distr., near Lusambo, *Luja!*

East Tropical Africa: Uganda, Mawokota, *Dawe*, 236 ! Entebbe, common in the lake shore forest, *Dawe!* Busero, *Dawe*, 201 ! Usambara, Lutindi, *Holst*, 3380 ! (leaves). Derema, *Scheffler*, 176 ! Island of Zanzibar, Dunga Estate, *Lyne*, 97 ! near Lake Nyasa, a follicle, communicated by the *African Lakes Corporation!*

Bolle says it occurs throughout the Lake Leopold II. District. Vernacular name, Bolé or Bobolé (Bolle).

K. Scheffleri was compared by K. Schumann with *Funtumia latifolia*, from which he stated it differed in having smaller,

minutely papillose corollas and a somewhat different disc. The delicate indumentum of the corolla is, however, one of the most characteristic features of *F. latifolia*, and as to the alleged differences in the disc, I cannot find them. *K. congolana* was placed close to *K. Scheffleri* by De Wildeman and described as a distinct species mainly on account of its distribution, whilst it was separated from *F. latifolia* for its more or less velvety corollas, those of *F. latifolia* being described as glabrous by De Wildeman. I have, however, pointed out in my original description of *F. latifolia*, that the corolla is very minutely pubescent without.

This species, like *F. africana*, does not seem to yield any serviceable rubber.

O. STAPF.

XXII.—PARA RUBBER IN CEYLON.

[*K.B.*, 1893, p. 159.]

As stated in the *Kew Report* for 1876, p. 8, Mr. H. A. Wickham, a resident on the Amazon, was commissioned by the India Office to collect seeds of *Hevea brasiliensis*. He arrived in England on June 14th with 70,000 seeds obtained on the Rio Tapajos, and on August 12th following, about 2,000 plants raised at Kew from these seeds were despatched to Ceylon in 38 Wardian cases. Ninety per cent. of the plants reached their destination in perfect condition. A further consignment of 100 plants was sent in 1877, making the total number of plants transmitted to Ceylon 2,119 (*Kew Report*, 1877, p. 15).

The following correspondence gives the first result of the experiment which affords anything like commercial data for deciding whether the cultivation of this staple would be a paying enterprise in the Old World :—

DR. TRIMEN to ROYAL GARDENS, KEW.

[Received February 6th, 1893.]

India-rubber (2 lb.) from *Hevea brasiliensis*, grown in Heneratgoda Botanic Garden, Ceylon, in 1892.

The tree from which this was obtained is now 15 years old, and the stem has a circumference of 6 ft. 5 in. at a yard above the ground.

It has now been tapped three times, and has given the following yield :—

In 1888 it gave 1 lb. $11\frac{3}{4}$ oz.
„ 1890 „ 2 „ 10 „
„ 1892 „ 2 „ 13 „

making a total of 7 lb. $2\frac{3}{4}$ oz. of dry rubber in five years.

The tree is in no respect the worse for this treatment, the rest in alternate years permitting the scars on the trunk to become completely healed.

(Signed) HENRY TRIMEN.

MESSRS. HECHT, LEVIS AND KAHN to ROYAL GARDENS, KEW.

21, Mincing Lane, London, E.C.
7th February, 1893.

DEAR SIR,

We have received your yesterday's letter, and also the sample of Ceylon rubber which you have sent to us. The quality of this rubber is very good indeed, and the curing of the same seems to have been effected in the proper manner. This quality would be easily saleable, and we estimate its value to-day as being about 2*s.* 3*d.* to 2*s.* 6*d.* per lb., according to whether the rubber would be dry or damp. It would be easily saleable in *large quantities.*

We return the sample to you, according to your desire.

We remain, &c.,

(Signed) HECHT, LEVIS AND KAHN.

John R. Jackson, Esq.,
Royal Gardens, Kew.

XXIII.—PARA RUBBER.

(*Hevea brasiliensis*, Muell. Arg.)

[*K.B.*, 1898, pp. 241–277.]

What is known as the Para rubber of commerce is obtained from the vast region drained by the Amazon and its tributaries estimated to embrace a territory nearly two-thirds the size of Europe.

The plants yielding Para rubber consist of several species of *Hevea* belonging to the natural order Euphorbiaceae, familiarly known as Spurges.

We owe the first authentic account of the plants of this genus to M. de la Condamine, the leader of the French expedition sent out in 1773 to measure an arc of the meridian near Quito. The tree was known in the Andean region as "Heve" or "Jeve," but according to Spruce this name is also applied to *Castilloa elastica* and to *Siphocampylus Caoutchouc.* In the Amazon valley it was called "Cahuchu," probably the origin of the word caoutchouc. The Portuguese, in Brazil, call the rubber "Seringa," and the native collectors "Seringuieros." The tree is "Pao de Seringa." These names suggest that the syringe was one of the earliest uses to which india-rubber was locally applied.

Plants belonging to the genus *Hevea* are widely distributed in tropical South America. They are apparently found wild in no other part of the world. In the present state of our knowledge it is impossible to state accurately all the species that yield Para rubber.

In a review of the species of *Hevea* by Mr. W. B. Hemsley, in *Hooker's Icones Plantarum*, figures are given of *Hevea spruceana*, Muell. Arg. (t. 2570), found in North Brazil, and of *H. benthamiana*, Muell. Arg. (t. 2571), collected by Spruce on the

Uaupés river in North Brazil, and reported to be under cultivation in Venezuela. The floral structure of eight species is elucidated (tt. 2573 and 2574), and the seeds of five species are carefully compared and discriminated (t. 2575). This is the most recent revision of the Heveas, but their geographical distribution in each case is not even yet satisfactorily settled. In addition to those mentioned above the following are known from North Brazil: *H. rigidifolia*, Muell. Arg., *H. discolor*, Muell. Arg., and *H. lutea*, Muell. Arg. The latter is found on the Rio Negro and also in East Peru. One or two species of *Micrandra* (with simple leaves) are also known as *Seringa*, and according to Spruce, yield a milk containing caoutchouc.

It is admitted that the chief species yielding the Para rubber of commerce is *Hevea brasiliensis*, Muell. Arg. (Siphonia brasiliensis, *H.B.K.*), the *Seringa* of the Portuguese and the Para rubber tree of the English. This is a slender tree reaching a height of 50 to 60 feet, with a circumference near the base of 6 to 8 feet. The leaves are digitate-trifoliate on long slender petioles. The diclinous flowers are produced in axillary panicles, the female larger and terminal. The fruit is a dry capsule splitting into three one-seeded pieces. The seeds are round-oblong about an inch in length, with a brown polished testa, mottled with dark blotches. (*Collins' Caoutchouc*, t. 1; *Hooker's Icones Plantarum*, t. 2575, figs. 1–7; Siphonia brasiliensis, *Hayne's Gewache*, xiv., t. 5.)

In a report recently furnished to the Foreign Office, by Mr. Consul W. A. Churchill (*F. O.* No. 2140, Annual Series, Trade of Para and district for the year 1897), the following account is given of this rubber tree (pp. 25, 26).

"The *Hevea* tree is not conspicuous, and resembles many other forest trees. People have travelled for thousands of miles through the rubber region and have lived for years in the centres of the industry without even noticing it. The new-comer invariably expects to see the glossy dark-green leaves of the *Ficus*, and is disappointed with the insignificant appearance of the *Hevea*. In habit it is more like the English ash than anything else. It grows to a height of upwards of 60 feet.

"The localities where rubber-trees thrive the best are on islands and low ground near rivers where the banks are periodically inundated. Ground that is above water at all times or that has no drainage is not so suitable to the tree.

"A peculiarity of this rubber-tree is, that it will not grow satisfactorily on cleared and open ground. It requires the shade of other trees, and still air, from the time that its growth begins until it becomes an adult tree. Without these conditions the supply of milk is very much affected. In fact, the tree has been known to die soon after the clearing of ground around it.

"No cultivation of rubber trees worth mentioning has been attempted in the Amazons region. It is considered useless to invest capital in cultivation so long as the Amazonian forests show no sign of exhaustion."

A very interesting note on the early history of the india-rubber industry on the Amazon was communicated by R. Spruce to

Hooker's Journal of Botany (vol. vii., 1855, pp. 193–196). This gives a graphic account of the beginning of the collection and preparation of Para rubber.

"When I ascended the Rio Negro in 1851, I pointed out to the inhabitants the abundance of seringa trees they possessed in their forests, and tried to induce them to set about extracting the gum; but they shook their heads, and said it would never answer. At length the demand for india-rubber, especially from the United States, began to exceed the supply; the price consequently rose rapidly, until early in 1854 it reached the extravagant sum of 38 milreis the arroba (2*s.* 9*d.* per pound). This woke up the people from their apathy, and the impulse once given, extended so rapidly and widely, that nearly throughout the Amazon and its principal tributaries the mass of the population put itself into motion to search out and fabricate *seringa*. In the province of Para alone (which now includes a very small portion of the Amazon) it was computed that 25,000 persons were employed in that branch of industry in the year 1854. Mechanics threw aside their tools, sugar-makers deserted their engenhos, and Indians their roças; so that sugar, rum, and even farinha, were not produced in sufficient quantity for the consumption of the province, the two former articles having to be imported from Maranham and Pernambuco, and the last from the river Uaupés."

The next authentic account is a "Report on the investigation and collecting of plants and seeds of the india-rubber trees of Para, &c.," by Robert Cross, presented to the Under Secretary of State for India in 1877. Extracts from this are given below.

Mr. Churchill's report, already cited, contains the latest and most authentic information in regard to the Para rubber industry.

"Out of a revenue of £428,894 collected on exports in the State of Para in 1896–97, £415,295 was collected on rubber alone. The export duty is 23 per cent.

"The entire Amazonian crop of 1895–96 amounted to 20,981 tons, whereas that of 1896–97 reached 22,315 tons, an increase of 6·4 per cent. The crop of the State of Para during 1896–97 amounted to 8,844 tons."

The sources of the rubber supply of the Amazonian region are approximately given by Mr. Consul Churchill, as follows :—

Sources.	Quantity.
	Tons.
From River Purús	3,500
" " Madeira	2,200
" " Juruá	2,100
" " Solimöes	1,000
" " Negro	700
" " Javary and Port of Iquitos	1,500
" Peru and Bolivia (Caucho)	2,000
" Para	9,000
Approximate annual production	22,000

"The internal water communication afforded by the river Amazon and its numerous branches is so great that railroads and other means of transport are hardly needed. Ocean steamers can reach Manaos, which is about 1,000 miles from the sea, at all times of the year. There is a regular service of ocean steamers plying during high river as far as Iquitos, a port of Peru, which is 2,200 miles from the mouth of the Amazons."

Mr. Churchill continues: "The great demand for rubber and the ever-increasing prices for it have the natural result of attracting the bulk of the people to this remunerative industry. So long as the demand for rubber continues, the prospects as regards the development of agricultural industry will be comparatively insignificant."

It follows that the rich lands of the Amazon are practically untouched, except to tap the wild rubber trees growing upon them. Nearly all the necessaries of life are imported from other countries.

The town of Para or Belem, the headquarters of the great rubber industry of the Amazon region, is on the right bank of the river Guama, and about 100 miles from the sea.

It is not on the banks of the Amazons, but is connected with the latter by a labyrinth of narrow channels through which passes all the shipping between the outer world and the numerous Amazonian ports inland. The true mouth of the Amazons is dangerous to navigation and is avoided. Hence the port of Para commands practically the whole Amazon region, and is the emporium where is transacted the largest india-rubber business in the world.

According to Mr. Churchill, during the year 1897, the distribution of Amazonian rubber from Para was as follows:—

	Tons.
United Kingdom	8,843
France	2,010
Italy	65
United States of America	11,626
Total	22,544

Locality, Soil, and Climate.

Para is in about south latitude 1°, but the district of the same name extends over a vast forest region to the south and west, throughout which and the enormous forests of Central and Northern Brazil the rubber trees are abundantly found. The climate has been often described, and is remarkable for its uniformity of temperature, usually not exceeding 87° F. at mid-day or below 74° at night. The greatest heat recorded is 95°, and the mean for the year is 81°.

The rainfall occurs principally during the months from January to June, the maximum being in April, when it reaches 15 inches. For the remaining six months of the year very little falls, but there are fine days in the wet season and occasional showers in

the dry. The whole country is covered with dense moist forests, and the soil near the numerous and gigantic rivers is deep, heavy, and very fertile. During the wet season much of the low-lying country near the Amazon's mouths is flooded. In the *gapos* near Para, visited by Mr. Cross, he found a flat district only three or four feet above the highest tides and completely intersected with water-courses at low tide, filled with a soft rich mud. The forest here, in which caoutchouc-collecting was vigorously carried on, was 80 or 100 feet high, and very damp and unhealthy, the soil full of moisture and very rich and fertile. The young plants, however, were not often observed to grow actually within the reach of the tides, but it is evident that they must occasionally be partially covered with water.

Propagation.

The most convenient means for propagating Para rubber trees is by seeds. As might be expected, seeds are difficult to collect in the dense growth of the Amazonian forests. There is, further, no certainty that they are sound. On the other hand, seeds are very readily obtained from cultivated trees now distributed over many parts of the tropics. If quite fresh they bear transport for a period of three or four weeks. Seeds forwarded from Ceylon to Kew in canvas bags have germinated to the extent of 95 per cent. If special precautions are necessary, they may be packed in soil or cocoa-nut fibre moderately dry. The disappointment sometimes experienced in despatching Para rubber seeds is due to the fact that the seeds have not been quite fresh when packed. It is absolutely necessary that they be packed within a day or two of the time they have been gathered. Where this is done the seeds, if sound, should bear transport for three weeks at least. The other method of propagating the tree is by cuttings. These cuttings may be taken from the green lateral twigs as soon as they begin to harden; they strike readily in rich firm soil. Mr. Cross (p. 8) observes that "for planting on inundated lands the period of high flood should be preferred. Cuttings of greater length would be required in this case, the lower ends of which should be sliced off in the form of a wedge. The workman could take a bundle of these, and wading into the water would plant at proper distances, but perfectly upright, taking care to push each cutting down deep enough in the soft muddy bottom, so that not more than three or four inches is above the surface of the water. The same rule would be applicable when planting in sludge or soft marsh land. The crowns of the cuttings must not, if possible, be put under water, as the young growths springing therefrom might rot. Seeds will not be found very applicable for planting in watery places or deep mud deposits. Some would come up, but a good many would mould and decay. In the varied course of circumstances and conditions, slight changes and modifications in the methods of working will no doubt suggest themselves. . . . It should be planted in places where nothing else could be profitably cultivated, such as frequently inundated river margins, marsh land, and mud deposits." These remarks, it should be noted, apply only to the Amazon region. In other parts of the world Para trees have been found very impatient of floods, and

have actually been killed by being planted within their reach. Again, it would not be desirable to form a plantation in any locality where the temperature at any time falls to 60° F.

The tree when fully grown does not exceed a height of about sixty feet, and the largest trunk measured by Mr. Cross was six feet ten inches in circumference at a yard from the ground. From the upright habit of the tree it will not be necessary to plant at any great distance apart.

Collection of Rubber.

Several accounts have been given of this; the fullest is that of Mr. Cross, who saw in practice the methods employed in the neighbourhood of Para. His description (p. 4) is as follows:—

"The collectors begin to work immediately at daybreak, or as soon as they can see to move about among the trees. They say the milk flows more freely and in greater quantity at early morn. I do not attach much importance to this statement, but I have recorded it. Another and more probable reason is that as rain often falls about two or three o'clock in the afternoon the tapping must be done early, as in the event of a shower the milk would be spattered about and lost. The collector, first of all, at the beginning of the dry season goes round and lays at the base of each tree a certain number of small cups of burnt clay. At the lesser trees only three or four are put, but at the larger ones from eight to twelve are deposited. The footpaths leading from tree to tree are likewise cleared of sapling growths, and the bridges over the *gapos* (natural ditches), formed at each place by the trunk of a tree, are, where necessary, replaced. On proceeding to his work the collector takes with him a small axe for tapping, and a wicker basket containing a good-sized ball of well wrought clay. He usually has likewise a bag for the waste droppings, and for what may adhere to the bottoms of the cups. These promiscuous gatherings are termed *sernamby*, and form the 'negrohead' of the English market. The cups, as already stated, are of burnt clay, and are sometimes round, but more frequently flat or slightly concave on one side, so as to stick easily with a small portion of clay pressed against the trunk of the tree. The contents of fifteen cups make one English imperial pint. Arriving at a tree the collector takes the axe in his right hand, and, striking in an upward direction as high as he can reach, makes a deep upward sloping cut across the trunk, which always goes through the bark, and penetrates an inch or more into the wood. The cut is an inch in breadth. Frequently a small portion of bark breaks off from the upper side, and occasionally a thin splinter of wood is also raised. Quickly stooping down he takes a cup, and, pasting on a small quantity of clay on the flat side, presses it to the trunk close beneath the cut. By this time the milk, which is of dazzling whiteness, is beginning to exude, so that if requisite he so smooths the clay that it may trickle direct into the cup. At a distance of four or five inches, but at the same height, another cup is luted on, and so the process is continued until a row of cups encircle the tree at the height of about six feet from the ground. Tree after tree is treated in like manner, until the tapping required for the day is finished. This work should be concluded by nine or ten o'clock in the morning, because the milk continues to exude

slowly from the cuts for three hours, or perhaps longer. I may state that there is a great difference among collectors in the performance of these duties. Some take care to get good clay previously, and incorporate it well, so that a very small portion is needed to lute the cup to the trunk. They also work with neatness and intelligence, and invariably collect a good quantity of milk. Others, again, do not take the trouble to prepare clay beforehand, but merely scrape up a handful when they require it at the side of a *gapo*, which is often of little consistence, so that a large quantity is required to fasten the cups. This class of collectors have often many fragments of clay or other impurities in their milk, the result of not following a proper method of working. The quantity of milk that flows from each cut varies, but if the tree is large, and has not been much tapped, the majority of the cups will be more than half full, and occasionally a few may be filled to the brim. But if the tree is much gnarled from tapping, whether it grows in the rich sludge of the *gapo* or dry land, many of the cups will be found to contain only about a tablespoonful of milk, and sometimes hardly that. On the following morning the operation is performed in the same way, only that the cuts or gashes beneath which the cups are placed are made from six to eight inches lower down the trunks than those of the previous day. Thus each day brings the cups gradually lower until the ground is reached. The collector then begins as high as he can reach, and descends as before, taking care, however, to make his cuts in separate places from those previously made. If the yield of milk from a tree is great, two rows of cups are put on at once, the one as high as can be reached, and the other at the surface of the ground, and in the course of working the upper row descending daily six or eight inches, while the lower one ascends the same distance, both rows in a few days come together. When the produce of milk diminishes in long-wrought trees, two or three cups are put on various parts of the trunk where the bark is thickest. Although many of the trees of this class are large, the quantity of milk obtained is surprisingly little. This state of things is not the result of over-tapping, as some have stated. Indeed, I do not believe it possible to overtap a tree if in the operation the wood is not left bare or injured. But at every stroke the collector's axe enters the wood, and the energies of the tree are required in forming new layers to cover those numerous wounds. The best milk-yielding tree I examined had the marks of 12 rows of cups which had already been put on this season. The rows were only six inches apart, and in each row there were six cups, so that the total number of wood cuts within the space of three months amounted to 72. It grew close to a *gapo*, only eight inches above high-tide mark, and being a vigorous tree the cups were usually well filled, but with two years or so of such treatment the tree would probably be permanently injured. It has been supposed that the quality of the milk is better in the dry season than during the rains. Such is the case with some vegetable products, but as regards india-rubber there ought not, I think, to be any appreciable difference. In the rainy season the milk probably contains a greater proportion of water, but, on the other hand, I am of opinion that then a larger quantity of milk flows from the tree. No doubt the dry season is the most suitable for caoutchouc collecting, although,

wherever a plantation is formed with preparing house, convenient tapping may certainly always be carried on when the weather is fine . . . There are two other methods adopted in tapping, which are chiefly confined to the Upper Amazon and tributaries. Both are exactly on the same principle, the materials used being only a little different. The loose outside bark of the tree is cleaned off to a height of about three feet. Beneath, a gutter or raised border of clay is pasted or luted to the trunk, enclosing one-half of the entire circumference. Cuts are thickly made in the bark above this, from which the milk flows down to the gutter, whence it is conveyed to fall into a calabash conveniently placed. The other mode is by winding round the trunk the stout flexible stem of a climber, and claying it round securely, so that no milk may escape between the trunk and the climber. These plans are not extensively adopted, and can only be successfully put in practice where the trees have not been previously tapped. There is always a great deal of 'negrohead,' the result of the distance the milk has to run, and of the large quantity of clay employed in the process.

"Going from tree to tree at a sort of running pace, the collector empties the contents into a large calabash, which he carries in his hand. As he pours the milk out of each cup he draws his thumb or forefinger over the bottom to clean out some which otherwise would adhere. Indeed, a small quantity does remain, which is afterwards pulled off and classed as *sernamby*. The cups on being emptied are laid in a little heap at the base of each tree to be ready for the following morning. The trees occur at various distances from 10 to 100 yards apart, and, as I travelled over the intricate network of muddy footpaths, I continually felt perplexed and surprised that the natives had not yet seen the advantages that would be derived by forming plantations, whereby more than twice the quantity of caoutchouc might be collected in one-fourth the time, and at far less cost and labour."

The trees are tapped if they have a circumference of eighteen or twenty-four inches, and the rough process above described is carried on for many years, until the constant and extensive injury to the young wood causes their death, for some years previous to which event they almost cease to yield milk and are practically abandoned.

It will be advisable, in order to avoid this injury, to employ an instrument for cutting so shaped and guarded that it shall not be able to penetrate beneath the inner bark. With this precaution it will probably be found unnecessary to rest the trees as has been recommended; but actual experience alone can decide on the method of tapping which will secure the greatest yield with the least damage to the tree's general vitality.

Preparation of Rubber.

The preparation of Para rubber has often been described. The process that turns out the best quality of rubber depends merely on a cheap and accessible supply of labour. The implements used are very simple. So far no rubber is so good as that prepared by smoking over a fire of palm-nuts. As suggested by Mr. Biffen, coagulation is partly due to the acetic acid contained in the smoke

(*Kew Bulletin*, 1898, pp. 177–181 [p. 11]). This also tends to preserve the rubber from fermentation during transit. The belief in the efficacy of the smoking process is so strong that even when the purest rubber is obtained from cultivated trees in Ceylon and the Straits Settlements the prices quoted are always below those of smoke-cured Para. The following graphic account of the preparation of Para rubber is taken from Wells' "Voice of Urbano" (London : Allen, 1888) :—

"Master and men then departed to various out-buildings, where the Indian boys and women, after partaking of a very hasty and meagre repast of dried piraurucu (a large river fish) and farinha, were set to work at converting the milk, or sap of the rubber tree, into india-rubber.

"This process does not require any great manual labour ; it is rather a work of patience. In a distant corner of the yard, under the shade of one of the few remaining trees, a quantity of the fruit of the Urucuri palm was burning on several fires. The burning of these nuts produces a dense black smoke, the acidulous properties of which has proved to be the most efficacious for rapidly coagulating the sap of the rubber tree. Near each fire, one of the large earthenware pots was placed between a couple of Indian boys, each boy having a small, round-bladed paddle in his hand ; the blade of the paddle is dipped into the milk, which, adhering to the wood, is held in the smoke of Urucuri, and rapidly coagulated and turned almost at once to the black india-rubber of commerce. The round blade of the paddle, covered with a thin coating of rubber, is then again dipped into the pot of sap, and the process repeated and continued until the rubber is about two inches thick, when one of the attendant drivers, who superintends the operations, makes a cut with a sharp knife along the outer circumference of the paddle, when the round cake of rubber is easily removed and then placed with others on the ground alongside the operator. So the process is continued, until the collected sap is exhausted and the rubber stored away.

"Early the next morning, the Indians will again go away in the canoes to the forest, there to empty out the contents of the tins that have been previously left adhering to the rubber trees by a dab of clay below a gash in the bark, whence the milk slowly drops into the tin pans. The pan, when emptied, is then replaced or affixed to another part of the trunk, or removed altogether to some other tree. It depends on the collector whether he completely exhausts the tree of its sap and thus destroys it, or only takes a quantity—about 16 lbs.—which a well-grown tree will allow to be taken from it without detriment. In the case of Ignacio's men all the sap that it was possible to obtain was taken from every tree" (pp. 119–120).

In the Museum No. 1 at Kew there is shown, in case 93 [now case 105], on the ground floor, a complete series of specimens illustrative of the Para rubber industry.

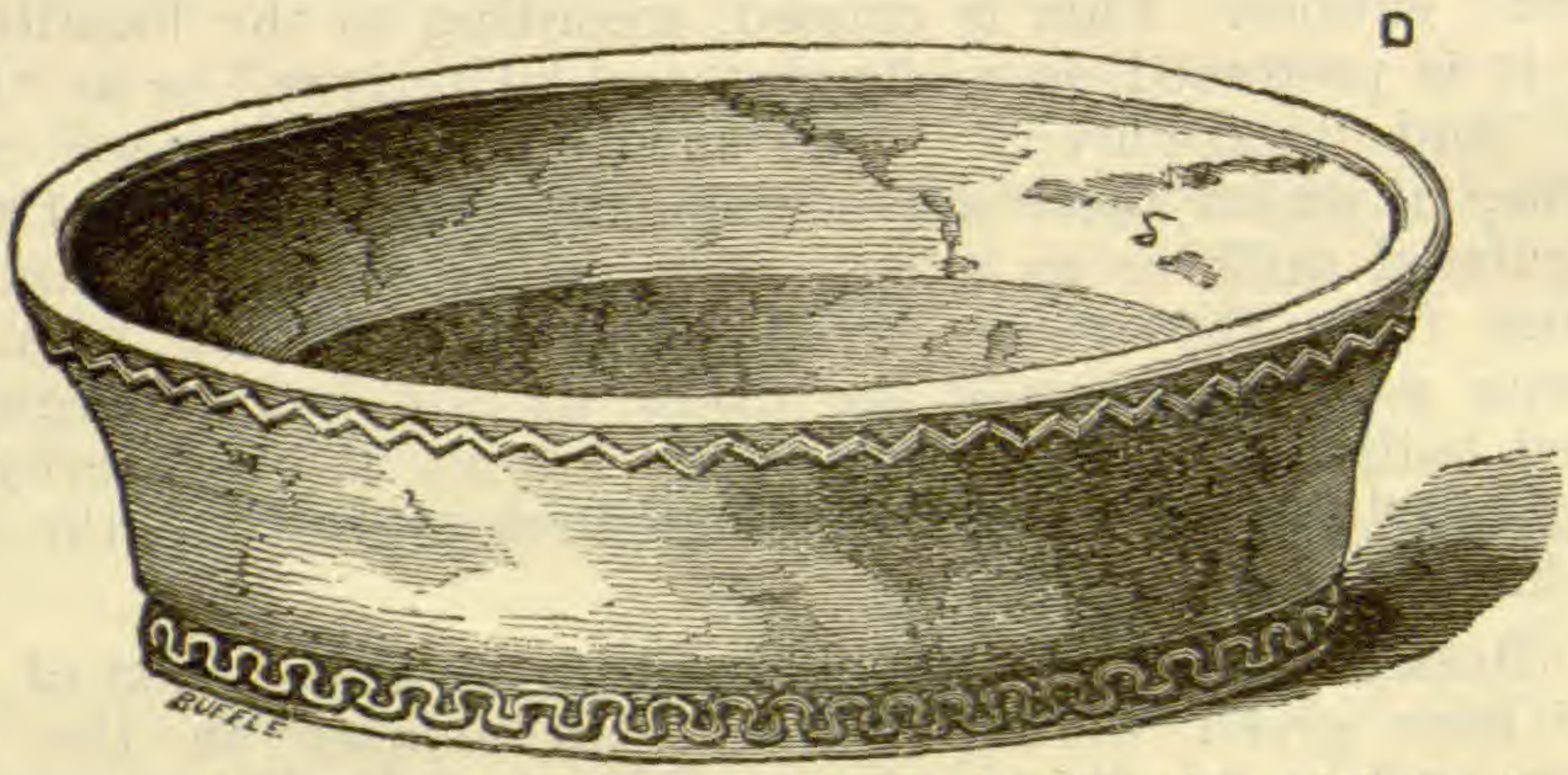
In the early stages, when the rubber was exported in small quantities, it appeared in the form of shoes or the grotesque form of animals ; the better qualities came in the form of bottles moulded over soft clay, which was afterwards washed out by water. The flat, rounded cakes prepared by being smoked on paddles, in the manner described above, are known as fine Para or

"biscuit" rubber. This is classed, according to the localities in which it is produced, as "Islands" and "Up-river," or as "hard-cured" and "soft-cured." The medium qualities are called *entrefine*, in which there are occasionally some streaks of white uncoagulated milk or an excess of moisture, while the uncured scrapings from the trees, mixed with the residues from the collecting pots and vessels, are made up into large, irregularly rounded balls and form a third grade known as "sernamby" or "negrohead" the latter from the fancied resemblance of the mass to the head of a negro.

The illustrations of implements used in the preparation of Para rubber here given were prepared from articles in the Kew Museum, and are kindly lent by the Editor of the *Pharmaceutical Journal*:—

ARTICLES USED IN COLLECTING AND PREPARING PARA RUBBER (*Hevea*) IN BRAZIL.

A. Small axe with cutting edge about 1-inch wide.
B. Small earthenware cup placed below incision to receive the latex.
C. Calabash carried by the seringuiero, in which is collected the latex from the small cups.
E. Portion of a calabash used to pour the latex over the paddle.
F. Wooden paddles—to the right before use, to the left with a first layer of cured rubber.
H. Cutlass used to collect the nuts of the Urucuri palm (*Maximiliana regia*).



D. Large earthenware pot into which the day's collection of latex is poured preparatory to coagulation.

G. Earthenware stove under which a fire of palm nuts is kept up. The latex on the paddle after exposure to the heat and smoke, emerging at the top, is coagulated and assumes a firm texture and dark colour.

Future Prospects.

Mr. Churchill discusses these as follows (p. 26) :—

"Some people suppose that the supply of Amazonian rubber may become exhausted in the near future. The most competent authorities are not at all of this opinion, but maintain that the supply is inexhaustible, because the *Hevea* is continually being reproduced by nature. Certainly some areas become exhausted when overworked, but when left alone for some time they recover. The district of Cametá, on the River Tocantins, gave an excellent quality of rubber. There was a special quotation for it in the foreign markets. This district, however, is now exhausted, because for about 40 years thousands of men have tapped its trees. All new-comers flocked to Cametá to make their fortunes. There are still many districts that have not been tapped.

"The area that is known to produce Para rubber amounts to at least 1,000,000 square miles. Further exploration, will, no doubt, show that this area is under-estimated.

"The richest zones as at present known are along the banks of all the southern tributaries of the River Amazons, and on the islands in the main stream and near Pará.

"The most prolific part is on the River Aquiry or Acré, one of the tributaries of the River Purús. Here 100 trees yield as much as one ton of rubber per annum.

"The northern tributaries of the Amazons do not produce much rubber. Of these, the River Negro produces the most. The quality, however, is soft. The River Branco yields very little rubber, and the upper part runs through pasture lands and high ground which is not suitable for good rubber. Some of the other northern tributaries have not been explored, and may yet reveal large stores of rubber. The *Hevea* is known to exist on the banks of the Japurá, but that district has not yet been opened up."

Bolivian Rubber.

The following interesting particulars respecting the yield of Hevea rubber in Bolivia are taken from a Report to the Foreign Office (*F.O.*, Annual, 1897, No. 1841) by Mr. Consul A. St. John :—

"Nearly the whole of the india-rubber collected in Bolivia goes to England *viâ* Para. On the spot it is worth from 22 to 25 Bol. per arroba of 25 lbs. Through the Bolivian custom-house of Villa Bella on the Brazilian frontier, 69,040 arrobas were exported in 1894, viz., 63,663 arrobas of fine rubber, and 5,377 arrobas of the inferior kind known as sernamby.

"During that year, about 3,400 arrobas are said to have been exported through La Paz (Puerto Perez), whilst 3,000 or 4,000 arrobas are said to have been exported through Puerto Suarez on the Paraguayan frontier. *Hevea brasiliensis*, the tree which yields this valuable sap, abounds in the virgin forests of Bolivia.

"If these figures be correct, and no contraband trade in that article be carried on, the annual production may be estimated at present at about 850 tons. The duty on fine rubber is 1 Bol. per arroba, and 50 c. on sernamby."

Some Bolivian rubber is shipped from the Port of Mollendo on the Peruvian coast. It is brought by rail from Lake Titicaca, and obtained from that portion of Bolivia which lies above the navigable portions of the River Beni. "Mollendo rubber" has only made its appearance during the last three or four years. It takes rank with good Para rubber, and commands almost identical prices. In Messrs. S. Figgis & Co.'s report, dated the 8th July, 1898, is mentioned :—"Mollendo" : 7 packages sold, fine, 3*s.* 11½*d.*; entrefine gutty, 3*s.* 10*d.*; negrohead, good, 3*s.* 2¾*d.*

Introduction of Para Rubber Tree to the Old World.

The introduction of the rubber-yielding trees of tropical America to British Possessions in the East was an enterprise in which, more than twenty years ago, Kew took an active part. The expense was entirely borne by the Government of India. The record of the steps taken in regard to Para rubber is given in the *Kew Reports* (1875, p. 7; 1876, pp. 8 and 9; 1877, p. 15, and 1878, p. 14).

A concise summary, published by Dr. Trimen in the Appendix to the Report of the New Products Commission (Sessional Papers, Ceylon, 1881, No. 13, p. 9), is reproduced below :—

"I am desirous of taking this opportunity of putting upon record something of the history of the introduction of the valuable Para rubber into the East, which has been effected at a large cost and with much trouble. When the Government of India had determined upon the enterprise, a commission was given to Mr. Wickham, then living at Santarem, to collect seed at the rate of £10 per 1,000. He succeeded in obtaining 70,000 seeds in the Siringals of the Rio Tapajos, which he packed with the greatest care and with a full knowledge of their evanescent vitality ; and coming straight home with them arrived at Kew on 14th June, 1876. The following day the whole number was sown ; not more, however, than 'about $3\frac{3}{4}$ per cent. germinated, some as early as the fourth day after sowing ; and many in a few days reached a height of 18 inches.' (*Kew Report*, 1876.) At Sir Joseph Hooker's suggestion, it had been previously arranged between the India and Colonial Offices that owing to the want of any accessible and properly constituted Botanical Garden in any part of India suitable for the growth of this completely tropical species, the seedlings should be sent to Ceylon to be cultivated and propagated for subsequent distributions to Burma, and other hot and moist districts of the Indian Empire. Owing to the plants' rapid growth, Wardian cases of a special form had to be made for their transmission, and, on August 12th, thirty-eight of these, containing 1,919 plants, were despatched from Kew in charge of a gardener (W. Chapman). In due course they were received at Peradeniya in very good order.

"Mr. Cross's share in the introduction of Para rubber was a very small one. He, also, had been sent by the Indian Government to South America to bring home live plants in case the transmission of living seed should prove impossible, and he arrived at Kew on 21st November, 1876. He brought with him about 1,080 seedlings without soil, of which with the greatest care, scarcely three per cent. could be saved. About 100 plants propagated at Kew from these were subsequently sent to Ceylon.

"The cost of procuring the seeds of Para rubber, freight and other expenses, appears to have been no less than £1,505 4*s*. 2*d*., the Wardian cases alone costing £120, and the gardener and his passage £163. The whole of this large expenditure was borne by the Indian Government. An undertaking involving such an outlay as this, it is obviously beyond the power of the Executive of this Colony to carry out ; but in this case, it is Ceylon which (from climatic causes chiefly) appears likely to benefit most largely from the successful action of the Government of India."

Experimental Planting in Ceylon.

As Ceylon was adopted as the central point in the East Indies for the cultivation and distribution of the rubber plants introduced by the Government of India from tropical America, this island naturally took an active part in starting experimental plantations.

A concise summary of the results attained up to the end of 1894 was prepared for Kew by the late Dr. Trimen, and as it contains observations made by a competent and experienced officer for many years in actual charge of the experiments, it is a valuable record :—

"In October, 1876, Dr. Thwaites being at that time director, there were received at Peradeniya from Kew, in charge of a gardener, Mr. W. Chapman, 38 Wardian cases containing some hundreds of young seedlings of *Hevea brasiliensis* in excellent condition.

"The seedlings were at once planted in bamboo pots, and in the rainy season of the following year, 1877, were transferred from Peradeniya to the new ground acquired for the purpose in the low country at Henaratgoda. Here they were planted out, and at once began to grow with great rapidity. Propagation by cuttings was commenced in order to send supplies to India, which was done in 1878 and 1879; and a moderate distribution was also made by Dr. Thwaites to planters in Ceylon.

"On my arrival here in February, 1880, I found at Henaratgoda about 300 of the original seedlings, tall, slender trees four years old, the tallest about 30 feet high, and at Peradeniya about 20 trees, smaller and less luxuriant in growth. Since that time the number has been increased, mostly by cuttings, and now consists of about 424 seed-bearing trees at the low-country garden, and 30 at Peradeniya.

"The rate of growth of the stem during this period is shown in the following table, the measurements being taken from one of the best grown of the original seedlings at Henaratgoda :—

		Ft.	In.
End of	1880	1	4
"	1881	1	9
"	1882	2	1½
"	1883	2	6
"	1884	3	0
"	1885	3	7
"	1886	4	1
"	1887	4	5½
"	1888	5	0
"	1889	5	0
"	1890	5	9¾
"	1891	6	1
"	1892	6	5
"	1893	6	7½
"	1894	6	8

"The circumference was taken at a level of 3 feet from the base. I doubt if the trees will increase much more in girth, as Mr. Cross states that the largest he measured in Brazil was but 6 feet 10 inches. The trunks are straight and tall, and the branches short, so that the trees do not occupy much space.

"The first flowering occurred at Henaratgoda in April, 1881, and a few (36) seeds were secured that year; at Peradeniya there were no flowers till 1884. The tree does not seed profusely, and it was not till 1887 that any large quantity was produced. Till

that year they were for the most part sown in nurseries, and the young plants distributed in Ceylon to Government officers and a few planters for trial. But as soon as larger crops of seed were produced we were able to comply with official requests for seed from other Colonies (*see* below), and I was able also to advertise their sale at a low price to the planting community generally. Thus we have distributed in Ceylon :—

	Seeds.
1889	8,000
1891	15,000
1892	16,000
1893	90,000
1894	86,000

"A large number of estates in the low country have now plantations of young seedling trees, and some must be themselves producing seed.

"As far back as 1882 I urged on Government the desirability of forming large plantations of this valuable tree in the south of the island, but as at that time there was no Forest Department here, nothing was done. Again, in 1888, after the favourable reports of the quality of rubber produced by Ceylon-grown trees, I again advocated this cultivation by Government, and in the next year, 1889, the lately formed Forest Department selected land in the Province of Sabaragamuwa. In 1890 a small commencement in planting this was made, the Gardens supplying 9,000 seeds for the purpose, followed in 1891 by 20,000 seeds and 2,000 stumped plants, and in 1892 by 30,000 seeds. We have had no requests for any further supply, but I understand it is the intention of Government to form another plantation this year.

"Mr. F. Lewis of the Forest Department (under whose charge the plantation is placed), has kindly given me a full report of the progress of the trees, from which I extract the following particulars. The land selected in May, 1890, is at a place called Edangoda, on the north bank of the Kaluganga River, and is under 100 feet above sea-level. It is 20 acres in extent; the rainfall is very heavy, approximately 150–170 inches per annum. At that time it was believed, owing to Mr. Cross's description of the locality of the wild trees in Brazil, that land occasionally flooded would be very suitable for this plant, and accordingly the site selected had its lower portion annually covered with water when the river was in flood. It was, however, found that three days' flooding was sufficient to completely kill all the young plants, and after a second trial in the next year, with the same result, this portion of the land was abandoned. The seedlings, in the small bamboo baskets in which they had been raised, were planted out at intervals of 12 feet. In 1891 further land was selected at a place called Yattipowa, 37 acres in extent, at a rather higher level on the same river, and not liable to flood, being raised in the centre, and sloping east and west; this was planted up in the same manner. It was necessary to weed carefully for the first two years, after which the young trees produced sufficient leaf-canopy to keep this vegetation down. They grew at a great pace, some reaching 16 feet high in the first year, branching

usually occurring in the second. At the end of 1893 a few of those first planted fruited, and the seed produced was successfully germinated.

"Measurements taken recently (December, 1894) of average sample plots from each plantation give the following mean girth, at three feet from the ground :—

At Edangoda (4 years old), average of 100 trees	12·96 ins.
At Edangoda (3 years old), average of 50 trees	8·75 „
At Edangoda (2 years old), average of 20 trees	4·96 „
At Yattipowa (3 years old), average of 108 trees, on western slope	9·37 „
At Yattipowa (3 years old), average of 108 trees, on eastern slope	9·13 „

the difference in the last measurements being due to amount of exposure to wind.

"My first experimental tapping was made in October, 1882, of five trees, then six years old ; and about $2\frac{1}{2}$ ounces only of dry rubber was obtained. This small sample was sent home, and reported by Messrs. Silver to be 'fully equal to good Para India-rubber as regards strength and elasticity,' and to be worth 4*s.* per lb. This was quite satisfactory as to quality, but it was obvious that the trees were yet too young to afford any quantity of milk. I therefore deferred any further tapping for a few years, till 1888, when the trees were 11 years old. One of the best grown and healthiest was then selected, having a stem circumference of 4 ft. $2\frac{1}{2}$ ins. at a yard from the ground. The plan followed was to scrape off a little of the rough outer bark, and to make V-shaped incisions with a $\frac{3}{4}$-inch chisel in the inner bark. The milk mostly dried on the trees in tears, thick strings, and small sheets, and that which ran down the trunk was prevented from reaching the ground by little cups of cocoanut shell, fastened with clay to its base. The operation was performed on 17 days in the driest months of the year, and the whole amount of dry rubber obtained was 1 lb. $12\frac{3}{4}$ ozs. ; the time occupied was in all about 20 hours, and the cost estimated at 62 cts. of a rupee. Though the bark was of course much scarred with the numerous incisions, the tree in no way suffered from the process. I, however, allowed it to remain untouched in 1889 and the bark to heal over, but it has been again treated in 1890, 1892, and 1894 with the following results :—In 1888 gave 1 lb. $11\frac{3}{4}$ ozs. ; in 1890 gave 2 lbs. 10 ozs. ; in 1892 gave 2 lbs. 13 ozs. ; in 1894 gave 3 lbs. 3 ozs. ; being a total of 10 lbs. $7\frac{3}{4}$ ozs. On a sample of this rubber sent home in February, 1893, Messrs. Hecht, Levis, & Kahn reported that it was 'very good indeed,' its value at that date being from 2*s.* 3*d.* to 2*s.* 6*d.* per lb., easily saleable in any quantity.

"A yield of over $10\frac{1}{2}$ lbs. of first-class rubber from a single tree in six years fully warrants a belief that the cultivation of large plantations would be highly profitable. Nor is there any reason to suppose that the trees would not easily bear tapping annually, and continue to yield for very many years if the wood were not

injured. I do not think they should be bled, however, until at least 10 years old. It is noticeable how rapidly the yield increases with age.

"In India the only localities in which the tree has been found to succeed are Lower Burma and Malabar, and to Forest Departments in both districts, Mergui in the former, and Nilambur in the latter, seeds and plants have been largely sent from Ceylon as follows :—

To Burma (Mergui)	1878,	Plants (rooted cuttings)	500
" "	1887,	Seeds.	
To Malabar (Nilambur)	1878,	Plants (rooted cuttings).	
" "	1879,	" " "	33
" "	1883,	" (stumps) ...	27
" "	1884,	" ...	26
" "	1884,	Seeds.	
" "	1885,	"	300
" "	1887,	"	

"In 1880 we sent two plants to the First Prince of Travancore, in 1881 a Wardian case of 28 plants to the Andaman Islands, and in 1888 about 3,000 seeds to the Commissioner of Agriculture at Nagpur, Central Provinces.

"We have also been able to comply with the requests for seed received from the Governments of several British Colonies, and in 1887 and 1888 we despatched to :—

Singapore (1888)	11,500 seeds.
Penang (1887)	Seeds.
Fiji (1888)	1,100 seeds.
Queensland (1887)	Seeds.
North Borneo	40 plants.
Jamaica (through Kew, 1887) ...	2,000 seeds.
Jamaica (through Kew, 1893) ...	200 seeds.

We have also supplied seeds to the Botanic Gardens at Buitenzorg, Java, and to the German East Africa Company.

HENRY TRIMEN."

At the beginning of the present year Dr. Trimen's successor, Mr. John C. Willis, F.L.S., issued a Circular (No. 4) in which he continues the record of rubber cultivation in Ceylon. The points dealt with in the following extract deserve a wider circulation than they are likely to obtain in the Circular :—

"The Para rubber trees planted in 1877 at the Henaratgoda Garden are now very fine trees, with an average height of about 60 ft., and an average girth at 6 ft. above the ground of 4 ft. From their seed other plantations have been made in the Botanic Gardens, and also by the Forest Department. A large quantity of seed has been sold to private planters since 1886. There are about 450 trees in the Botanic Gardens producing about 100,000 seeds per annum.

"The number of trees on private estates in Ceylon is probably about 200,000 of various ages from one to twelve years. This number represents an area of about 750 acres.

"*Soil.*—In its native country *Hevea* is a jungle tree usually growing in deep, rich, alluvial soil which is liable to be flooded during the wet seasons. The earliest plantations made in Ceylon were therefore made on low-lying land subject to floods. It was found that if the plants were well grown up, flooding did them no harm, whereas it was fatal to seedlings or very young plants. It would seem, therefore, that what the plants really require is a damp soil, and this has been borne out by local experience. The immense level area of the Amazon valley tends to prevent floods of any great depth, whereas in Ceylon the valleys are narrower, and the water may easily rise several feet. Land liable to frequent flooding should therefore be avoided.

"Chena land has been tried at Edangoda, but the result has been unsatisfactory; sandy soil has also been found unfavourable to the growth of *Hevea*, and the tree also grows badly where exposed to much wind.

"It would appear therefore that the most suitable soil and situation for this tree is fairly flat land, at about sea level, with good alluvial soil, preferably jungle land, and not sandy. The land should not be subject to frequent floods or strong winds.

"The area of land in Ceylon suitable for profitable rubber cultivation is thus comparatively small, possibly not more than 10,000 acres, but, on the other hand, this cultivation need not interfere with that of cocoanuts.

"*Cultivation.*—*Hevea* forms a moderately tall tree, not very much branched. It begins to flower at about six years old, but for planting purposes the seed of more mature trees (12 or more years old) is preferable.

"About February, in Ceylon, the leaves mostly turn brown and drop off, and the flowers soon afterwards appear. They are followed by large woody fruits, each containing three seeds, which ripen in July and August. The fruits open explosively, usually in the hot part of the day, and scatter the seeds to some distance. The seed is very large, weighing about half an ounce. It has a hard seed coat and the interior substance is very oily.

"The seed soon loses its power of germination, and ought to be sown within a week of its falling from the tree. If it has to be sent on a voyage of more than a week, it should be very carefully packed in charcoal. Even thus, however, the majority of the seeds soon die, and the only satisfactory way of sending seeds to distant countries is to plant them in soil in a Wardian case and allow them to grow on the way.

"The germination of the seed is very rapid, and a long tap root is soon produced. The seed should be sown about an inch deep in well prepared soil, in nurseries, or, if preferred, in bamboo pots or baskets. They should be kept shaded and watered, and when the young plants are from 18 inches to 24 inches high they may be planted out. Good results are also obtained by stumping, the plants being allowed to grow about 3 feet high, then taken up, and the main root cut across about a foot below the ground; but the method of planting out the smaller seedlings is perhaps preferable.

"The plant may also be propagated by cuttings. The method employed in the botanic gardens has usually been to take cuttings near the ends of the branches, but further back than any of the leaves. Each cutting is about a foot long and as thick as a lead pencil, and is cut off at both ends by oblique cuts made just below leaf scars. The cuttings are planted in nurseries in wet earth. This method is somewhat precarious; sometimes nearly all the cuttings grow, at other times only a small proportion.

"The seedlings, stumps, or cuttings should be planted out during rainy weather in prepared places. Holes should be dug as in the case of cacao, and filled with good soil. A little manure will often be advantageous. The young plants require to be lightly shaded for a time until they are established, and probably for the first two or three years they will grow the better for a certain amount of shade, such as would be given by narrow belts of trees running through the plantation. These belts should be arranged to act as wind belts, as the *Hevea* is easily injured by wind. By the time the trees are about three years old they will have grown up to a height of about 25 feet or 30 feet and form their own shade.

"Various distances apart have been tried in planting *Hevea*. The younger plantation at Henaratgoda Garden has the trees planted 12 feet apart. Their average girth is now about 30 inches, and they require thinning. It will not do, however, to conclude from this, as is sometimes done, that the trees should be originally planted more than 12 feet apart. On the contrary, the best results have been obtained by planting 8 or 10 feet apart each way. The trees thus form their own shade and keep down weeds, and a process of natural selection of the best trees goes on, and the more weakly and dwarfed trees may be gradually thinned out in subsequent years. Another advantage of close planting is that the trees grow up straight without forming many branches low down, and this very greatly facilitates tapping.

"Para rubber is a surface-feeding tree, and catch crops should not therefore be grown between the trees, which require all the nourishment that the soil can afford.

"The young plants are greedily eaten by cattle, deer, hares, and other animals, and require careful protection for about eighteen months, after which time they are generally tall enough to require but little further protection.

"Weeding is also required for the first year or two, but afterwards the trees form a dense shade, under which but few weeds grow.

"The comparatively superficial growth of the roots renders manuring easy, and it would probably be found advantageous in poor or sandy soils.

"*Rate of growth.*—The tree grows very rapidly in height. The original trees planted at Henaratgoda in 1876, were about 30 feet high and 14 inches in girth two years later. In 1882 the largest tree was 50 feet high and 25 inches in girth at a yard from the ground. The girth of this largest tree was taken annually after this, with the following results :—It was 30 inches in 1883,

36 in 1884, 43 in 1885, 49 in 1886, 53½ in 1887, 60 in 1888, 65 in 1889, 69¾ in 1890, 73 in 1891, and 79½ in 1893. The girth of the largest tree measured in Brazil by Mr. Cross was 82 inches.

"The measurements above given are those of the largest tree. More useful data for scientific and practical purposes are obtained by taking the mean girth of all the trees on a considerable area. This was done in January, 1897, on the plantation made at Henaratgoda in 1876. This now consists of 45 trees, about 30 feet apart. The girth was taken at the height of the eye, about 5 feet 6 inches above the ground. The largest tree was 7 feet 5 inches, the smallest 2 feet 1 inch in girth. The mean girth was 4 feet ⅓ inch.

"*Tapping.*—The yield of rubber from very young or slender trees is too small to make their tapping worth while, and it is best for many reasons to abstain from tapping a tree until it has reached a girth of 2 feet. In a large plantation the girth of the trees always varies between wide limits. A few trees may be fit to tap after the sixth year, and in every subsequent year more and more trees will reach the size necessary. In favourable localities the bulk of the trees should be in bearing before the end of the eleventh year. The results of the experiments hitherto made at Henaratgoda go to show that it is inadvisable, having regard to the future, to tap trees of less than two feet in girth, but it is still an open question whether the minimum size of tree for tapping should not be fixed even higher. This, however, would of course necessitate longer waiting for the return, as the mean rate of increase of girth in trees of this size is only about 3 inches per annum.

"The methods of tapping and of coagulation of the rubber employed by the native collectors in Brazil and elsewhere are rough, wasteful, and inefficient, and there is great room for improvement. Experiments are being made at Henaratgoda to test methods of tapping and coagulation, and their results will form the subject of a subsequent circular. At present we shall only describe the method which has been employed for some years in the tappings carried on at Henaratgoda.

"The requisites for the work are a ¾-inch chisel, a wooden mallet, a number of clean cocoanut shells, each cut in two so as to form small basins, a knife, and a supply of clay and water with which to form the gutters round the trees.

"The tree is first carefully and lightly shaved with the knife from a height of about 6 feet down to the ground, so as to form a perfectly smooth surface. Only the outermost layers of the bark must be removed in this process, otherwise the tree will be injured. When the shaving is completed, the tree may be polished by hand, or carefully brushed. The great object in view is to obtain a smooth and clean surface, over which the milk can run easily, without becoming contaminated by small particles of bark or other rubbish, as the market value of rubber depends on its cleanliness.

"A clay gutter is next made round the tree about 6 inches above the ground, so arranged as to catch the milk which will trickle down the tree and empty it by two or more spouts into as

many clean cocoanut shells placed below. Three shells are sufficient for a tree of 2 feet 6 inches in girth, but larger trees may require four or five. The gutter is made by rolling rather wet clay into a sausage form, between the hands, and then pressing it on to the bark by the aid of a wet finger. The gutter must not be allowed to dry before the tapping is begun, otherwise the rubber will be contaminated by particles of clay; neither must the gutter be so wet or irregular as to allow the rubber to be dirtied.

"Incisions may now be made in the bark with the mallet and chisel, commencing near the top of the cleaned portion. A V-shaped cut is made in two strokes. The object to be a said time to make these cuts to such a depth as just not to reach the wood. They should stop in the bark close to the cambium, as the vessels which contain the rubber occur only outside, but very close to the cambium. If the cambium is not injured the wound rapidly heals, but if the cut penetrates this layer, and enters the wood, the healing of the wound is much slower, and at the same time risk is run of introducing parasitic fungi into the wood, which may cause much damage. Injury to the wood also causes a check to the upward flow of sap, and thus to the growth of the tree. Considerable practice is required before the chisel can be habitually driven in to the exact depth necessary. In dealing with a number of trees it will be found most economical and satisfactory to keep separate coolies for each of the various operations required, as they all need much practice.

"As soon as the cut is made, the white and very sticky milk commences to flow. A second V-shaped incision should be made about a foot below the first, and others at similar distances down to the gutter at the base of the tree. Another set of incisions may then be made parallel to the first, at about 10 or 12 inches from them, and other vertical rows of cuts may be made if there be sufficient room for them. On a tree of 2 feet 6 inches in girth, four vertical rows of cuts may be made without serious injury.

"As each cut is made, the milk flowing from the cut above it should be guided downwards to it along the bark by means of a twig, otherwise the milk is liable to be wasted by dropping to the ground from projecting portions of the bark.

"The bulk of the milk, especially in large trees or trees which have not been recently tapped, ultimately flows into the cups at the base of the tree. These should be kept covered in such a way as to prevent dust or other rubbish falling into the milk. As soon as the milk ceases to flow into the cups, these are removed to a warm place, and in a few hours a cake of solid rubber can be removed from each, which should be kept in a dry place until it has become properly dry all through. The remainder of the milk dries upon the tree in the form of long strings, which are stripped off and rolled into balls. The whole of the rubber when dry is now ready for market. The most suitable times of the day and of the year for tapping are still the subject of experiment. The most satisfactory results have on the whole been obtained by tapping in the drier parts of the two monsoons, *i.e.*, from January to April, and in August and September. The tapping should be done on dry days, otherwise it is difficult to prevent dilution of the milk and to dry the rubber.

"The tappings may follow one another at intervals of a week for about four to eight weeks. The second tapping gives a much larger yield than the first, and the third and fourth tappings are usually very productive. In a series of experiments made during 1897 on trees of about 2 feet mean girth, the average yield per tree of the successive weekly tappings was as follows :—

	oz.
First week	·73
Second „	1·48
Third „	·97
Fourth „	·80
Fifth „	·67
Sixth „	·52
Total	5·17

"*Yield.*—The statements as to yield of rubber found in books of travel and popular articles are very unreliable, and experiments are being made to test the whole question of yield. The late Dr. Trimen commenced in 1888 to tap one of the original trees at Henaratgoda, then nearly twelve years old and 50½ inches in girth, a yard from the ground.

"It was tapped on seven days between January 25th and February 15th, yielding 17¼ oz. of rubber, on six days between July 20th and August 29th, yielding 7 oz., and on four days between December 6th and 20th, yielding 4½ oz., a total of 1 lb. 12¾ oz. The same method was followed in alternate years, with results as shown below :—

	lb.	oz.
1888	1	12¾
1890	2	10
1892	2	13
1894	3	3
1896	3	0¼
Total	13	7

"The average yield of this tree from the twelfth to the twenty-first year is thus almost 1½ lb. per annum. This result is very good, and if all the trees of the same age yielded as much rubber, the success of the cultivation would be assured. It should, however, be noted that the girth of this tree in 1888 was larger than the mean girth of the whole plantation, as mentioned above, in 1897, and that therefore this yield, if the tree tapped be accepted as a fair sample, represents rather the result to be expected after twenty years, by which time the average girth of the trees should be equal to the girth of this one at the time its tapping was commenced. The trees in question are about 30 feet apart, *i.e.*, 50 trees to the acre. These data thus indicate a yield of about 90 lb. of rubber per acre in the twentieth year, a result insufficient to make it worth the while of private planters to take up rubber cultivation.

"It seemed probable that better results might be obtained by tapping younger and smaller trees more closely planted, and experiments were therefore begun in 1896 on a younger plantation of trees at Henaratgoda. The mean girth in January, 1897,

taken at 5 feet 6 inches from the ground, of 225 of these trees, was 2 feet 4½ inches. The figures already given for the average weekly yields represent the mean results of the tapping of 27 trees of a mean girth of 1 foot 10½ inches, 6 inches less than the mean girth of the whole plantation. From six consecutive weekly tappings of each, a mean yield of 5·17 oz. per tree was obtained. This represents a yield of 97 lb. per acre of 300 trees (12 feet apart). If the trees tapped had been of the same mean girth as the whole plantation, the yield would probably have been at the rate of about 120 lb. per acre. Further, only six tappings were made, and the trees, after a rest of a few months, would probably have stood three or four more tappings whose yield might have been at the rate of 30 or 40 lb. per acre.

"No record, unfortunately, was kept of the date when this plantation was made. It is probably twelve years old at least. The sandy soil at Henaratgoda is unfavourable for Para rubber, and in better soil the trees would probably reach this mean girth in ten years or even less. It would seem, therefore, that if this cultivation is taken up in favourable localities, a yield of about 120 to 140 lb. of rubber per acre may be expected after the tenth year. This estimate is, however, liable to modification by the results of experiments which are still in progress.

"*Cost of opening Plantations.*—The following estimate of the first year's cost of opening a plantation of 300 acres of forest land with rubber was prepared by Mr. F. Lewis, Assistant Conservator of Forests, Colombo :—

	Rs.
Felling and clearing at Rs. 12 per acre...	3,600
Lining, 10 ft. by 10 ft., at Rs. 2 per acre	600
Holing, at 75 holes per cooly at 40 cents	697
Filling and planting and carrying plants from their nursery to holes, 300 per cooly at 40 cents	175
Draining—300 ft. of drains per acre at 1 cent per foot run	900
Lines for coolies—1 shed of 10 rooms of 12 ft. by 10 ft., mud walls, and battocalla roof, at Rs. 30 per room	300
Roads for inspection, 2 miles	160
Plant nursery, including watering	150
Weeding, at Re. 1 per acre per month	3,600
Cost of surveying lines round plantation, say... ...	75
Contingencies, such as special work, bridges over streams, or supplying vacancies, &c.	250
Salary of assistant	1,000
Tappal cooly	120
Tools	300
Total	11,927

"This represents an average of Rs. 40 per acre. A return of Rs. 4,200 is estimated to be obtained by the sale of timber and firewood from the land cleared. This should suffice to erect the Assistant's bungalow and leave a small margin for contingencies.

"To this estimate private planters must add the cost of land and of seed (about Rs. 20 per 1000). These items will probably

bring up the total cost for the first year to at least Rs. 125 per acre. As a matter of fact, 300 acres is more than can be opened in one year, as the number of seeds required will be at least 160,000, which amounts to nearly two years' crop of the trees in the Botanic Gardens.

"For the second, third, and fourth years Mr. Lewis estimates the expenditure on weeding and supplying at Rs. 12, Rs. 8, and Rs. 5, respectively. Assuming that the expenditure in the years following is at the rate of Rs. 5 per acre, the cost of the plantation up to and including the tenth year might work out as follows :—

	Rs.
Cost of land, 300 acres at Rs. 75	22,500
Cost of seed, say	3,600
First year's cost, as above	11,927
Weeding and supplying, second year	3,600
" " third year	2,400
" " fourth year	1,500
" " fifth to tenth years, inclusive	9,000
Salary of assistant, second to tenth years, inclusive ...	9,000
Tappal cooly and tools, second to tenth years, inclusive	1,250
Total	75,777*

"Allowing interest at the rate of 7 per cent. on all money expended up to the end of the tenth year, the outlay upon the plantation will amount to at least Rs. 110,000 or Rs. 366·66 per acre.

"*Return.*—The value of Para rubber in the London market varies between 2*s.* and 4*s.* per lb., according to the quality of the rubber and the state of the market. Of the rubber which has been collected in the Botanic Gardens and sent home for valuation, a large proportion has been valued at almost the highest market price then ruling, but a considerable proportion of the rubber is always of an inferior quality, being mixed with particles of dirt. If we estimate the average value of the crop at 2*s.* per lb., and the yield in the tenth year at 100 lb. only per acre, the return in that year will be £10, or say Rs. 150 per acre. The cost of harvesting should not be more than Rs. 50 per acre, including carriage to London. This leaves a margin of Rs. 100 per acre, representing a return of 27 per cent. upon the original outlay ; if 12 per cent. be allowed for contingencies and the usual vicissitudes of a tropical cultivation, there remains still a prospect of a good return on the capital expended."

Para Rubber in India.

The climate of Bengal, where there is a distinct cold season, was soon found to be unsuitable for the cultivation of *Hevea brasiliensis*. After experimental efforts in other parts of India it was ultimately decided to establish rubber plantations at Mergui, in Lower Burma, and Nilambur, in Southern India. In accordance with the arrangement with the Government of India a first lot of plants propagated at Ceylon was despatched to Mergui in 1878. These consisted of 500 rooted cuttings. In 1887 there was sent a further consignment of plants and seeds. To Nilambur, from

* [An error of calculation ; the correct total is Rs. 64,777.]

1878 to 1887, rooted cuttings and stumps were forwarded, as well as several lots of seeds. Of the latter 300 were sent in 1885. Further, in 1880 two plants were sent to the First Prince of Travancore; in 1881 a Wardian case with 28 plants was forwarded to the Andaman Islands, and in 1888 about 3,000 seeds were sent to the Commissioner of Agriculture at Nagpur, in the Central Provinces. There are now numerous trees both in Burma and Malabar producing regular supplies of seed. The introduction of *Hevea brasiliensis* trees into India has, therefore, been successfully accomplished.

In a letter received from the India Office, dated the 24th September, 1888, the following memorandum was enclosed containing an account of the result of the experimental cultivation of *Hevea brasiliensis* in Burma.

NOTE on the CULTIVATION of *Hevea brasiliensis* in the TENASSERIM FOREST CIRCLE, by COLONEL W. J. SEATON, CONSERVATOR of FORESTS, dated 24th April, 1888.

Early Experiments.—Experiments on a small scale were commenced at Mergui in 1877, with eight seedlings, the survivors of a small batch received from Dr. King, Superintendent of the Royal Botanical Gardens, Calcutta.

They were successfully set out in the Forest Office compound at Mergui, and although on a low hill, a not very desirable site, yet their growth was for some time satisfactory.

In 1879, a large number of *Hevea* plants, believed to be well-rooted cuttings, were forwarded by Dr. Thwaites, Director of the Royal Botanical Gardens, Ceylon, and although in the charge of a subordinate who had been sent to Ceylon for special instructions, only 178 survived the voyage. These were set out in the plantation area selected, about $1\frac{3}{4}$ miles inland from Mergui, on somewhat low ground drained by the sources of the Boke Chaung, a small tidal creek.

Only 64 of the healthiest plants survived the planting operation, and of these again casualties continued to take place yearly, owing chiefly to attacks of white ants, until the number was reduced to 50 in 1886, since when there have been no further casualties. The following were the sizes of ten of the largest trees of 1879 on 29th March, 1888 :—

No.	Height in feet.	Girth in inches at 2 feet from ground.	——
1	39	$29\frac{1}{2}$	Forked into two branches 4 feet from ground.
2	$43\frac{1}{2}$	37	Clean bole of 9 feet.
3	40	38	" " 8 "
4	$34\frac{1}{2}$	$40\frac{1}{2}$	" " 12 "
5	$36\frac{1}{2}$	$39\frac{1}{2}$	Forked at 3 feet from ground.
6	$38\frac{1}{2}$	$27\frac{1}{2}$	Clean bole of 8 feet.
7	$36\frac{3}{4}$	31	" " 10 "
8	30	18	" " 6 "
9	31	27	" " 6 "
10	$21\frac{1}{2}$	$18\frac{1}{2}$	" " 8 "

Propagation with cuttings.—In the rains of 1879, 24 cutting from the young trees in the Forest Office compound were set out in the plantation, but the experiment proved unsuccessful.

Subsequent attempts made from time to time met with no better success, the cuttings generally dying off during the second year.

Propagation with seed.—In 1884, a few of the older trees having commenced to seed, experiments were made, with the result that 51 seedlings were successfully raised.

These, however, when transplanted into the main plantation, were speedily reduced in number to 28 by attacks of white ants and the browsing off of the young shoots by deer.

The following year a large quantity of seed was procured from the 50 older trees, but, not being sown immediately after collection, a great portion of it failed to germinate, and only 121 seedlings were raised.

In the rains of 1886 better results were obtained by the timely sowing of the seed obtained from the older trees, and by the part removal of the husk enclosing the seed. As many as 7,030 seedlings were raised, germination occupying three to four days.

Experiments were continued in 1887, and 8,430 additional seedlings obtained.

From Ceylon 54 seeds were received in October, 1887, of which only 31 were fit to sow, but all failed to germinate.

Stock on hand at end of March, 1888.—The stock of trees and plants in the plantation and nurseries was as follows at the end of March :—

Trees set out in 1879	50
Seedlings of 1884 to 1886 set out in the main plantation at 20′ × 10′	2,752
In the nurseries ready for transplanting and distribution, of 1886	3,609
Do. do. of 1887	8,430
Grand Total	14,841

General Remarks.—The 50 older trees appear to be in perfect health, with evidence of such vigour as to leave no doubt that they are fully established, and have outgrown all danger from attacks of white ants.

They yield an abundant supply of seed, some of which, if allowed to fall, occasionally germinate under the trees.

The flowering takes place generally in January, in the cool season. The fruit forms in March and April, and ripens in July and August, about the middle of the rainy season.

It will be seen that the propagation of the *Hevea brasiliensis* in this part of Burma is now quite independent of external assistance, and that its acclimitization has been successfully demonstrated.

It now only remains to subject the larger trees to periodical tapping to ascertain the yield in caoutchouc, after which the question will have to be determined as to the precise area which it may be advisable to plant up at Mergui and other suitable localities with this valuable tree.

The following further correspondence affords information respecting the experimental tapping of *Hevea* trees in Tenasserim :—

INDIA OFFICE to ROYAL GARDENS, KEW.

India Office, Whitehall, S.W.
April 26th, 1889.

SIR,

IN continuation of Mr. Walpole's letter of the 24th September last (R.S. & C. 1269/88), I am directed by the Secretary of State for India in Council to forward for your information a copy of a letter received from the Government of India, together with its enclosures, reporting the results obtained from tapping *Hevea brasiliensis* trees near Mergui, in Tenasserim.

The specimens of caoutchouc referred to in the enclosures have been forwarded to you separately by parcels post.

I am, &c.,

(Signed) C. E. BERNARD,
Secretary,
Revenue, Statistics, and Commerce Department.

The Director,
Royal Gardens, Kew.

MEMORANDUM from COLONEL W. J. SEATON, CONSERVATOR of FORESTS, TENASSERIM CIRCLE, to the CHIEF SECRETARY to the CHIEF COMMISSIONER of BURMA, dated 28th January, 1889.

Referring to my letter, No. 330-24, dated 6th October, 1888, I have the honour to advise the despatch by parcel post of a package containing the following quantities of caoutchouc, which have been obtained in the tapping of the *Hevea brasiliensis* trees in the plantation near Mergui :—

Collected in July, 1888.

(1.) From 5 trees on the west bank of the Bôkchaungale, 5 oz.

Collected in November, 1888.

(2.) From 37 trees on the east side of the Bôkchaungale, 9 oz.
(3.) From 5 trees on the west bank ... ... 3 oz.

2. The tapping experiment was first undertaken in July, under the impression that the flow of milk would be more abundant in the rainy season.

Small bamboo pots were, in the first instance, affixed to the trees by means of well-wrought potter's clay, and above them small pieces of tin were also placed in such a position as to protect them from the rain ; but as the clay yielded to the rain and fell to the ground, tapping had to be undertaken at intervals between

the showers, the bamboo pots being affixed by sharpening the upper end and forcing them into the bark in the manner followed by the "Thitsi" collectors. In order to obtain the largest quantity of milk in the shortest time possible, numerous incisions were made on the trees. The incisions were made in an upward direction and converging as required.

The quantity of milk collected was so small in the intervals between the showers that it was deemed necessary to limit the experiment finally to five of the larger trees on the west bank of the Bôkchaungale, which flows through the plantation. The milk was found to flow much more freely from these trees, although not much larger than the trees first experimented upon. They have, however, thicker bark, and it was observed that the exudation of milk was greatest near the ground, where the bark was thickest, while at a height of 6 or 7 feet it was almost *nil*.

Owing to continued wet weather, it was found necessary to dry the milk over a fire and keep it subsequently in a warm place near the fire for about three weeks.

3. The experiment was renewed between 22nd and 26th November, when the rains had fully ceased, 42 trees being operated on, *viz.*, 5 to the west and 37 to the east of the Bôkchaungale.

4. I append a statement exhibiting the girths of the *Hevea* trees tapped between the 22nd and 26th November, 1888, and the number of incisions made on each :—

—	Average Girth.	Average number of Incisions.
	ft. ins.	
5 trees west of stream	3 1	22
37 trees east of stream	2 7	12

Mr. J. W. Oliver, Deputy Conservator of Forests in Charge of Tenasserim Circle, supplied the following information explaining the method of collecting and drying the rubber :—

The milk collected from the trees west of the stream was poured into a deal-wood box, and the milk from the trees east of the stream was poured into bamboo split into halves lengthwise. The milk was put out in the open air in the sun during the morniug, placed in the shade during the heat of the day, and again put out in the open in the afternoon at about three o'clock. As soon as the milk became firm, more milk was poured over it. The milk coagulated so quickly on the trees that about 30 per cent. of the milk was collected in the shape of *sernamby*. Instead of keeping them separate, these odd pieces were placed in the milk in order to secure the rubber in one mass. These are the darker pieces of rubber which may be seen in the largest piece of rubber. I do not think that they effect the quality of the rubber in any way, the odd pieces themselves being drier, and so perhaps of a better quality than the surrounding rubber.

Royal Gardens, Kew, to India Office.

Royal Gardens, Kew,
June 4, 1889.

Sir,

I am desired by Mr. Thiselton-Dyer to acknowledge the receipt of your letter of the 26th April last (R. S. & C. 614) forwarding a copy of a letter received from the Government of India with enclosure reporting the results obtained from tapping trees of *Hevea brasiliensis* near Mergui in Tenasserim.

2. The specimens of caoutchouc referred to were duly received by parcels post, and they were subsequently submitted for valuation and report, through S. W. Silver, Esq., F.L.S., to the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, at Silvertown.

3. I enclose herewith a copy of the valuation and report received respecting them. On the whole this report is favourable. The small quantity of rubber available (in no case exceeding a few ounces in weight) rendered its manipulation somewhat difficult; but bearing this fact in mind the result aa shown in the samples of prepared rubber sent in a separate cover is very encouraging.

4. It will be noticed that the best quality, valued at 2*s.* 3*d.* per pound, is nearly equal to the best South American rubber. This was labelled "Sernamby" and was formed by milk which coagulated immediately on the trees in the dry season.

5. The rubber (marked No. 3) obtained from trees during the rainy season was dried over a fire. The quality of this appears to be better than either No. 1 or No. 2, and it approaches very near to No. 4. Except as regards the difficulty of coagulating the rubber there appears from these experiments to be little difference between the specimens collected during the rainy season and those collected "when the rains had fully ceased."

6. All the trees tapped were young, and few were more than 12 inches in diameter. Mr. Thiselton-Dyer is of opinion that it is very desirable that these interesting experiments should be continued if there are sufficient trees available. If during the dry season the milk is found to coagulate readily on the trees, this method might be provisionally adopted with the view of testing on a larger scale its suitability for general use in India. Where, however, the milk does not coagulate readily, it might be advisable to try the cautious application of dry heat in the most convenient manner locally available. Mere sun heat, especially during the rainy season, does not appear to produce good rubber.

7. In South America the milk of *Hevea brasiliensis* is collected generally at the beginning of the dry season. When the quantity collected is large it is necessary, in order to prevent decomposition, to obtain the caoutchouc in a solid mass as soon as possible. The best Para rubber is prepared by dipping a wooden paddle in the milk and holding it in the thick, hot smoke from burning wood and palm nuts. When the first layer is dry the paddle is dipped

again and the process repeated until a thick solid mass of caoutchouc is obtained. A slit is made down one side, the rubber is peeled off the paddle and hung up to dry.

I have, &c.,
(Signed) D. MORRIS.

J. A. Godley, Esq., C.B.,
India Office, Whitehall, S.W.

[Enclosure.]

REPORT from INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS COMPANY, LIMITED.

Silvertown, May 30, 1889.

The four samples of *Hevea* rubber received from Kew have been treated with sulphur in the same way as that adopted in the case of the better kinds of Brazilian rubber. Allowance must be made for the smallness of the quantity experimented upon.

Eight samples sent herewith, four each, "washed" and "cured."

No. 1. Has the appearance of that imported some 12 months since, and known as Rio rubber; is soft, and would decompose if exposed to the necessary heat after washing, losing 12 per cent. in that process; its commercial value 1*s.* 11*d.* to 2*s.*

No. 2. Slightly firmer; in other respects the same as No. 1.

No. 3. Percentage of loss somewhat less, and therefore of a trifling increased value.

No. 4. Found to be stronger and firmer, not so likely to decompose when drying; worth 2*s.* 3*d.* Owing to the scrappy nature the loss is greater than it otherwise would be.

In Southern India the results of the cultivation of Para rubber trees have so far not been satisfactory. In 1888 Mr. Lawson was asked by the Government to supply a short resumé of the success which had attended the cultivation in the Madras Presidency. He replied as follows :—

"There are three young trees of *Hevea brasiliensis* in the Barliyár Gardens. They are about 20 feet in height, and have stems of about 18 inches diameter at the base . . . They grow vigorously, and they have flowered for the first time this spring, but so far I have been unable to extract rubber from them in any quantity."

At Nilambur the rubber trees (Ceara and *Hevea*) were planted amongst teak trees. In the Administration Report for 1884–85 it was stated "the growth of the rubbers on the whole continued good, though Mr. Hadfield doubted whether they would yield much revenue as there was little milk in the seven years' old trees." Again: "One pound of rubber was obtained from 80 of the largest trees in 1886–87, but no tapping was done subsequently."

No distinction appears to have been made in these reports between the *Hevea* and Ceara rubbers. It is possible that the failure noted applies more particularly to the latter trees.

The latest information available on the subject is contained in the Report of the Nilambur Teak Plantations, 1895 (Appendix C., p. 69). The following remarks (quoted from Commercial Circular, No. 8 of 1897, issued by the Reporter on Economic Products to the Government of India) appear under Exotic Plantations—Rubber :—

"3. *Working.*—The rubber is quite out of place in the middle of a teak plantation, even should it prove itself of any commercial value. The soil occupied is some of the most valuable in the plantations. Experiments are now being conducted in tapping the rubber, and, as far as they have gone, show little prospect of any material revenue being realised. The biggest trees are now nearly 20 years old, and each covers the space required for two teak trees of the same age. The yield appears to be from 4 to 6 oz. of rubber, which production may perhaps be continued for five or six years (even this is very doubtful), and the result expressed in current coin would compare very unfavourably with the value of two teak trees of the same age.

"Probably the most paying thing to do would be to fell this area in 1895, clean and to plant it up with teak. In order, however, that the success or failure of the rubber growing may be proved, it is proposed to clean and fell at the end of the first rotation in 1900, when very few clean saplings of small size will be available, and plant up the whole area with teak in 1901. This compartment will then work into the working circle."

In a Note on the Working Plan for the Nilambur Valley Teak Plantation, the Inspector-General of Forests in India, Mr. B. Ribbentrop (*Indian Forester*, 1898, p. 168) discusses the suggestions for cutting out the rubber trees as follows :—

"It would appear that the experiments carried out with the introduction of rubber-yielding trees have so far been unsuccessful, but I feel nevertheless disinclined to agree in the proposal that the experiments of making the Nilambur Basin an important centre of rubber supply should be discontinued. . . . To me it seems that the Nilambur Basin is eminently adapted for the growth of rubber-yielding plants, and the facility of export renders the prospect of a trade in a product which can bear a land transport of hundreds of miles particularly attractive. The demand for rubber, and its price, are constantly increasing, and I would strongly advise that experiments should be continued till the most suitable rubber-yielding tree is found, which will grow in localities not required for the extension of the teak plantation."

Para Rubber in the Straits Settlements.

Plants of Para rubber were forwarded direct from Kew to Singapore in 1876. In 1877 Mr. Murton reported : "Our climate is evidently suited for the growth of *Hevea*, judging by the progress the plants sent last year have made." Some of these plants were afterwards introduced to Perak, where, in 1879, Mr. (now Sir Hugh) Low reported : "The Heveas are 12 to 14 feet high. They take to the country immensely."

Kew possesses very little information in regard to the number and character of the Para rubber trees now existing at Singapore. Mr. Ridley, Director of the Gardens and Forest Department, was, however, good enough to forward photographs, in May last, of a rubber plantation in the Botanic Gardens, showing a grove of trees of different ages and sizes. One of these had been tapped at nine years old, and had yielded two pounds of rubber.

An interesting account of the original trees planted at Kuala Kangsar by Sir Hugh Low was lately given by Mr. R. Derry in *Perak Museum Notes*, Vol. II., pp. 101–102. They are yielding seeds freely (25,000 last year), and are considered at present of more value as seed bearers than as rubber producers. The following letter has been received from Mr. Derry :—

CURATOR, GOVERNMENT GARDENS and PLANTATIONS, TAIPING, PERAK, to ROYAL GARDENS, KEW.

Government Plantations Office, Taiping.
October 6, 1897.

DEAR SIR,

I AM now able to reply to your letter, dated December 14, 1896, with reference to Para rubber trees planted by Sir Hugh Low at Kuala Kangsar, Perak.

It is quite a mistake to suppose that these yield no rubber. I have collected over 1 cwt., and find the trees run quite freely. From a few trees I have collected 5 lbs. each and only stopped for fear of taking too much.

I notice in the extract from Sir Hugh Low's letter (which you sent me) that the trees had previously been tapped by Dyaks unsuccessfully. As you are aware, Para rubber does not exude for some days after the incisions have bean made, and Dyaks, who are familiar with such rubbers as *Alstonia*, *Ficus*, *Willughbeia*, &c., no doubt concluded that as the trees did not run at once when tapped there was not any rubber—hence the mistake.

I am now sending samples home for valuation.

I am, &c.,
(Signed) R. DERRY.

The Director,
Royal Gardens, Kew.

The following further particulars, communicated by Mr. Derry, are taken from the *Perak Government Gazette* for April 8, 1898 :—

PARA RUBBER (*Hevea brasiliensis*).

Many trees have been tapped, and a report on the work submitted. The rubber obtained is not yet sufficiently smoked for sending home, but samples have been valued in Mincing Lane at 2*s.* 8*d.* and 3*s.* per pound, and considered equal to Brazilian-produced rubber, and also worth 1*s.* per pound more than that usually sent home from the Straits.

There has been a large demand for seeds, and about 35,000 have been supplied. How far this industry is deserving attention may be inferred from the following moderate estimate :—

(Planted 14 feet × 14 feet = 225 trees to the acre.)

Age.	Yield per tree.	Yield per acre, *i.e.*, one tree × 225.	Gross value estimated at 2*s*. per lb.
Years.	Ounces.	Pounds.	£ *s*. *d*.
6	10	140½	14 10 0
7	18	250	25 0 0
8	26	365	36 15 0
9	34	478	47 13 0
10	42	590½	59 1 0

The importance of close planting is not generally realised. Planted at 14 feet × 14 feet, against 25 feet × 25 feet, would possibly result in a difference of one year in six in favour of close planting. I am of opinion that, planted 14 feet × 14 feet, trees could be tapped in the fifth year, if not earlier. Para rubber is a remarkably adaptable tree, growing in swampy land, or dry, high ground without, so far as I have tested, any difference in the yield of rubber.

The following extracts are taken from Notes on Rubber Growing in Perak by Mr. L. Wray, Curator and State Geologist, Perak, dated 4th December, 1897 :—

In 1887 some seed was obtained from the Kuala Kangsar trees and planted in the Museum grounds, Taiping. The soil is very bad, the land having all been mined over, but still the trees have grown well and have attained, in the ten years which have elapsed since they were planted, a considerable size.

The tree has also been planted at Parit Buntar, where it grows well. It is in the garden of the District Magistrate, and close to the river. The land is occasionally flooded by the river, and in the ordinary way at high tide the river is only a foot or two below the level of the surface of the ground. The river is quite salt enough for the Nipa palm to grow well on its banks.

It has been planted at Sitiawan, also on low land near the sea ; at Tapah, Batu Gajah in Kinta, and other places in the State, and in all it has grown well.

It may therefore be stated that it will thrive in any locality, from the *bakau* swamps to the foot-hills, and on any soil, from rich alluvial to old mine-heaps.

So far I have not noticed that it has any enemies which do it serious injury. When large areas come to be planted up there may arise trouble with some pest, but at present there does not appear to be any indication of such a contingency.

Hitherto the trees have been planted singly, and, as might be expected, they have grown with short trunks and bushy tops. To be a success—that is, to yield large quantities of rubber—the tree must be planted so that it will run up and form a tall, straight, branchless trunk.

There is little to guide one on the subject, but from 15 to 20 feet apart would appear to be about the correct spacing. At 20 feet it might be necessary to plant something in between them to keep them from early branching, but this would not be necessary at 15 feet. In Larut, at an estate at Kampong Dew, they are being planted at 10 feet by 10 feet, that is 544 per acre. It is very close but it is the intention, I am informed by Mr. Waddell Boyd, the manager, to thin them out later on to 20 feet by 20 feet or 108 per acre, tapping the intermediate trees—that is, those which are ultimately to be thinned out—as early as possible and as severely as they will stand, while the others are allowed to grow to a large size before tapping.

With a view to giving some data respecting the growth of the trees, I have measured thirteen of those in the Museum grounds. These trees, it is to be remembered, are ten years old, and are planted on mined land of the poorest quality. For these 13 trees the mean height is 74 feet, and the mean girth at 3 feet from the ground is 4 feet 2 inches. This gives a mean annual growth in height of 7 feet 3 inches, in circumference of 5 inches, and in diameter of 1·6 inch.

The trees are very prolific seed bearers. Those in the Museum grounds have this year yielded nearly 14,000 seeds—or, to speak more correctly, that number have been collected. Most of the trees are planted by the side of a large ditch, and all the seeds which fall into it are at once carried away, as they are very light and float on the water. The seeds have beeu distributed, 3,000 going to the Jebong Estate, and 11,000 to the Sam Sing Estate.

At 15 feet by 15 feet 14,000 seeds would be enough to plant 72½ acres of land. Where the land is ready it is certainly an advantage to plant the seed at stake, but where this cannot be done not much loss would follow planting in nurseries and then transplanting. The thing to avoid in this method is the production of double stems near the ground, caused by the original shoot dying out or being broken off.

It has recently been proved by Messrs. Curtis, Derry and others that these trees will yield at least one pound per tree per year of clean rubber. Taking the value of the rubber at 2*s.* per pound only, we get for an acre of land planted at 20 feet by 20 feet, an annual crop worth £10 16*s.*, and if planted at 15 feet by 15 feet worth £19 6*s.* This should begin, as far as is now known, at about the sixth or seventh year, and by the 12th year should have increased to double the amounts given.

A sample of rubber obtained from a tree cultivated in the Botanic Garden, Penang, and recently forwarded to Kew by Mr. C. Curtis, has been submitted to Messrs. Hecht, Levis & Kahn, 21, Mincing Lane, E.C., who report upon it as follows :—

"Worth to-day (31/8/98) 3*s.* 3*d.* per lb. ; beautiful rubber, very well cured."

It may be mentioned that Fine Para rubber is now selling at about 4*s.* 4*d.* per pound. It would be interesting to learn why this "beautiful rubber" from Penang should be valued at more than a shilling per pound less than Amazonian rubber. One explanation is that *Hevea* rubber cured in any other way than by

the smoke of palm nuts is intrinsically not so good as Fine Para. This is evidently not the whole story. It is possible there is a certain amount of prejudice existing against *Hevea* rubber in any other form than that in which it has always been received in this country. In any case it is desirable to institute a comparative chemical investigation of the value of Brazilian rubber as against that obtained from cultivated trees. So far it would appear that no *Hevea* rubber obtained from cultivated trees has reached the highest prices attained by Amazon rubber.

Zanzibar.

In the "Shamba," the Journal of Agriculture for Zanzibar (October, 1897, p. 2), issued by Mr. R. N. Lyne, F.L.S., the Director of Agriculture, the following interesting note appears respecting a fine tree of *Hevea brasiliensis* growing at Mbweni. This, originally received from Kew, was planted in the Botanical Garden established by Sir John Kirk when he was Consul-General at Zanzibar (see *Kew Bulletin*, 1896, pp. 80–86) :—

"The cultivation of rubber is beginning to occupy attention here now. At Mbweni, there is a Para rubber tree 50 feet in height and over 6 feet in girth. It is a beautiful tree, clean and straight in the trunk, with not a branch to interrupt its tapering symmetry till the crown is reached. It is now flowering. We believe that this tree has not beeu tapped, but a casual stab in passing induced a flow of milk which suggested a good reserve. This tree is growing in a spot which by no means corresponds to the conditions of its natural habitat in Brazil which are low and alluvial. At Mbweni, the Para rubber tree is found on a porous sandy ridge within 100 yards or so of the sea cliff. And yet it has grown on this apparently uncongenial locality with the greatest vigour. In the richer and damper soils it ought to thrive as in its native country."

Mozambique.

In the report on the trade of Portuguese East Africa for the year 1889 (*F. O.* Annual Series, 1890, No. 742), forwarded by Sir H. H. Johnston, Mr. Vice-Consul Ross at Quilimane records the existence of trees of *Hevea brasiliensis* as follows (p. 10) :—"In a private garden on the bank of the Chinde River I was shown half-a-dozen very healthy Para rubber trees a year old, and some 15 feet high. They had fruited well, and the owner had sown in the neighbourhood most of the seed they had borne."

West Africa.

Gambia.—In the report on the Botanic Station at the Gambia for 1897, the Curator reported (*Kew Bulletin*, 1898, p. 41) : "a few plants of this are at the Station, but they do not appear to be growing well, owing to the long dry season."

Sierra Leone.—In the First Annual Report on the Botanic Station at Freetown, Mr. Willey, the late Curator, states : "Some plants of the Para rubber, the premier rubber of the world, are growing here, but they are too small yet to express an opinion as to their ultimate success. They will be reported on later."

Gold Coast.—In the report on the Botanic Station at Aburi for 1894 the Curator states, "rubber plants, especially Para rubber, are making good progress. Some of the trees only 18 months' growth are 10 feet high and have stems 3 inches in diameter."

Lagos.—In Mr. Millen's Report on the Botanic Station for the quarter ending 30th September, 1895, mention is made of *Hevea spruceana* but none of *H. brasiliensis*. The former is described as having done "fairly well." In the Report for the year 1897 seeds of *Hevea brasiliensis* are acknowledged as having been received from Kew.

Para rubber trees have been introduced to French and German possessions in West Africa. They are described as having done well in some localities in the Cameroons, and according to the *Tropenpflanzer* rubber has already been obtained from them.

West Indies.

Jamaica.—Seedling trees of Para rubber have existed at the Castleton Gardens, Jamaica, since 1882. In the *Bulletin* of the Botanical Department, 1894, p. 104, Mr. Fawcett, the Director of Public Gardens and Plantations, states :—

"There are young trees at both the Castleton and Hope Gardens, but they have not yet yielded any rubber. The bark is about $\frac{1}{2}$ inch thick, and the lactiferous vessels lie in the inner half of the bark. From examination made in the Gardens, it would appear that this tree will succeed only in Jamaica grown as a forest tree with its bark shaded, and its roots in a soil which is constantly wet. It is quite possible that these conditions are more important than the rainfall, and that the tree might be grown in the swamps along the South Coast."

Dominica.—In the Report on the Botanic Station at Dominica for 1896 it is stated : "We have now all the best kinds of rubber trees, viz., *Hevea*, *Castilloa*, *Ficus*, *Manihot*, and *Kickxia* . . . The plants of *Hevea* and *Kickxia* are still small."

St. Vincent.—According to the Report on the Botanic Station at St. Vincent for the quarter ending 30th of June, 1891, six plants of the Para rubber tree were planted out at the Station during that period. There is no record in later Reports of the success of this experiment. The Central America rubber tree (*Castilloa elastica*) is said to be doing very well in St. Vincent.

Grenada.—The Para rubber tree is recorded as under cultivation at the Botanic Station, Grenada, in a list published in September, 1893. In 1895 it was in flower and fruit.

Trinidad.—In the Annual Report for the year 1897 on the Royal Botanic Gardens at Trinidad, Mr. Hart, the Superintendent, states "the Heveas or the Brazilian and Demerara rubbers are trees of large size and do not bleed so freely as *Castilloa*, neither do they grow so quickly, but they have the advantage of being able to grow in places where *Castilloa* could not thrive. Trees of large size are present in the Garden and annually give us seed in limited quantities."

The following interesting particulars have lately been received respecting rubber obtained from these trees during this year :—

SUPERINTENDENT, BOTANICAL DEPARTMENT, TRINIDAD, to ROYAL GARDENS, KEW.

Botanical Department, Trinidad.
June 22, 1898.

SIR,

I FORWARD you a ball of *Hevea* rubber collected from our trees in the following manner :—The rough bark was first "spoke-shaved" so as to obtain a clean surface without injuring the cambium. At the upper part of the surface thus exposed, longitudinal slits were made some four or five inches long and sufficiently deep to reach the xylem. Streams of latex then commenced to run down on the clean surface, which when partially dry were collected by rolling into a ball. Every night for eight successive nights the latex started afresh and was collected in the morning. The quantity appears to be greater after rainfall. It came without fresh cutting.

Yours faithfully,
(Signed) J. H. HART.

The Director,
Royal Gardens, Kew.

MESSRS. HECHT, LEVIS and KAHN, to ROYAL GARDENS, KEW.

21, Mincing Lane, London, E.C.
July 12, 1898.

DEAR SIR,

IN reply to your favour of the 8th instant, which only reached us this morning, we have examined the ball of *Hevea* rubber from Trinidad which you sent us and find the quality excellent in every respect, clean, strong and dry. This rubber would be readily saleable in this market and would at the present moment command a very high price, probably about 3*s*. to 3*s*. 2*d*. per lb., perhaps even a little more.

Yours faithfully,
(Signed) HECHT, LEVIS and KAHN.

BRITISH GUIANA.

Hevea brasiliensis does not appear to have taken well in this colony. According to Mr. Hemsley there are at least two species of *Hevea* native of British Guiana. *Hevea pauciflora*, Muell. Arg. (*H. Spruceana*, Oliver, pro parte, in *Kew Report*, 1880, p. 37), has been collected by Jenman (Nos. 725 and 2450), and by im Thurn (No. 200), on the Mazaruni River. The other Guiana plant has recently been described as a new species and is *Hevea confusa*, Hemsley (*Hooker's Icones Plantarum*, vol. vi., pt. iii., t. 2574, figs. 1–3). This was collected by the Schomburgks and by Prestoe on the Mazaruni River, by Jenman on the Mazaruni (No. 621) and Essequebo Rivers (No. 1332), and is now under cultivation at the Trinidad Botanic Gardens (Hart, No. 3554).

A Report on "some of the Rubber-producing Plants of British Guiana, by the Government Botanist," was published at the

"Royal Gazette" office, in Georgetown, in 1883. Later information on the same subject is included in a Report on "the Balata Industry of British Guiana," published in 1885.

The following brief account of the rubber-yielding plants of British Guiana appeared in the Appendix to the Report of the West India Royal Commission, 1897 (*Kew Bulletin*, Additional Series, I., pp. 34–35) :—

The most promising rubber tree is the "Hatie." This is found in the upper basin of the Essequebo and Mazaruno rivers, and probably yields some of the crude rubber sometimes received from that region. It is also found in some districts on the Pomeroon river. Mr. Jenman calculates that from a large tree several pounds of rubber might be produced. The milk of a tree or trees known as "Touckpong," or "Cumakaballi," is sometimes mixed with balata milk, but it is not separately prepared. A specimen of rubber obtained by Mr. Jenman from a large twining plant known locally as "Macwarrieballi," and determined to be *Forsteronia gracilis*, was received at Kew in 1888. It was shown that if the plant from which this rubber was prepared existed in any quantity in the interior of the Colony, the collection of the rubber would be a very promising commercial undertaking (*Kew Bulletin*, 1888, pp. 69–71 [p. 40]).

It is very desirable that all these rubber trees should be carefully and exhaustively investigated in order to find out their true value. It is probable that it may be found profitable to establish natural plantations in districts where the best rubber trees are already found. This could be done with little difficulty, and it offers the best means of immediately extending the area under rubber trees in different parts of the Colony. Where plants are plentiful it would only be necessary to clear away some of the other vegetation and allow the rubber trees more light and air, as well as thinning them out when too crowded. Where the conditions are favourable and the plants only sparsely found, wild seedlings might be transplanted or fresh seeds "dibbled in" at intervals to fill the vacant places. The cost of this plan would not be considerable, as the trees would require little attention after they were well started.

XXIV.—PARA RUBBER IN THE STRAITS SETTLEMENTS.

[*K.B.*, 1899, pp. 21, 22.]

Penang.—A brief reference to the experimental production of this rubber was given in the *Kew Bulletin* for 1898, p. 273 [p. 106]. Two samples have since been received from Mr. C. Curtis, the Assistant Superintendent of Forests, both of which were taken from a tree growing in the Botanic Garden, the quantity collected amounting to three pounds. One sample had been coagulated with, and the other without, alum, but both were dried by fire heat. Accompanying the samples was a bag of chips or shavings of the wood of the rubber tree, containing a quantity of the coagulated juice; it was thought that they might prove a marketable article for the

extraction of the rubber. All the samples were submitted to Messrs. Hecht, Levis, and Kahn, the well-known rubber brokers of Mincing Lane, who kindly furnished the following report under date February 3rd, 1899:—"The rubber shavings are almost valueless, containing as they do only small traces of rubber. We estimate the value of these shavings from 4*d.* to 5*d.* per pound. The other two samples are of excellent quality, and would meet with a ready sale at probably about 3*s.* 6*d.* per pound, if the bulk of the rubber is equal in dryness to the two small cakes you have sent us. The treatment of No. 1 with alum does not in any way interfere with the quality."

Perak.—The experimental cultivation of Para Rubber in the Straits Settlements has been discussed in the *Kew Bulletin*, 1898, pp. 271–274 [p. 106].

The following report gives a higher valuation for the produce of the trees grown in Perak than that already quoted.

THE SUPERINTENDENT, GOVERNMENT PLANTATIONS, PERAK, to THE SECRETARY TO GOVERNMENT, PERAK.

Government Plantations Office,
Taiping, October 3, 1898.

SIR,

I HAVE the honour to forward herewith a copy of the correspondence in connection with a parcel of Para Rubber (208 pounds sheet, and 8 pounds scrap), prepared at Kuala Kangsar, and sent home for sale.

The correspondence is interesting, as it shows market value of Para Rubber grown in Malaya. The parcel realised $293·90, exclusive of charges.

The Rubber was valued at about 3*s.* 5*d.* per pound, but sold for 3*s.* 1*d.* owing to the cost of analysis.

The analysis showed a loss of 26½ per cent. in washing, but the manufacturers think that if sent home in bulk, the loss would be 30 per cent., as a large quantity could not be sent home so dry.

I have, &c.,
(Signed) R. DERRY,
Superintendent of Government Plantations.

XXV.—EXPORT OF PARA RUBBER SEEDS.

[*K.B.*, 1906, pp. 196–197.]

The following valuable note by Mr. H. N. Ridley, of Singapore, is reprinted from the *Agricultural Bulletin, Straits and Federated Malay States*, Vol. V., No. 1 (1906):—

"As is well known, the seed of the Para rubber tree deteriorates very rapidly after it is ripe, and soon loses its germinating power. It is not always easy to send seed long distances without a very large percentage of losses; at the same time the demand for seed in distant parts of the world is very considerable, and a good

many experiments have been tried in the Botanic Gardens in various methods of packing to ensure their arrival in good condition. The reports received from the recipients of these seeds have been remarkably good, as the following records will show— 7,500 seeds sent to Jamaica on August 31st were received on 25th October, and Mr. Fawcett writes: 'The 7,500 seeds sent in biscuit tins are all germinating very well, and we shall scarcely lose 500 of them.'"

[With reference to this consignment Mr. Fawcett remarks in the *Bulletin of the Department of Agriculture, Jamaica*, Vol. IV., No. 7 (1906): "Over 87 per cent. of the seeds sown germinated, but some of the seedlings were constitutionally weak and died, so that only 5,071 plants survived, or about 68 per cent. of the seeds sown. A Wardian case arrived with 2,500 seeds, but only 18 plants were raised out of the whole number."]

"One hundred were sent in a similar manner to Calabar on the date July 6th, and arrived on September 20th. The Acting Secretary writes in reply: 'The seeds were soaked in water for two days on their arrival, and were then planted with the upper portion left above the soil. Ninety out of the hundred seeds have already germinated (November 7th), and appear healthy young plants.'

"To the Royal Gardens, Kew, 135 seeds were sent on July 6th, packed in charcoal in a biscuit tin. They arrived in a month, and 123 germinated. On February 12th, 1903, 20 seeds were sent to Mr. J. C. Harvey, Vera Cruz, Mexico, who writes, May 19th, 1903, that 'out of the 20 seeds of *Hevea brasiliensis* I have 14 young plants. They came up in a few days, and possibly a few more may germinate, though three seeds were decayed.' These were all sent in biscuit tins. Those sent to Jamaica were packed in slightly damped incinerator earth, but it was necessary to replace the upper part of the packing with sawdust to reduce the weight, as incinerator earth is very heavy, and the box, a two-pound tin which contained 150 seeds, would have been over parcel post weight.

"The other tins were filled with damp charcoal finely powdered. In packing a certain amount of care is required in damping the charcoal so as to get it equally moistened all through, and not either over wet or over dry. This is best done by damping the charcoal thoroughly, and then drying it in the sun, constantly stirring and turning it over till it is uniformly slightly damped. The incinerator earth, which had been exposed to the elements, was damped when received, and only wanted partial drying to fit it for packing. Its weight is against its use, but both it and the powdered charcoal have the great advantage of preventing any attacks of mould or bacteria likely to cause decomposition. Other experiments with powdered coir fibre and coir dust, sawdust, and variously prepared soils have been tried, but the results do not seem to have ever been as successful. One experiment was made in putting the seeds in water for a month, and though that might be effective for a fortnight or so, they had all perished by the end of the month."

XXVI.—PARA RUBBER.

(*Hevea brasiliensis*, Muell. Arg.)

THE RISE AND FALL IN PRICES OF THE FOREST PRODUCT FOR THE PAST 30 YEARS AND OF THE CULTIVATED FORM FOR THE PAST 4 YEARS.

[*K.B.*, 1906, pp. 241-242.]

In the *Kew Bulletin* for 1898 a chart was published shewing the average prices of fine Para rubber (*Hevea brasiliensis*), for the years 1877 to 1898 inclusive, and in view of the constantly increasing importance of the rubber industry it has been considered expedient to bring this up to date. A graphical writing should explain itself, and without entering on too great detail it will be observed that the general tendency has been an upward one, although some of the variations are rather remarkable. At no period has the price remained fixed throughout any particular year, the nearest approach to this occurring in 1897 with a range of 3*d*. only; the greatest deviation from it in 1879 with a range of 2*s*. The figures, maximum, minimum, and average, in all instances, are given minus fractions of a penny.

Some explanation is necessary in connection with the lines for cultivated or plantation Para rubber, which so far appears to have come exclusively from Ceylon and the Straits Settlements. The history of the industry in respect of these Colonies has been fully discussed in previous issues of the *Bulletin*, and it will, perhaps, be unnecessary here to do more than point out that the plantation rubber, according to statistics, first began to appear in marketable quantities in 1905, although exports on a smaller scale from Ceylon were made in 1901 (*Ceylon Administration Reports*, 1901, part iv., p. H 2, Roy. Bot. Gardens). Samples had been submitted as early as 1882 from there (*Kew Bulletin*, 1898, p. 255) [p. 91], and in 1898 from the Straits Settlements (*Kew Bulletin*, 1898, p. 274 [p. 107]; and 1899 p. 22 [p. 114]). On this subject it may also be of interest to quote the following letter from the Straits' *Agricultural Bulletin* (Vol. ii., 1903, p. 193), which, together with the accompanying Chart, will give a fair idea as to their relative positions and to the trade in general at that date (1903).

"36 Fenchurch Street,
"London, E.C.,
"7th April, 1903.

"Harold Tunnicliffe, Esq.,
"Atherton Estate, Port Dickson,
"Straits Settlements.

"DEAR SIR,

"WE duly received your favour of the 8th March with sample of rubber grown from Para seed. There are fair quantities of similar rubber beginning to come from Ceylon and they find a ready market. The sample which you send us seems to be of very good quality, tho' perhaps a trifle 'tacky' which, however, may be due to the way in which the sample has been sent and

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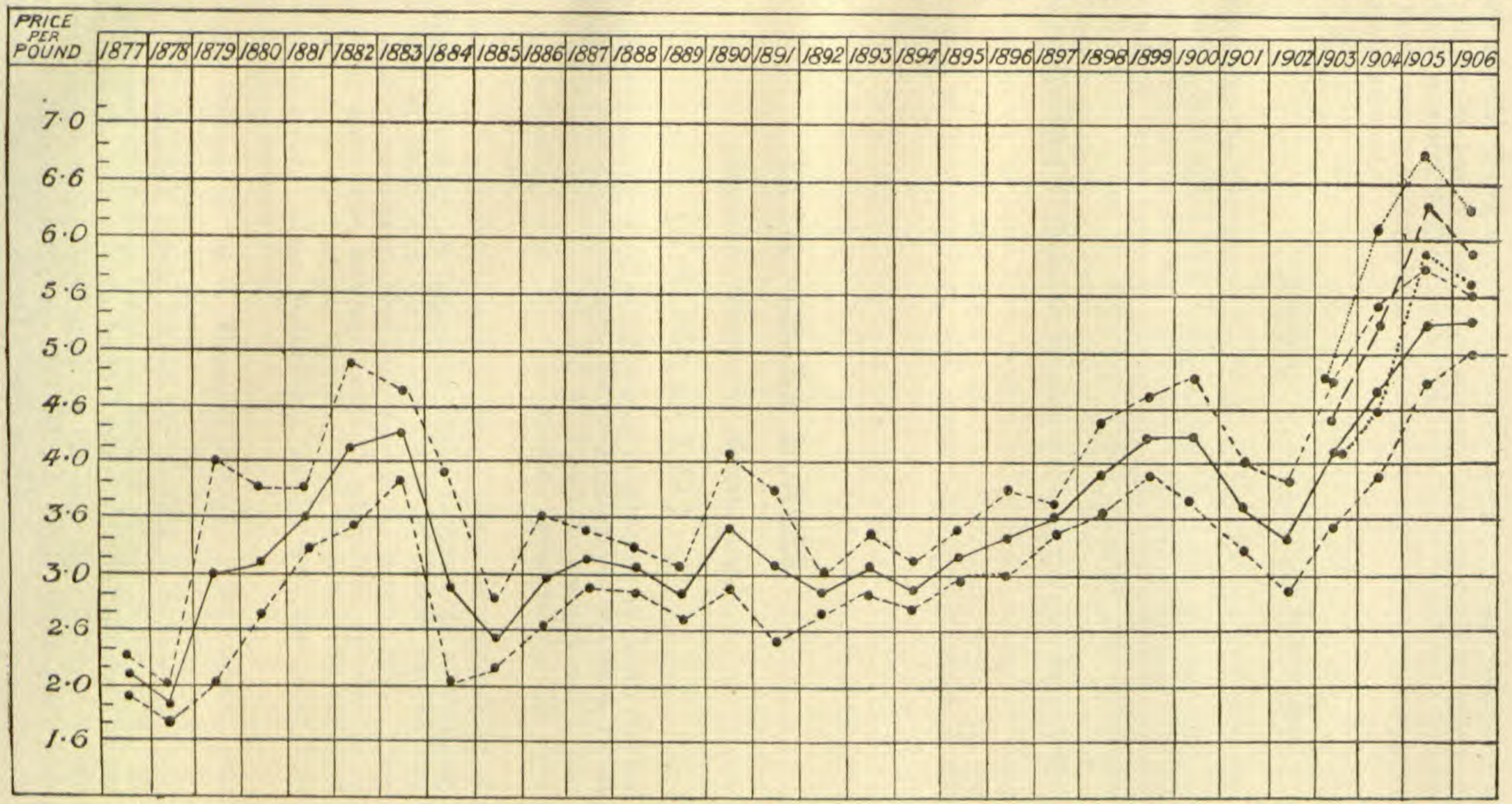
PRICES OF FINE PARA RUBBER DURING EACH YEAR FROM 1877 TO 1906 INCLUSIVE IN LONDON AND LIVERPOOL AND OF CULTIVATED PARA (CEYLON & STRAITS SETTLEMENTS) FROM 1903 TO 1906 INCLUSIVE (COMPILED FROM THE LISTS OF MESSRS HECHT, LEVIS & KAHN)



Fine Para { Average ——— Maximum and Minimum - - - - -

Cultivated Para { Average — — — Maximum and Minimum .....

may not be the case in bulk. In to-day's market, which is a good one, we should think a parcel of this rubber would fetch from 4*s.* 3*d.* to 4*s.* 5*d.* per lb., and our idea of the immediate future of the article, anyhow until next autumn, being a favourable one, we don't think that a shipment on the basis of our valuation will lead to disappointment.

* * * * * *

"(Signed) Hecht, Levis and Kahn."

As shewing the improvement on the beginning referred to in the above letter it is stated that "the most remarkable development in Ceylon agriculture during 1905 was the planting of rubber, under which there were at the end of 1905 some 40,000 acres as compared with 11,000 in 1904 and 7,500 in 1903, and the value of rubber exported in 1905 was Rs. 557,945 as compared with Rs. 221,000 in 1904." (Colonial Report, No. 494, Ceylon, 1906, p. 23.)

It remains to be seen how soon, and to what extent, the West Indies, West Africa, and other Colonies that have taken up the cultivation of this product, will meet the requirements of the market.

XXVII.—CEARA RUBBER.

(*Manihot Glaziovii*, Muell. Arg.)

[*K.B.*, 1898, pp. 1–15.]

The plant yielding what is known in commerce as Ceara rubber or Maniçoba, and shipped from the Brazilian ports of Ceara, Bahia and Pernambuco, was identified at Kew eleven [twenty-one] years ago. The following note on the subject appeared in the *Kew Report*, 1877, p. 16 :—

"I mentioned in my last Report that a plant in cultivation in the Botanic Gardens of Regent's Park, London, of Buitenzorg (Java), and of Mauritius, under the name of *Hevea guyanensis* was, in reality, probably *Manihot Glaziovii*, Muell. Arg. I am now able to state that, having received authentic specimens of this species from the Botanic Gardens, Rio Janeiro, it is identical with the cultivated plant mentioned above, and also with that producing the Ceara rubber."

Manihot Glaziovii is a Euphorbiaceous plant which was described by J. Mueller in Martius' *Flora Brasiliensis* (xi., pt. ii., p. 443). Dr. Glaziou (after whom the species is named) sent to Kew specimens from Rio, where he had it under cultivation. A full description, with a plate, from a plant growing in the Ceylon Botanic Gardens, was contributed by the late Dr. Trimen to the *Journal of Botany* (1880, pp. 321–325, t. 215). This plate was reproduced in the *Kew Report* (1880, p. 17).

Manihot Glaziovii is a moderate-sized tree, 30 to 50 feet high, with an erect stem, 8 to 20 inches in diameter, branching di- or

trichotomously, the branches ascending and frequently branched in a similar manner, forming a dense rounded crown ; the bark is purple-grey, the thin silvery outer layers readily peeling off transversely in narrow strips. The *leaves* are palmate, deeply cut into three, five or seven oblong-ovate lobes, smooth on both surfaces except for a small tuft of woolly hair at the junction of the petiole, thin in texture and deep bluish-green above, paler beneath. The *flowers* are rather large, completely unisexual (male and female in the same raceme) from the forks of the younger branches, the male (more numerous) above, the female below, and expanding several days before the male. The *fruit* is a pendulous capsule, about an inch in diameter, nearly globular, dry and hard, when ripe, containing three smooth and polished *seeds*, greyish yellow or brownish, variously mottled and splashed with purplish black. The testa (or coat of the seed) is very hard and thick ; the cotyledons are very thin, foliaceous, slightly cordate at the base ; the endosperm oily but solid.

In the young state *Manihot Glaziovii* somewhat resembles the well-known Cassava or Mandiocca plant (*Manihot utilissima*, Pohl.) and has similar swollen roots. The tree, when fully grown, has a stem resembling a birch, "and the outer bark comes off in the same way in thin silvery peelings."

In 1876 Mr. Cross, who had been engaged on behalf of the Government of India to collect seeds and plants of india-rubber trees in South America, visited the Ceara region on the north east of Brazil, midway between the towns of Para and Bahia. This is outside the great forest region of the Amazon valley, and is known as the *Sertao* or wilderness, extending in a great belt from the Paranahyba river to the São Francisco.

Mr. Cross, in his Report to the India Office in 1877 (p. 14) describes the flat country from Ceara, running back to the mountains, on which the tree abounds, as manifestly possessing "a very dry arid climate for a considerable part of the year. This is evident from the fact that the mandiocca and other crops require to be irrigated. The rainy season is said to begin in November and end in May or June. Torrents of rain are then reported to fall for several days in succession, after which the weather moderates for a brief space. According to some statements there are occasional years in which hardly any rain falls. This assertion concurs with the aspect presented by the country in general. The daily temperature on board the ship ranged from 82° to 85° F., but inland it is often probably 90°. The localities traversed by me nowhere seemed to be elevated more than 200 feet above the sea." At Pacatuba, about 40 miles from Ceara, the actual place where the specimens were obtained, "the general forest was tolerably high, but the sparse, small, foliage did not afford much shade from the fierce rays of the sun. The soil was in places a sort of soft sandstone or gravel which was bound up in the most extraordinary manner. Neither grass nor weeds grew among this underwood, and there was an entire absence of ferns, mosses and other plants." In another place, somewhat further from the coast, the traveller, shortly after entering the bush-like forest, "came on a large tract of land covered by immense masses of grey granite, some of which might be fifty

tons or more in weight. Rounded masses of the same rock also cropped out in many places. . . . . Many good-sized rubber trees were growing in the spaces between these granite masses. . . . The situation was very dry, but no doubt some seedlings had sprung up, which, owing to numerous thickets of shrubs, were not perceived."

Cross obtained at Maracanahu, 30 miles inland from the town of Ceara, lat. 4° S., 60 plants and 700 seeds. (*Report*, pp. 12–14.) Of these, 42 plants and the seeds were safely deposited at Kew on the 23rd November, 1876. The following note appeared in the *Kew Report* (1877, p. 16) :—

"As stated in my last year's Report, we obtained from the seeds and stems of the Ceara rubber brought to this country by Mr. Cross a stock of 55 plants with which to commence propagation. On June 11th four plants were sent to Singapore, and on September 15th, at which date our stock had increased to 300 plants of all sizes, 50 were sent to Dr. King at Calcutta, and 50 to Dr. Thwaites in Ceylon, all the stems collected by Mr. Cross being divided amongst these two recipients. At the end of the year our stock amounted to 448 plants."

The further steps taken to distribute plants of the Ceara rubber are given in the *Kew Report* for 1878 (p. 15) as follows :—

"At the end of August of last year consignments of plants of the Ceara rubber, consisting, in each instance, of two wardian cases containing 80 plants, and one dry box containing 40 plants were sent to Lieut.-Colonel Beddome, Conservator of Forests, Madras, and Dr. King, of the Royal Botanic Gardens, Calcutta. Of those sent to Madras all were alive on arrival in the wardian cases, while of the contents of the dry box about half were saved. Those originally sent to Dr. King (*see Kew Report* for 1877, p. 16) arrived in rather bad condition. Few were saved, and the growth of these did not impress Dr. King favourably. 'They all look more or less weak and lanky, as if the climate were too damp for them.' This was, perhaps, a premature judgment from want of familiarity with the habit of the plant. Dr. King now writes :— 'Ceara rubber is going to be a success here.'"

"At Ceylon, in April, one of the plants first sent out had already made an attempt to flower, and by the end of the year Dr. Thwaites was distributing copious supplies of seed to Calcutta, Burmah, Madras, and Singapore (where, however, it seems unable to stand the wet season)."

"I regard, therefore, the work of Kew completed as regards the Ceara rubber. Living plants of it have been distributed during the past year to Dominica, Fiji, Jamaica, Java, Sydney, Trinidad, Queensland and Zanzibar."

Of Ceara rubber there are imported into this country about 200 to 300 tons per annum. There are three grades found in commerce, varying according to the mode of tapping the trees and the care taken in the preparation. When pure it is regarded as almost next to Para in value. It is a "dry" rubber, very elastic and free from stickiness. It is, however, mixed with wood and foreign matter, causing a loss to the manufacturer amounting sometimes to 25 per cent. It would appear that the Ceara rubber industry is not extending in South America, for "every year

there is an extensive migration of Ceara people to Para bound for the forests of the Amazon." (*Kew Bulletin*, 1892, p. 69.) In case 96 [now case 106], Museum No. 1, samples are exhibited from Brazil, and also from plants grown in India, Ceylon, Natal, and Zanzibar. It may be mentioned that the rubber produced under cultivation in Ceylon has been singularly pure and free from impurities. In 1883, according to Dr. Trimen, "as much as 4*s*. per pound had been obtained for Ceylon Ceara rubber."

System of collecting the rubber.—According to Cross (*Report*, p. 14) "this is an operation of a very simple description. On commencing work, the collector takes with him a stout knife and a handful of twigs to serve as a broom. Arriving at a tree, any loose stones or dust are swept from the ground around the base, and some large leaves are laid down to receive the droppings of milk which trickle down. Some do not go to the trouble of sweeping the ground or laying down leaves, for which reason the milk adheres to sand, dust, decayed leaves, and other impurities. The outer surface of the bark of the trunk is pared or sliced off to a height of four or five feet. The milk then exudes and runs down in many tortuous courses, some of it ultimately falling on the ground. After several days the juice becomes dry and solid, and is then pulled off in strings and rolled up in balls or put into bags in loose masses. Only a thin paring should be taken off, just deep enough to reach the milk vessels; but this is not always attended to. Nearly every tree has been cut through the bark, and a slice taken off the wood. Decay then proceeds rapidly, and many of the trunks are hollow. In this condition the trees must yield far less milk, and many no doubt are broken over by the wind or wither away. Collecting is carried on during the dry season only, when rain seldom falls."

Germination of Seed.—The following is taken from *Notes on some Trees yielding India-rubber* (p. 4), by the late Dr. Trimen (Ceylon, Sessional Paper, vii., 1880):—"The seed coat is of remarkable thickness and very hard, and the natural process of germination occupies a long period—it is said more than a year. All that is necessary to hasten this, if desired, is to assist the seed coat in splitting. This is best effected by holding the seed firmly, and rasping off with a file both edges at the radicular end. It is best not to file off the actual end, as it may thus easily happen that the radicle of the embryo may be injured. After this treatment, properly performed, the young plant appears above ground in two or three weeks. The seedlings require no particular attention. They grow rapidly and may be finally planted out at distances of twenty feet. A peculiarity which they share with their close relative the mandiocca is the possession of large tubers on the spreading roots. The trees at Peradeniya, from which seed has been distributed to Burma, India, Jamaica, &c., flowered at the age of eighteen months, and at the present time (at $2\frac{1}{2}$ years) the larger ones form branching trees about 25 or 30 feet high, with a stem 1 foot 9 inches in circumference at a yard from the base, and a smooth, silvery, birch-like bark readily peeling off; being about half the size of those which Mr. Cross describes, and which may be assumed to have been fully grown."

Propagation and Planting.—Mr. Cross (p. 14) suggests "the formation of plantations by cuttings, which will take root as easily as a willow. These should be taken from the points of strong shoots and may be one foot in length. In planting, each cutting may be put down in the soil to a depth of six inches. If scarce, the entire shoot may be cut into pieces, each possessing a bud, all of which will grow if covered with half-an-inch or so of soil. On loose sandy soils or exhausted coffee land, plantations may be formed at little expense. Hard dry gravelly wastes, if found to support any kind of bush, are also suitable sites. Holes might be made in strong land with an iron jumper and a stout cutting put into each and filled with pebbles. On bare or thinly covered portions of rock the cuttings might be laid down flat, and a little heap of stones or any kind of *débris*, about the size of a molehill, piled over each, care being taken that the extreme point of each cutting with a bud is left uncovered. I do not advocate planting in an entirely barren desert, but wherever there is any sort of stunted tree or scrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper."

Dr. Trimen adds (l. c. p. 4) :—

"Experience of the plant in the botanic garden here has proved the general accuracy of the above remarks. There can be no doubt of the hardiness of the species, its readiness of culture, and adaptability to circumstances. It grows equally readily from seed or from cuttings, and, though a native of a tropical sea-level, thrives well here in Ceylon up to at least a level of 3,000 feet, and on the most barren soils. It has succeeded equally in Calcutta and Madras, but the wet season seems to have killed it at Singapore. It would seem especially adapted for the dry and barren districts of our eastern and northern provinces, or in the higher districts, but it would not be wise to risk it in localities where the temperature is liable to fall below 60° F."

In the following notes the results are given of the attempts to establish the Ceara rubber tree in our various colonies and possessions.

Ceylon.

The cultivation of the Ceara rubber tree was carried on with considerable energy in Ceylon for many years. Numerous experiments were made to find out the best means for tapping the trees and producing the rubber in commercial quantities.

In the *Kew Report* for 1880 (pp. 17–18) the following information is given on the authority of Dr. Trimen: —

"Of the three species of South American trees here in cultivation (the successful introduction of which was due to Kew. See *Kew Reports*, 1876, pp. 8, 9; 1877, pp. 15–17), *Manihot Glaziovii* is still the only one which has flowered. Seed of this has been supplied during the year to the Government gardens in India (Calcutta, Saharunpore, Ootacamund) and distributed as widely as possible among the planters in the colony, 24,550 seeds having been thus disposed of, as well as 1879 rooted cuttings. We have also sent small quantities to the Botanic Gardens of Singapore,

Mauritius, Jamaica, British Guiana and Kew, the Acclimatization Seciety of Queensland, and Mr. Low, Her Britannic Majesty's Resident in Perak."

Dr. Trimen adds :—" This plant is now flourishing in Ceylon in suitable places and proves very hardy ; in the new estates in the Trincomalee district it is reported to be thriving, but to have shown itself intolerant of wet."

Dr. Trimen wrote in his *Report* for 1883 (p. 13) :—" A planted area of 977 acres is credited to this cultivation, but rubber has not yet appeared among our exports. Since it has been ascertained that the quality is excellent, cultivators have been endeavouring to discover a means by which the milk can be obtained at a cost sufficiently low to give a return, but without, as yet, encouraging results. The removal of the outer separable bark has been objected to on the ground that the bark formed in its stead is of a different character, very hard and inseparable from the green layer a second time. Instruments have therefore been devised for bleeding without such removal. A knife with two parallel blades, which took out a strip of bark, has been modified into one in which the very sharp cutting edges meet to form a V, the basal angle during use being at the cambium. Another invention avoids all cutting, being a double spur-like wheel with sharp but guarded points, which puncture the bark without further injury. The milking (one can scarcely call it tapping) has also been practised on trees of various ages and at different intervals and seasons. While it is found that the yield of individual trees varies extremely, none of the experimenters is satisfied that the small quantity obtainable by present methods is sufficient to make the cultivation profitable at the existing price of rubber. Mr. Wall, however, who states that hundreds of young trees have been bled daily with the 'pricker' for some weeks, and that thus a cooly can collect about half a pound of dry rubber per diem, thinks that, if trees will bear this treatment for 240 days in the year, the cultivation would be remunerative. It appears evident that milking must be repeated at frequent intervals, and (as often already pointed out) the cultivation be conducted on a large scale. Much of the 35,000 acres in private hands in Ceylon, at present growing nothing but *Lantana* and other weeds, is suitable for this hardy plant, which costs nothing to cultivate, affords a substance of a value which is continually increasing, and awaits only the discovery of a process by which the latter can be cheaply and exhaustively extracted."

In the *Tropical Agriculturist* for March, 1887, Mr. W. B. Lamont furnished the following results of experiments carried on by him in the districts of Heneratgoda and Mirigama. These may be regarded as the most favourable obtained in the island :—

" Having reared about 100 plants of Ceara rubber up to their fifth year, and having given a good deal of attention to them, I have arrived, through a long course of experiments, at the following practical results :—No satisfactory result will follow any attempt to obtain produce before the tree is at least four years old ; no system of cutting or piercing the bark will give a satisfactory yield ; and it is only in the dry season, when the tree is leafless, and the growth at a standstill, that a satisfactory result can be

obtained in the way of harvesting. The plan of obtaining the rubber that my experiments led up to was, as soon as the leaves begin to fall, to remove the outer bark in vertical strips of not more than two inches wide, and not less than four inches apart. The tender inner bark thus exposed to the sun breaks out in something like running sores, from which the rubber slowly exudes and drips on the surface as fast as discharged. In this process the strip of exposed bark is destroyed, but a vigorous tree will close in the bared part in the course of the year, if the width is not more than two inches. Ceara rubber, planted at 100 trees per acre will, after the second year, require hardly any expense in cultivation. As for harvesting, I collected 30 lbs. last January and February by one boy at 15 cents. a day, or say 23 cents. per lb., the local value being about 80 cents. Supposing each tree gave an average yield of 1 lb. per annum, and allowing 30 cents. for cultivation and collecting, 50 cents. would remain as profit, or R50 per acre. It is well to have the plant in the island, but it is not likely to be largely planted so long as there are other products that pay better, or that are better understood, but a time may come when it will *kep a strait*."

In his *Report* for 1890, Dr. Trimem states :—" Interest in Ceara rubber has of late years very much died away, the yield of rubber having been found too small to satisfy the planter's expectations. Thus I have made no report on it since 1884. There are, however considerable plantations on some estates, and now that the trees are older it is found to be profitable to harvest the product. Several shipments have been made to London during the past year, and have realised very good prices. Of course the quantities have not been large. One shipment of 4 cwt. fetched 1*s.* 8½*d.* to 1*s.* 9½*d.* per lb. net, showing a profit here of about 37 cents. (of a rupee) per lb. A planter estimates the cost of collection at about 36 cents. per lb., and reckons that trees of eight years old afford at least 3 ozs., whilst some ten years old gave half a pound. The collection is done in a somewhat primitive way during the dry season, January to March. After the outer flaky layers of bark have been peeled off. the inner bark is pricked copiously ; the tears of rubber which exude are allowed to dry on the tree, and are picked off, the resulting product being quite like 'Ceara scrap' of commerce, but in small tears."

"The present opinion of planters seems to be that this kind of rubber pays to harvest, but not to cultivate, and they are prepared to destroy their trees to get the crop. But, even on such a system (which has been largely followed here with cinchona), extensive areas of bad soil could surely be profitably occupied with this tree, so grown as to provide a crop annually ready for tapping."

A review of the position in 1893 is given by the *India-Rubber, Gutta Percha and Electrical Trades Journal* of June 8 of that year :—" A few years ago great hopes were entertained in Ceylon as to rubber culture. We regret that the spirited efforts made by many planters have not hitherto been so remunerative as was expected. A fresh instance is just to hand, as the *Tropical Agriculturist* for May, 1893, regrets to learn from Mr. Vollar that his rubber cultivation in Dumbara is not likely to be permanent. The Cearas were originally planted for shade trees for the cacao,

but they have not proved very suitable for this purpose, and will probably have to be cut down. Meantime, perhaps 5,000 lbs. of rubber will be collected on Pallakelle this season; a cooly, by beginning the tapping early in the morning, usually gets 3 lbs. of rubber in the liquid or soft state, which hardens and dries down to perhaps to half that weight. There is no fortune to be made out of this (says our contemporary), considering how long the rubber trees have to grow before yielding an appreciable quantity of milk. Of course, it is the time of waiting, during which so much capital lies idle, that is the great difficulty in the matter. Still, we cannot bring ourselves to think that Ceylon has done with rubber culture. If the climate suits the plant, we believe that colonial energy and enterprise will eventually find out the way to overcome all hindrances."

Dr. Trimen, in his *Report* for 1893 (p. 13), remarks:—"Ceara rubber has not taken any hold on planters here as a permanent cultivation; yet it might, I think, be worked at a profit by a system of annual planting, and the sacrifice of successive crops of trees when they reach ten or twelve years. About 1½ lbs. of dry rubber is at that age obtained from each tree."

The subject is not further touched upon in the Reports of the Ceylon Botanic Gardens. The whole interest in regard to rubber in that island has now been transferred to the cultivation of the Para Rubber tree (*Hevea brasiliensis*).

Madras.

The Director stated in the *Kew Report* for 1880 (p. 17):—"In the Nilgiris, I am informed, Ceara rubber is doing well at 2,400 feet."

The following is the most recent information (*Annual Report of the Forest Department, Madras Presidency*, 1895-96, pp. 29-30):—

"In Ganjám an area of 3 acres in Napier's Park at Chatrapur was planted with india-rubber seedlings and they are doing well, their height ranging from 4 to 9 feet. The sowing of rubber seed in Gódávari was unsuccessful.

"In South Arcot there were at the close of the year 410 trees, including the self-sown seedlings (295) during the year.

"In North Malabar, the sample rubber sent to Kew last year was reported on by the Director, Royal Garden, as follows:—

'First sample.—Well cured, but cuts very wet; value 1*s.* 6*d.* to 1*s.* 8*d.* per lb. [This sample is in Case 96 (now Case 106), Museum No. I, at Kew.]

'Second sample.—Well cured, dry, rather barky; value 1*s.* 9*d.* to 2*s.* per lb.'

"It is proposed to tap the trees after the rains in order to obtain statistics as to the average yield in rubber. The trees grow luxuriantly and reproduce themselves very freely.

"In South Malabar, the Ceara rubber trees are flourishing. It reproduces itself everywhere in Nilambúr. Experimental tapping was made in April, but as the plants were then leafless they did not bleed freely and no rubber was therefore collected. They will again be tapped in 1896–97."

Mysore.

The results of experiments with Ceara rubber plants in Mysore are summed up by Mr. J. Cameron, F.L.S., in his *Report on the Lal Bagh Gardens*, dated April 12, 1886 :—

"Further experience has justified my opinion that the Ceara rubber tree is adapted to the climate. Its cultivation progresses so favourably that every encouragement is offered to plant on an extensive scale. The tree loses its leaves during the driest period of the year, and is thus preserved in a semi-dormant state until the vernal showers excite growth again. Irrespective of their commercial value, deciduous trees of this class are much needed, and in the rocky maidan regions of Southern India would be invaluable. Judging from our own experience, the Ceara rubber tree requires no pampered treatment, although, like most plants, it prefers a little kindness to starvation and utter neglect. It grows very rapidly in vegetable mould, but planted in any ordinary soil, at the break of the South-West Monsoon, the seedling will shift for itself and possibly have taken such a hold on the ground that no artificial watering is required during the subsequent dry season. This is what I have done with a hundred seedlings six months old, on poor gravelly soil, and I am certain that nearly the whole will burst forth into fresh growth when the rains set in. At present they look like so many dead canes. In open land the tree will attain an average height of 30 to 35 feet, with a diameter, through the branches, of 15 to 20 feet. Seedlings might therefore be planted uniformly at 18 feet apart each way. The latter are ready for the field when six months old and about 15 inches high, with a woody base."

The Report of the following year contains further information as under :—

"A ball of Ceara rubber, weighing 6 ozs., has been collected from one or two trees in the garden (chiefly one tree which was growing by a channel and had not lost its leaves, as the trees invariably do in dry ground during the months of March and April). But it was evidently too late in the season, as the milky juice will not run freely when the trees are wintering. I therefore regret that tapping must be postponed again. We have collected 17 lbs. of Ceara seeds for propagation."

Burma.

Colonel E. S. Berkeley, Rangoon, reported in 1884 that "The plants of *Manihot Glaziovii* received from Dr. King in 1879 are growing into robust trees. The climate of Burma seems to suit this plant ; it seeds freely."

Straits Settlements.

Ceara rubber trees were introduced into the Malay Archipelago in 1879, but owing possibly to the excessively damp climate they do not appear to have succeeded anywhere. Mr. H. N. Ridley, F.L.S., regards *Manihot Glaziovii* as quite unsuited for remunerative cultivation in Singapore, and a similar opinion is

expressed in regard to the prospects in the Native States. It is possible, as in Ceylon, that the best rubber plant for regular cultivation in Malaya is the Para rubber tree (*Hevea brasiliensis*).

Mauritius.

The following interesting particulars respecting the propagation of Ceara rubber trees in Mauritius in 1883 were communicated by the late Mr. Scott :—

"Of all the places where the Ceara rubber trees have been planted they appear to thrive better and grow more vigorously at the Gardens, Pamplemousses, than in any other locality. An experiment was made when the trees of three years' growth shed their leaves in transplanting them. These were lifted carefully, but without balls of earth attached to the roots, and planted in another part of the plantation ; these transplants all held, and although they have not made such a strong growth as the other trees, it proves that this tree can be transplanted with impunity."

Further, Mr. Scott states :—

"During the season when the Ceara rubber trees were at rest, they were cut back to about three feet from the ground, and the stems, some of which were 8 feet long, cut into lengths of 6 inches and tied up in grass-enveloped balls of earth, and arranged in beds under shade until they had formed rootlets and thrown up a stem of about four inches high, when they were planted out where it is intended they should grow permanently. By this method 5,800 cuttings were propagated ; these were then divided amongst the plantations in the lower parts of the island."

Seychelles.

Mr. E. H. Edwards wrote on the 1st July, 1885 :—

"Ceara rubber I pronounce a great success, both cuttings and plants raised from seed grow rapidly : it is too early yet to give any opinion as to the yield, but, if growth of wood be any criterion, in the not distant future Mahé should be a rubber-producing country."

Zanzibar.

The following extract is taken from a *Report* on the cultivation of Ceara rubber trees in Zanzibar by Sir John Kirk, dated December 19th, 1883 (*F. O. Reports. Commercial*, No. 11, 1885, pp. 38, 39):—

"Five years ago I received from the Director of the Royal Gardens, Kew, in exchange for plants of our African india-rubbers of the genus *Landolphia*, other sorts of india-rubber giving plants, among which was the Ceara rubber, *Manihot Glaziovii*.

"This I find grows here with the greatest rapidity and propagates itself freely in the worst soil. It is only now, however, I have been able to obtain a sample of the india-rubber likely to be produced, and on which the value of the new introduction entirely depends. I find that trees only begin to yield when five years old, and no doubt these are even then too small to be remunerative.

"I have collected a sample of the produce, which I forward by this mail, and which I would ask your Lordship to be good enough to forward to Sir Joseph Hooker at Kew to be reported on. If the quality of this india-rubber is found to be good, I can then confidently encourage the Sultan to plant widely the new tree in the unoccupied parts of this island. It stands the climate, grows freely, needs no care, and would be a source of income on which his people might fall back in the event of other crops failing.

"The sample sent includes two qualities—that picked from the trunk of the tree, which, of course, is the best, and that fallen on the ground, and so become mixed with sand."

The Report on the samples of Ceara rubber from Zanzibar by the India Rubber and Gutta Percha and Telegraph Works Company, Limited, dated the 7th February, 1884, was as follows :—

"The appearance and general physical properties of this rubber would lead to the opinion of its being derived from the same source as the ordinary Ceara rubber; but the statement in Sir John Kirk's letter above referred to 'that trees only begin to yield when five years old, and no doubt these are even then too small to be remunerative,' is conflicting.

"The quantity of ash obtained from the sample collected from the trunk of the tree amounts to 3·64 per cent., which, together with its composition, are strongly corroborative of its being obtained from the Ceara plant.

"Of the two samples of this rubber which have been received, the one which had fallen on the ground, and had become mixed with sand, was so deteriorated and decayed as to require no further consideration from a manufacturer's point of view.

"The sample collected from the trunk of the tree had such a promising appearance that its unfavourable behaviour under the vulcanizing process was somewhat disappointing; the quantity available for experiment was too small to determine the cause of its becoming spongy and porous.

"Its loss on drying and washing was 23·46 per cent.; this shows that the rubber contains a large amount of soluble matter. Ceara rubber under cultivation in Ceylon gave only a loss of about 7 per cent. under similar circumstances, but obtained from plants about two years old.

"It is by no means improbable that the collection of samples from younger plants may lead to more favourable results.

"The india-rubber collected from the trunk of the tree would be at the present time commercially worth about 1*s.* 9*d.* to 2*s.* per lb. The sample collected from the ground we can put no value to."

Sir John Kirk wrote (Dec. 16th, 1885) as follows in regard to the above Report :—

"As to the Ceara rubber reported on, which proves so unsatisfactory when worked, it is certainly the product of trees I first received from you as *Manihot Glaziovii*. I am quite satisfied the tree is *here* of no use to a private planter. Some trees yield a watery juice with almost no rubber, and at best the amount is

small. I have, however, had the seed widely scattered on the mainland over 300 miles of coast, and as it seems to grow so well and propagates so freely, it may be a resource to the natives, and repay them the trouble. Perhaps inland, in less moist climates, the produce may be better, but I have condemned the tree as useless to a European planter, and a troublesome weed where once introduced into a plantation."

Natal.

The *Kew Report* for 1880 (p. 18) records :—

"Mr. Keit, the Curator of the Botanic Garden, reports that the Ceara rubber plants raised from seed obtained from Ceylon in 1878 have grown luxuriantly, and had flowered, but had not had time at the date of his last report (December 31, 1880) to perfect their seeds."

The climate and soil in 1884 were found well suited to the growth of the plants, little progress has, however, been made in extending the cultivation. Mr. Wood, the Curator of the Botanic Garden, Durban, reported, 1885 :—

"The plant, which yields 'Ceara scrap,' is considered to be one of the most valuable of the rubber-yielding plants, and was introduced into these gardens from Kew, in 1878, but all attempts to propagate it were unsuccessful. In consequence, however, of further information received by me from abroad, another trial was made, and about 25 plants were reared and planted out in the garden, and thus a small beginning has been made, to test whether or not the cultivation of this plant may be successfully carried out in the Colony. The present appearance and condition of our plants shows unmistakably that the climate and soil of our garden is well suited to its growth. More plants will be ready for next spring, as we shall go on propagating them as quickly as possible for distribution."

West Africa.

As might be expected the humid climate in the lowlands in West Africa has not been favourable to the production of Ceara rubber. An exception must, however, be made in the case of the Gambia, which possesses, on the whole, a drier climate with a light sandy soil. The Administrator in 1888 (*Kew Bulletin*, 1889, p. 144) stated that plants sent out from Kew thrive "vigorously in the soil of the Gambia, and their introduction here cannot fail to be of immense advantage to the settlement. I have transplanted several young trees in the spaces now made available for experiments of this nature, and have no doubt that they will be successfully established."

Jamaica.

The *Kew Report* for 1880 (p. 17) gave the following particulars, supplied by Mr. Morris :—

"This plant is evidently very hardy, and adapts itself readily to the exigencies of culture. Plants at Castleton (600 feet) and at the Parade Garden, Kingston (50 feet), are doing well. At

the former gardens, young trees when about 9 to 12 feet high were beginning to flower, but the hurricane deprived us of the hope of procuring seed this year. Judging by reports from South America it is possible that tracts of dry, stony, almost worthless lands, in the plains may be turned to good account by means of this cultivation."

The *Report of the Botanical Department* for 1884, states :—"Of the Ceara rubber there are seven large trees at the Castleton Gardens; the largest is about 25 feet in height, with a circumference of 28 inches about one foot from the ground. It appears to be more at home than any of the other species of rubber-yielding plants at Castleton.

"Being anxious to obtain a small specimen of Ceara rubber the trees at Castleton were tapped early in September. Although the trees are strong and healthy the flow of milk was certainly very small. When the trees were tapped they were bearing a heavy crop of both flowers and fruit. It is intended to try them again later."

The *Report* for 1886 states further :—"The trees of Ceara rubber in the several gardens continue to grow well, but no rubber has yet been prepared from them."

Dominica.

The early account of Ceara rubber trees in this island was communicated to Kew by Dr. H. A. Alford Nicholls, in 1884, as follows :—

"This is now established in the island, and the tree has taken very kindly to the soil. From small experiments I have made, the juice appears to be abundant and very rich in rubber in the dry months. The seeds have been borne abundantly, and I have distributed them to planters here and in Grenada."

Later Information.

The most recent account of Ceara rubber in South America has been obtained as the result of a visit made to the north-east coast of Brazil by Mr. Esme Howard and Mr. R. H. Biffen, Demonstrator in Botany at the University of Cambridge.

The following letter, addressed to the Governor of Jamaica by Mr. Howard, was published in the *Jamaica Bulletin* (Vol. IV., p. 242):—

"I have been travelling in Mexico and Brazil for some months to examine the habits of the different rubber-producing plants of those countries with a view to finding out which are the most suitable for plantations. In Ceara, Brazil, I bought several thousand seeds of *Manihot Glaziovii*, which I think will grow well in many parts of the West Indies, meaning to distribute them in various islands for the purpose of experiment. It seems to me that parts of Jamaica would be well suited for the cultivation of this tree, which produces a good rubber, fetching at present where well collected and cured, the second highest price of any rubber on the market, *viz.*, about 3*s.* 3*d.* per lb. *Manihot Glaziovii* will

grow well on hill sides in a rocky and rather poor soil. We found it growing in Ceara up to a height of 3,600 feet above the sea. It is a rapid grower and can be tapped in five years after planting, provided it has grown well. I believe a rainfall of about 100 inches or more is most suitable for it, but it will do with much less, say 65 or 70 inches."

The occurrence of the plant at an elevation of 3,600 feet, and the wide range of conditions under which it appears to thrive are facts that have not hitherto been fully recognised. It is quite possible that we may yet see successful plantations of Ceara rubber trees established in districts that have been regarded as unsuitable, and under conditions that may afford a sufficient yield of rubber to render the enterprise remunerative. Mr. Biffen has been good enough to furnish the following particulars as the result of personal observations on trees in the wild state :—

"The leaves fall in August and September. Seeds produced very abundantly ; ripe in September ; they keep their power of germination well. The tree is apparently very liable to a dry-rot, for rotten branches are continually falling.

"Growth is very rapid : in Baturité we saw one-year old plants 10 to 12 feet high ; in five to six years it is ready to tap ; then it is some 25 feet high and 8 to 9 inches in diameter.

"Propagated either from cuttings or from seeds. So far nurseries have failed in Ceara. Shade for established trees is unnecessary. Large plantations are now being made in the district.

"The tree has a singularly wide range of conditions ; it grows in the desert plains where rainfall is said to be under 50 inches, and the vegetation is scorched up for the greater part of the year ; also, in the mountains (plantation at 3,500 feet at Monte Alegre) where rainfall, I should say roughly, is over 100 inches. In the mountains the temperature falls even below 60° F. at night.

"The tree is never found in marshy soil ; apparently it thrives best in somewhat scanty soil among granite boulders.

"The rubber is exported in three forms :—(*a.*) In pale yellow-brown threads, $\frac{1}{4}$ inch in diameter and several inches in length, obtained by peeling off the thin layer of old bark and making a slight incision with a narrow-bladed axe. A small quantity of latex flows and coagulates on the trunk. (*b.*) In small flat cakes prepared by tapping the base of the tree and allowing the latex to flow on the ground and coagulate there. Hence the rubber contains large quantities of dirt on its lower surface which is removed to a certain extent by rubbing in coarse-meshed sieves. (*c.*) By smoking with the vapour from the burning nuts of a palm, in a similar manner to Para rubber. So prepared it contains a large quantity of water, which partially sweats out on exposure to the heat of the sun. The exudation on evaporation leaves a brown resinous substance. This last method is becoming very general.

"To collect the latex small tin cups are used ; each tree is tapped 80 days, divided, by an interval of about three months, into two periods of forty each. Under this system the tree is said to live for 15 to 20 years.

"The tapping is always done in the dry season—from July to December.

"The average yield per tree is from ½ to 1½ kilos. (1 to 3 lbs.) per year; coagulation may be effected by churning, or by the addition of an excess of water, or salt solution. In the former case the rubber particles which are unprotected by any film (as the fat particles of milk are) simply adhere to form a mass.

"In the case of the addition of excess of water, salt, or smoking, coagulation is brought about by means of the globulin present (Green, *Proc. Roy. Soc.*, 1886, p. 39). This coagulates at 74–76° C., or on dilution, etc., and tangles up the rubber particles in its meshes, much as white of egg gathers up particles in suspension when used for clearing jellies."

Summary.

The result of experience so far gained in the experimental cultivation of the Ceara rubber plant may be summarised as follows:—

1. The plant is readily propagated both from seeds and cuttings. Seeds are abundantly produced in almost every part of the world where the plant has been introduced. They may be gathered from plants when only three to five years old. There is therefore the great advantage that a large area could be planted within a comparatively short period. Sowing the seeds in the position where they are to grow permanently is universally adopted in Brazil. It is possible, if adopted elsewhere, this plan would greatly reduce the cost of establishing plantations.

2. The Ceara rubber plant is very hardy, a fast grower, free from insect and fungoid attacks, requires little or no attention when once established and thrives in poor, dry and rocky soils unsuited to almost any other crop. It is evident, however, that the yield of a few trees cannot be remunerative and only large areas can hope to make the industry a paying one.

3. It produces a good class of rubber, second only when well prepared to the best Para rubber. For this there is a steady and continuous demand. The yield per tree is apparently small, but a return is obtained earlier than from any other rubber plant. With thick planting and judicious thinning as the trees grow up, it may be possible to increase the yield hitherto recorded; while with skilful treatment the permanent trees may be tapped twice yearly and last in a productive state for 15 to 20 years.

4. In spite therefore of the apparent want of success which so far has attended experiments with Ceara rubber plants in Ceylon and other countries, the increasing importance of rubber as an article in large demand in all civilized countries at good prices, suggests a reconsideration of the merits of this interesting plant. In many of our colonies possessing a dry climate and a poor stony soil, it is possible that large areas could be profitably occupied with Ceara rubber trees so grown as to provide annual crops for tapping.

XXVIII.—COLOMBIAN INDIA-RUBBER.

(*Sapium biglandulosum*, Muell. Arg.)

[*K.B.*, 1890, pp. 149–158.]

The United States of Colombia have long been recognised as a subsidiary source of india-rubber. Colombian rubber has been generally known in commerce from the place of export as "Carthagena." It has been supposed to be the produce of a species of *Castilloa*, and this may to some extent have been actually the case. The larger proportion of the export found its way to the United States.

In the following correspondence, Mr. Robert Thomson, formerly in charge of the Cinchona plantations, Jamaica, and now settled at Bogota, gives an interesting account of a tree which yields the india-rubber, known in commerce as "Colombia Virgen." This has the peculiarity, unlike all other known sources of this substance, of growing at high elevations, and therefore in a comparatively cool climate.

From the indications furnished by Mr. Robert B. White, and subsequently by Mr. Thomson, there can be little doubt that the tree is one of the multiform varieties of *Sapium biglandulosum*, a member of the family *Euphorbiaceae*, to which the trees yielding the Para and Ceara rubbers also belong. This widely spread and extremely variable species extends from Mexico and Panama to Colombia, Venezuela, Guiana and Brazil. The variations which it presents in habit are probably as extreme as are to be met with in the vegetable kingdom. And it is probable that its rubber-producing qualities may be equally variable. In the West Indies it exists in forms which are probably conspecific. But though recognised as abounding in a milky juice it has never been regarded in that region as a source of caoutchouc, at any rate in appreciable qualities.

In British Guiana the species occurs in two forms, which have been carefully studied by Mr. G. S. Jenman, F.L.S., Government Botanist. The form which occurs on the Pomeroon River is known in Carib as *Touckpong*, in Arawack as *Cumakaballi*. The examination of the caoutchouc-like product of this tree, conducted at the works of the India-rubber, Gutta Percha and Telegraph Works Co., Limited, at Silvertown, through the courtesy of Mr. S. W. Silver, F.L.S., were, on the whole, unsatisfactory as regards its utilisation for any commercial purpose. This was due to the presence of a resinous substance, which seriously deteriorates its characteristic properties. There can, however, be no sort of doubt as to the value of the Colombian rubber yielded from the same species, and this would make it desirable to give the Guiana trees a fresh trial. M. Sagot, the well-known Guiana botanist, to whom Mr. Jenman's specimens were submitted, knew nothing of the caoutchouc-producing properties of the species beyond the fact that the aborigines of the West Indies used the sap as a bird-lime for catching birds.

INDIA OFFICE to ROYAL GARDENS, KEW.

India Office, Whitehall, S.W.
January 26, 1889.

SIR,

I AM directed by the Secretary of State for India in Council to forward, for your information, a copy of a correspondence on the subject of a proposal made by Mr. Robert Thomson, of Bogota, in connection with the introduction to India of the species of *Hevea* [Sapium] which produces the rubber known as the "Colombia Virgen."

You will observe that the Government of India are desirous that Mr. Thomson's proposal should be submitted to you in the first instance, and I am to ask you to be so good as to favour me with any remarks you may wish to make on the subject.

I have, etc.,
(Signed) J. A. GODLEY.

The Director,
Royal Gardens, Kew.

Mr. ROBERT THOMSON to INDIA OFFICE.

Bogota, Republic of Colombia,
July 23rd, 1888.

MY LORD,

I HAVE the honour to submit the following remarks relative to a species of india-rubber tree indigenous to this country, it having occurred to me that the introduction of the cultivation of this species would be attended with important results to India.

This rubber is known in commerce as "Colombia Virgen." It has been exported chiefly to the United States, and next to the Para rubber it has realised the best prices in the market. But the Para rubber undergoes elaborate preparation for the market, whereas the Colombia Virgen is simply dried in the sun and by fire; hence it is capable of much improvement. As far as I am aware, this plant has not been botanically described, but it is Euphorbiaceous, and is closely allied to the genus *Hevea*, the Para rubber plant.

I have established in this country during the last five years a plantation of this rubber consisting of about 70,000 trees, this being, I believe, as yet the only plantation made of this sort. Under cultivation this tree thrives admirably, growing with great rapidity, and averaging about five feet a year.

Crops are obtainable in from six to eight years, but a tree five years old yields as much as 1 lb. of rubber. It is a large forest tree, the trunks attaining six and seven feet in circumference. Four arrotas (100 lbs.) of rubber have been extracted from a single tree, but the average yield is far less.

All the well-known South American rubber plants, viz., the Para, Castilloas, and Ceara have been introduced into India. But the species under consideration is not, I believe, known in India.

The important consideration as regards this species, apart from its intrinsic value, is that it grows at great elevations on the

Colombian Andes, viz., at from 6,000 to 8,000 feet above the sea; hence in a salubrious mountain climate, a condition of cultivation of prime importance in the estimation of the planters of India and Ceylon, for the planters appreciate the advantage of growing a product in the genial climate of the mountains as compared with cultivation in the malarious climate of the plains. The conditions of climate requisite for the other species of rubber are described by Mr. Gustav Mann, an authority on Indian products, thus, "the heat is about 98° in the shade in Upper Assam. Under these conditions, which are of excessive moisture, even partial inundations during a portion of the year, caoutchouc trees of all countries thrive best." The Ceara rubber, however, grows in hot *arid* regions.

Prior to the wholesale destruction of this tree (but few now remain) by the rubber collectors, I explored, some five years ago, the forests wherein it abounded in order to examine the soil, climatic and other conditions affecting its growth. It may be mentioned that its area of distribution has been peculiarly limited to a small section of the Cordilleras some 1,500 miles from the sea. The total quantity of rubber exported during the few years the article existed could not have amounted to many hundred tons.

It is very difficult to propagate the tree from cuttings; hence I have had to resort, during my supervision of the plantation, to propagation from seed, which, moreover, were always procured with much difficulty.

Efforts are being made in India to cultivate the *Ficus elastica* on a large scale, which, according to Mr. Clements R. Markham, "may be tapped in 25 years"—a long time to wait for a crop, a fact which must dissuade planters. The Colombian species, beside being adapted to a salubrious mountain climate, yields early returns and a more valuable product.

I would undertake to convey to India a supply of plants and seeds, the germination of the latter to be ensured on the spot, and to deliver the same in Sikkim, the Nilgiris or Ceylon. The supply of plants thus to number from 10,000 to 50,000, which I would deliver for the sum of £1,000.

* * * * * *

I have, etc.,
(Signed) ROBERT THOMSON.

The Right Hon. Viscount Cross,
Secretary of State for India,
London.

INDIA OFFICE to the GOVERNOR-GENERAL OF INDIA.

India Office, London,
20th September, 1888.

MY LORD,

I FORWARD herewith a copy of a letter, of the 23rd of July last, from Mr. Robert Thomson, of Bogota, in the Republic of Colombia, drawing attention to a new species of *Hevea* (N. O. *Euphorbiaceæ*) as a valuable source of rubber, and recommending its experimental cultivation in India.

2. Mr. Thomson offers to personally deliver "from 10,000 to 50,000" established seedlings in India for the sum of £1,000. After you have consulted the officers of the Forest and Botanical Departments I shall be glad to have the opinion of your Excellency's Government on this proposal.

I have, etc.,

(Signed) CROSS.

His Excellency the Right Hon.
the Governor-General of India
in Council.

GOVERNMENT OF INDIA to INDIA OFFICE.

Revenue and Agricultural Department,
Calcutta, 4th December, 1888.

MY LORD,

WE have the honour to acknowledge the receipt of your Lordship's Despatch No. 80 (Revenue), dated the 20th September last, forwarding a copy of a letter from Mr. Robert Thomson, of Bogota, in the Republic of Colombia, South America, in which he draws attention to a new species of *Hevea* (N. O. *Euphorbiaceae*) as a valuable source of rubber, and recommends its experimental cultivation in India. Mr. Thomson has offered to personally deliver from 10,000 to 50,000 established seedlings in India for the sum of £1,000, and your Lordship desires, after we have consulted the officers of the Forest and Botanical Departments, to be furnished with our opinion on the proposal in question.

2. In reply, we beg to say that in the absence of any safe information as to whether the plant would yield rubber in sufficient quantities to justify the expenditure proposed, or, indeed, as to whether the plant would grow at all in India, we do not think it expedient to entertain Mr. Thomson's proposal. We would therefore suggest, for your Lordship's consideration, that the Director of the Royal Gardens, Kew, should be asked to place himself in communication with Mr. Thomson, and if Mr. Thiselton-Dyer, after due consideration of the matter, is of opinion that the proposed experimental cultivation of the plant in India is really worthy of a trial, arrangements might be made, under your Lordship's orders, for the purchase and transmission to this country of a few plants only, or of a small supply of the seed. This procedure would be in keeping with the course approved by past experience, viz., that all new economic plants should reach India through the Director of the Royal Gardens, Kew.

We have, etc.,

(Signed) DUFFERIN AND AVA.
C. A. ELLIOTT.
P. P. HUTCHINS.
D. M. BARBOUR.

The Right Hon. Viscount Cross, G.C.B.,
His Majesty's Secretary of State for India.

ROYAL GARDENS, KEW, to INDIA OFFICE.

Royal Gardens, Kew,
July 8, 1889.

SIR,

I HAVE had before me for some time your letter (R. S. & C. 1784) of January 26, 1889, forwarding a copy of correspondence with Mr. Robert Thomson, of Bogota, relative to the proposed introduction into India of a species of *Hevea* which produces the rubber known as Colombia Virgen.

2. Having regard to the very large expenditure which the Government of India has already incurred in the introduction of South American rubber trees into India, I confess I am not disposed to support any further outlay upon it. The plants yielding Para, Ceara, and Nicaragua (or Guatemala) rubber have all been successfully introduced into India. It now only remains by practical experience to find positions in which they may be established on a sufficient scale to yield in the not distant future a remunerative revenue to the Government or to the private planter. My own conviction is that the cultivation of these trees is emphatically a matter to be entrusted to the Forest Department. And I have deliberately waited before dealing with Mr. Thomson's application till the Secretary of State in Council had had the opportunity of considering the interesting results which I communicated to you in June 4th last, and the receipt of which you acknowledge on the 29th following (R. S. & C. 922), of the examination of samples of rubber from Para-rubber trees (*Hevea brasiliensis*), near Mergui in Tenasserim.

3. It appeared from Mr. Silver's report that rubber collected from these trees, on which it had congealed without any preparation at all, was valued at 2*s.* 3*d.* a pound, and was nearly equal to the best South American rubber. This disposes of Mr. Thomson's statement that "Para rubber undergoes elaborate preparation for the market."

4. There are considerations, with which I need not trouble you, why I should hesitate to recommend Mr. Thomson's employment. But I may point out that the only real recommendation of the species of rubber which he wishes to introduce into India is that its cultivation is suitable for high levels. It appears to me more than doubtful whether land adapted to the tree would not in India and Ceylon be generally devoted to other cultures likely to yield more profitable results than india-rubber.

5. As far as I am aware nothing is known to botanical science of the tree recommended by Mr. Thomson. I propose therefore to write to him to ask him to send botanical specimens for its identification, and also a few hundred seeds, for which I shall be prepared to pay a small gratuity from the annual sum placed at our disposal by the India Office for inquiries relative to economico-botanical subjects.

6. I entirely concur in the wise hesitation shown by the Government of India in entertaining Mr. Thomson's proposal without the precise and definite information on the subject which we do not at present possess.

I am, etc.,
(Signed) W. T. THISELTON-DYER.

J. A. Godley, Esq., C.B.,
India Office.

ROYAL GARDENS, KEW, to MR. R. THOMSON.

Royal Gardens, Kew,
July 16, 1889.

SIR,

I AM desired by Mr. Thiselton-Dyer to inform you that your correspondence with the India Office on the subject of "Colombia Virgen" rubber trees has been referred to him with the decision of the Government of India on the subject.

2. As no doubt you are aware it has been resolved, in the absence of accurate information respecting the nature and value of these rubber trees, that this establishment place itself in communication with you and obtain botanical specimens for the exact determination of the species, and also some plants or seed for experimental trial at Kew.

3. If you are disposed to accede to the wishes of the Government of India, Mr. Thiselton-Dyer is prepared to authorise you to incur expenses in the first instance to the extent of five pounds in procuring botanical specimens, and in sending some seeds or plants of this particular kind of rubber to this country.

I have, etc.,
(Signed) D. MORRIS.

Mr. R. Thomson,
Bogota, Republic of Colombia.

Mr. R. B. WHITE to ROYAL GARDENS, KEW.

Agrado, January 12th, 1890.

MY DEAR SIR,

I HAVE been trying to get the flowers and seeds of the cold region india-rubber tree, but it is pretty clear that hereabouts it is not the flowering season. I think there is little doubt of its being a species of *Siphonia*. It is not a *Ficus*.

At elevations of 3,000 to 4,000 feet a *Ficus* has produced much india-rubber, but this—the best white Virgen—comes from 5,000 to 7,000 feet elevations, and is another thing entirely. Its mean temperature is about 50° to 60° Fah.

I know the tree giving the white rubber of Choco in years gone by, growing in the hot climate. It is a *Siphonia* and its habit is very similar to the cold country tree.

Ficus are usually irregularly branched and are not so straight. The milk of this tree coagulates directly it is taken from the tree. Most india-rubbers do not, and many have to be coagulated by alkalis. Some of the milks can be kept for weeks, and articles may be painted with them, when the rubber will dry and make a good hard coating. I have mended my air pillows, &c., in this way.

But this cold region rubber will not keep, and it evidently contains much more caoutchouc (caucho is better) than the other sorts.

I expect that it will turn out that the tree flowers in May, and has seed in June or July, and then I will try again to get you

specimens. The trees have become so scarce in the most accessible parts that it is both troublesome and expensive to get samples, but I will do my best.

I am, etc.,
(Signed) ROBERT B. WHITE.

W. T. Thiselton-Dyer, Esq.,
Director, Royal Gardens, Kew.

P.S.—I enclose a leaf with its scaly stipules and peculiar glands (?) at base. The leaves are alternate whorled.

[There could be little doubt that this leaf belonged to a form of *Sapium biglandulosum*.]

Mr. R. THOMSON to ROYAL GARDENS, KEW.

162, Belsize Road, London, N.W.
14th May, 1890.

SIR,

WITH reference to the conversation I had with Mr. Morris, the Assistant Director, on the 26th ultimo, on the subject of my correspondence with the India Office relative to the introduction into India of the cultivation of Colombia Virgen rubber, I respectfully beg leave to submit the following remarks:—

As I informed Mr. Morris it is to be regretted that your letter on this subject, addressed to me in Colombia, never came to hand. I now have to thank you for a copy of the lost letter dated the 16th July, 1889, which I received some days ago.

Having informed Mr. Morris that I possess drawings of the inflorescence, &c., of this species of rubber, at his suggestion I submitted the same to Professor Oliver (Keeper of the Herbarium) for identification. Professor Oliver in a note to me says "I can hardly doubt that your rubber plant is *Sapium biglandulosum*, a variable tropical American species, and known rubber producer." Subsequently the Professor showed me the Kew Herbarium specimens of *Sapium biglandulosum*, obtained from British Guiana, &c.

My impression, judging from these specimens, is that the Colombia Virgen is quite a distinct species. In the latter there is very slight variation in the size of the leaves, whereas in the Guiana specimens the variation is extremely marked. The leaves, too, in the Colombia Virgen are in point of size several times larger than the others. Also the glands at the base of the leaves are several times larger than those in the Guiana specimens.

In addition to the rubber-yielding species in question there are several very distinct species of this genus widely distributed in the interior of Colombia, all of which contain large quantities of milky juice, which, however, does not coagulate on exposure to the air, as is the case with the rubber-yielding species. Thus, on account of the milky juice not coagulating on exposure to the air, these kinds have never been utilised for commercial purposes.

At the same range of altitude at which the Colombia Virgen grows, two very distinct species of the same genus abound. The latter are easily distinguished by the rubber collectors (coucheros) by the size of the fallen foliage, as well as by the size, colour, and texture of the trunk. The foliage, fruits, and seeds are small as

compared with the rubber producer. These species are found at altitudes ranging from 5,500 to about 8,000 feet above the level of the sea.

Descending the slopes of the forest-clad mountains from the lower elevations at which the Colombia Virgen grows (5,500 feet), another distinct species occurs at an altitude of about 3,500 feet. This species presents a striking resemblance to the Colombia Virgen, and it can only be distinguished after considerable experience. This kind, too, yields only a milky juice. Lower down the mountains still another species extends, viz., from about 3,500 to 2,000 feet above the sea. This latter is found on land denuded of forest, and in regard to its general aspect, foliage, &c., it approximates very closely to its rubber congener, so much so, indeed, that at first sight it is easily mistaken for the other. All the species are characterised by the two glands at the base of the leaves.

It may be here mentioned that some three years ago a distinct variety of the Virgen rubber was discovered at a considerably lower altitude than that at which the species in question grows, thus at about 4,000 feet above the sea. This variety existed only on a very circumscribed area, and all the trees were felled and the product extracted with great celerity. The prices obtained for this corresponded exactly with those obtained for the typical article.

During the past fortnight I have been making enquiries at museums, &c., in London with the view of ascertaining whether a sample of the rubber is on exhibit here. Only at Mincing Lane I have detected samples of the Colombia Virgen. There it is designated "Colombia scrap," and the expert in charge of this department informed me that the current rate of value of this rubber is 3*s*. per pound. That gentleman further informed me that there can be no doubt that if large consignments of this were obtained from Colombia instead of insignificant quantities, the price of the article would be enhanced, for manufacturers adapt, to some extent, their machinery to the class of article under treatment.

I herewith forward some 3,000 seeds of the Virgen species. These seeds were collected fully a year ago, but I have succeeded in the germination of seeds four years old.

Having resided during seven years on the spot, between 3° and 4° N. latitude, where these rubber trees grow, I am well acquainted with the conditions of soil, humidity, and temperature requisite for the successful cultivation of the plant. For further information on this point I beg to refer you to my letter dated the 23rd July, 1888, to the Secretary of State for India.

In conclusion I may mention that in India the best localities for this cultivation would be obtainable at points between 20° and 26° latitude, and at elevations of from 2,500 to 5,000 feet above the sea. Of course, in more southern latitudes higher elevations would have to be selected.

I have, etc.,
(Signed) ROBERT THOMSON.

W. T. Thiselton-Dyer, Esq., C.M.G., F.R.S.,
Director, Royal Gardens, Kew.

MESSRS. HECHT, LEVIS AND KAHN to ROYAL GARDENS, KEW.

21, Mincing Lane, London, E.C.
17th May, 1890.

DEAR SIR,

IN answer to your yesterday's letter we beg to say that Colombian scrap rubber has been known in the market for the last few years, and is of a very superior quality indeed.

It would be difficult to give you the exact average market value, but it has varied during the last few years between 2*s*. 3*d*. and 3*s*. per lb.

At the present moment the value is about 2*s*. 11*d*. to 3*s*.

In accordance with your desire, we are sending you to-day a small sample, which will show you the fine texture of this rubber.

We are, &c.,
(Signed) HECHT, LEVIS AND KAHN.

John R. Jackson, Esq.,
Royal Gardens, Kew.

INDIA OFFICE to ROYAL GARDENS, KEW.

India Office, Whitehall, S.W.
14th June, 1890.

SIR,

I AM directed by the Secretary of State for India to inform you that Mr. Robert Thomson, of 162, Belsize Road, N.W., has forwarded to this Office a copy of your letter to him of the 24th ultimo on the subject of the Colombia Virgen rubber.

As Mr. Thomson is desirous of knowing whether the Government of India will be likely to undertake the experimental cultivation of this tree, I am to ask you to be so good as to furnish this Office with the definite information concerning Colombia Virgen which is alluded to in paragraph 4 of your letter quoted above, and at the same time to state whether the opinion concerning the introduction of this variety of rubber into India expressed in your letter to this Office of the 8th July last, has been in any way modified by the information now in your possession.

I am, etc.,
(Signed) J. A. GODLEY.

The Director,
Royal Gardens, Kew.

ROYAL GARDENS, KEW, to INDIA OFFICE.

Royal Gardens, Kew,
June 18, 1890.

SIR,

I HAVE the honour to acknowledge the receipt of your letter of June 14th (R. & S. 772).

2. We are advised by competent brokers that "Colombian scrap rubber has been known in the market for the last few years, and is of a very superior quality indeed." Its present value is about 2*s*. 11*d*. to 3*s*. per pound.

3. I wrote to Mr. Thomson in the sense of paragraph 5 of my letter of July 8th, 1889. I agreed to pay him £5 for botanical specimens adequate for the determination of the tree and for a supply of seeds for experimental cultivation. This letter apparently never reached Mr. Thomson. From the indications, however, which he has supplied to us as to the tree which he affirms produces Colombia Virgen, we believe it to be *Sapium biglandulosum*.

As the species of this genus are known to yield a milky juice and it belongs to a family, *Euphorbiaceæ*, which includes the plants yielding Para and Ceara rubber, the identification is probable accurate. The seeds furnished by Mr. Thomson failed to germinate.

4. I still remain of the opinion expressed in paragraph 2 of my letter of July 8th, that the slender results which have accrued from the large outlay incurred by the Government of India in introducing South American india-rubber plants into that country are not such as to justify any further present expenditure in the matter. As I pointed out in paragraph 4, on high level land Colombia Virgen would have to compete with other cultures likely to yield a quicker return. I do not see that the Government of India need interfere in the matter. If the profits of its cultivation are likely to prove remunerative, in my opinion it may well be left to private enterprise.

5. I propose to embody the information which I have obtained in a note for the *Kew Bulletin*. This will doubtless have the effect of drawing the attention of practical planters to the subject.

I am, etc.,
(Signed) W. T. THISELTON-DYER.

J. A. Godley, C.B.,
India Office.

XXIX.—LAGOS RUBBER.

(*Ficus Vogelii*, Miq.)

[*K. B.*, 1888, pp. 253–261.]

The investigation of plants likely to yield the caoutchouc of commerce is being carried out in West Tropical Africa by numerous correspondents of Kew. Possibly in no other part of the world is there such a wide field for investigation of this kind, and in recent years a considerable trade in india-rubber has arisen through the exertions of officials and traders who have given attention to the subject.

A useful summary of information respecting West African rubbers is given by Captain Moloney in the *Forestry of West Africa*, pp. 78–95. At present the chief rubber-yielding plants on the west coast appear to belong to species of *Landolphia*. These are climbing shrubs with stems 4 to 6 inches in diameter near the ground, but dividing above into numerous branches which support themselves on the neighbouring trees. The rubber of the Gold Coast, known in commerce as Accra rubber, is the produce of *Landolphia owariensis*, Beauv. This is probably the best

rubber plant in West Africa. The rubber is obtained by cutting off portions of the bark in strips varying in length from 3 to 10 inches. The cuts are made sufficiently deep to reach the latex canals, and soon the crude juice starts out in drops and gathers on the newly-cut surface. The rubber of the *Landolphia* coagulates on exposure to the air and requires no preparation other than rolling it up into balls. "A quantity of the milk is first dabbed "on the forearm of the operator, and being peeled off forms a "nucleus of the ball. This nucleus is applied to one after another "of the fresh cuts, and being turned with a rotary motion the "coagulated milk is wound off like silk from a cocoon. The "coagulation takes place so rapidly on exposure to the air that not "only is every particle cleanly removed from the cuttings, but "also a large quantity of semi-coagulated milk is drawn out from "beneath the uncut bark, and during the process a break in the "thread rarely occurs." [Kew Report, 1880, p. 40.]

Another method of collecting West African rubber is described as follows: The blacks wipe off the milk with their fingers and smear it on their arms, shoulders, and breasts until a thick covering of rubber is formed. This is peeled off their bodies and cut into small squares, which are then said to be boiled in water. In European markets such rubber appears in more or less agglutinated masses of small cubes. Specimens of such rubber are shown in the Kew Museums under the name of Thimble rubber [*ib.*, p. 39].

The quantity of rubber exported annually from West Africa from British and other possessions is about 30,000 cwt. The value in 1885 was £265,617.

It appears that in some districts, such as the Gaboon, owing to the reckless destruction of rubber vines the trade is becoming less and less every year. In the other districts the trade is gradually increasing. Attention has been specially directed to rubber plants in the colonies of Gold Coast and Lagos, and owing in a great measure to the interest taken in the subject by Captain Moloney, the exports from these British possessions have risen from nothing in the year 1882 to a value in 1885 of £69,911.

There are doubtless other plants in West Africa from which commercial rubber might be obtained. The Mbungu rubber plant is *Landolphia florida*, Bth. This is distributed over the whole of Central Tropical Africa. There are also several species of Ficus, the original genus yielding commercial rubber, which deserve to be investigated.

We are glad to find that following the enterprising example of the Governor of the Colony of Lagos, Captain A. C. Moloney, C.M.G., Mr. Alvan Millson, Commissioner of the Western District residing at Badagry, has recently given attention to the preparation of commercial rubbers from the latex of the trees generally known there as "Abba" trees. Mr. Millson previous to taking up his duties at Lagos had served in British Honduras, where he had become acquainted with the preparation of what is known in commerce as Nicaragua or Central American rubber, the produce of *Castilloa elastica*. A contribution on this latter subject from Mr. Millson will be found in the *Kew Bulletin* for the month of December 1887, p. 14 [p. 172].

The investigations undertaken by Mr. Millson in West Africa are described in the following notes, which have been communicated to this establishment by the Secretary of State for the Colonies :—

Badagry, 15th April, 1888.

In nearly all the native villages of the western district of the Colony of Lagos, and, I believe, throughout the colony and interior, are to be found large spreading trees, which have been planted for shade in the market places, streets, and compounds. These trees are of the fig family, and are called by the natives *Abba*.

I have measured a tree of this species of the age of 13 years, and found its girth, at 3 feet from the ground, to be 6 feet 4 inches, and its height to the branches 12 feet, while its total height could not be less than 50 or 60 feet, and its foliage area a quarter of an acre. A tree of this size ought to give large quantities of milk if tapped at the right time of the year. Although it was in fruit when I tapped it, and the season being very dry, was in every respect unsuitable, yet the milk exuded in large drops, and flowed for a considerable distance down the trunk. Three quarts of milk were extracted from this tree without injuring it in any way, and I have little doubt that at any time between the months of July and February from four to five gallons could have been obtained with but little trouble. The trees, however, should only be tapped on alternate years, so as to leave time for a fresh growth of bark to replace that which is removed. It is difficult to form an accurate estimate of the percentage of dry rubber that would be yielded by a gallon of milk, but I have reason to believe from previous experiments on Central American rubber trees (*Castilloa elastica*) of similar richness of milk, that each gallon should give about three pounds of india-rubber. The value of the rubber produced depends largely upon the care with which it is prepared, and I have reason to believe that the milk of this species, at least, of the "Abba" tree, can be made to give an excellent sample.

Should the above facts be established, it becomes evident that plantations of the "Abba" tree would be a highly profitable investment. It is planted by the simple method of cutting off a branch and pushing it into the ground, and on account of the facility and rapidity with which it is raised, the natives use it largely for fence posts. From the trees already in full growth in the bush and towns a considerable export trade could be readily established, and careful planting would develop this trade to almost an unlimited extent.

The rubber gatherer has no need of expensive implements or heavy baggage when he goes into the bush to collect and prepare the milk. He should take half a dozen or more well-cleansed kerosine-oil tins. With these tins, a sharp cutlass, a few yards of strong cotton cloth, and a sieve made of doubled muslin fastened like a jelly bag to a round hoop, he has all that he absolutely requires for his work.

On reaching the tree to be tapped, deep incisions are made on one side only of the stem and branches. The milk, as it flows from the incisions, is directed into the collector's vessel by a small piece of tin which is inserted into the bark so as to serve as a spout,

When the day's work is done, the milk should be mixed with an equal quantity of pure rain water, and strained through the sieve into clean kerosine-oil tins, which have been well scalded so as to remove all traces of grease. The mixture should be left to stand, without being moved or shaken, for 36 hours. The milk will then have risen to the surface, and the water and impurities which have sunk can be drawn away through a small hole near the bottom of the tin, which has been stopped by a plug of wood. As soon as white particles are seen to pass through the hole with the water, the plug should be inserted, and the washed milk poured into the prepared tin with the cotton-cloth bag inside.

The milk, having been poured into the bag until the tin is half full, should be left with the mouth of the bag well tied, and a square piece of wood lying on the top of it for 12 hours. A bag of sand weighing about 10 pounds may then be put on top of the piece of wood for another 12 hours. Quantities of discoloured water will be seen to flow from the perforations in the sides and bottom of the tin during this process, and on touching the top of the bag it will be found to offer some resistance to pressure.

A stout tree branch about 20 feet long should now be cut and trimmed, or if palm-leaf "bamboos" are obtainable, six or eight of them can be strongly lashed together. The pole thus obtained should have one end firmly fixed by thrusting it into a hole dug under a strong tree root, and a block of wood having been cut large enough to fit loosely into the tin, so as to rest on the square piece of wood which lies on the top of the bag of rubber, and to project above the mouth of the tin for about a foot; the tin and block should be thrust under the pole at the distance of perhaps a yard from the end which passes under the tree root. A large bag should now be filled with sand, and hung on to the pole. It is evident that the farther this bag is moved up the pole, the greater will be the pressure on the block of wood which acts as the fulcrum of the lever, and consequently upon the bag of rubber milk upon which it rests. Great pressure can be brought to bear by this simple means on the coagulating juice. Indeed, it will be found advisable to have the prepared tins replaced in their wooden case, and to press the milk in them side by side, by placing a flat board from block to block, and allowing the pole to rest upon that rather than directly upon the blocks. Unless some such precautions be taken, the tins will be apt to bulge, and perhaps burst outwards, when full pressure is applied.

The bag of sand should weigh about 100 pounds, and should be hung as near the tin as possible for 12 hours. It should then be moved along the pole gradually until it reaches the end farthest from the tin, where it should be left for two or three days.

On removing the weights and taking the bag out of the tin, which can be done by pressing the sides and lifting slowly, the mouth of the bag may be untied and the rubber removed, by turning the bag inside out. It will not be found to adhere to the cloth in the slightest degree, nor will there be any traces of viscosity in the rubber itself. It will appear as a white semi-elastic mass, which on exposure to the air will gradually turn black, and will gain in elasticity as it dries.

The samples when prepared should not be unnecessarily exposed to the sun, but will not be injured in any way by exposure to rain. They will, if anything, be improved by immersion in water.

The above method was employed when preparing the sample which I forward as Exhibit 1. At this season of the year it is difficult to obtain large enough quantities of milk for extensive experiments, and the specimens I am able to show are in consequence too small for commercial purposes. It is, however, my intention to continue the experiments on which these notes are based when the rains begin and the trees yield more sap. A further report will then be submitted should any new features present themselves.

Exhibits Nos. 2 and 3 are of unwashed milk coagulated by pressure, but as an insufficient weight was applied, they show a cellular structure, and are also not free from impurities.

Exhibits Nos. 4 and 5 are of shade-evaporated, unwashed milk, and are of fair quality. This method, however, cannot well be applied during the rainy season without the application of artificial heat, which I have proved to give unsatisfactory results.

Exhibits Nos. 2, 3, 4, and 5 are the results of preliminary experiments which were carried on with a view to proving the possibility of adopting, for the preparation of West African rubbers, the process described in notes already submitted to the Government of this Colony (*see* Government Gazette, Colony of Lagos, February, 1888).

Exhibit No. 1 shows that the method indicated has been to a certain extent successful, even under extremely adverse circumstances. It will, however, be for experts in England to point out the good and bad qualities of the samples, and to declare the price that it ought to command in the English market.

These notes have been strictly limited to the consideration of certain attempts to apply the method above described to the preparation of india-rubber from the juice of the "Abba" tree. There is now on hand a series of experiments on the "Ibo" vine juice, which may be further reported on when complete, but at present no results have been arrived at of sufficient definiteness to warrant a detailed report.

It is important to remember that the results here noted have been obtained from one series of experiments only, and are not to be considered as in any way final. They serve to prove the possibility of applying a simple and inexpensive system of preparation to African rubbers which has already produced good results elsewhere. It will always be a sincere pleasure to me to show what little I know about the subject to anybody who may be sufficiently interested by these suggestions to wish to apply them to the preparation of india-rubber for the European market, and any question addressed to me in writing will also meet with attention, and will be answered as fully as my slight knowledge of the matter may permit.

ALVAN MILLSON.

As it was the desire of the Government of Lagos to obtain an authoritative opinion upon the specimens of rubber prepared by Mr. Millson, the good offices were sought of Mr. S. W. Silver, F.L.S., who already has most obligingly assisted this establishment in the investigation of specimens of rubbers obtained from various sources. Mr. Silver was kind enough to forward the samples of "Abba" rubber to the India-rubber, Gutta percha, and Telegraph Works Company, Limited, at Silvertown.

The report received on the specimens is as follows :—

REPORT on FIVE SAMPLES of INDIA-RUBBER received from S. W. SILVER, Esq., 6th July, 1888.

The samples are numbered in accordance with the report of Mr. Alvan Millson.

No. 1 internally was dark in colour, almost black, with a bluish fringe, tint gradually vanishing towards centre, which is nearly white. It was strongly alkaline in patches, evidently due to a little original moisture, other portions neutral.

No. 2, light (white) colour in centre, blackened about $\frac{1}{8}$ inch in depth, reddish fringe, very faintly acid.

No. 3, pink colour, blackened about $\frac{1}{8}$ inch in depth, contains much wood ; slightly acid, especially in neighbourhood of woody particles.

Nos. 4 and 5. No. 5 is softer than No. 4, and lighter in colour ; both samples have a pink tint and are distinctly alkaline.

Samples marked No. 1, No. 3, No. 4 were treated in detail ; the quantity of the others being too small. Washing and drying, No. 1 lost 1·42 per cent. moisture, No. 3 lost 5 per cent., and No. 4 lost 7 per cent.

The temperature of the drying room was that used for the usual descriptions of rubber. If the samples had been hung up as usually adopted, the want of strength and firmness would have caused them to drop. Other means of drying would have to be devised. When dry, No. 1 was very clammy, No. 3 was firmer than No. 1, but not nearly so good as No. 4. No. 4 might be more easily handled in drying.

They were all very short, with very little elasticity ; this might have been expected from appearance of the original samples. They were kept in the drying room no longer than would be required if working on a practical scale.

Mixed with a suitable proportion of sulphur and vulcanised, they cured soft and short, but were not blistered. With pigments it may be made firmer and slightly tougher. It can evidently not be used by itself in any form. All the samples were troublesome to work in the mixing machines. It would not be right to assume that this behaviour is in any way a barrier to its usefulness.

When we take into account the great improvements which have been introduced in preparing certain African and Asiatic varieties of rubber, manufacturers must feel that the praiseworthy efforts of Mr. Alvan Millson to increase our sources of supply are in the right direction. Whether the recovery of the rubber from the "Abba" tree in the way these samples have been prepared is such

as to ensure the best product in a commercial sense, is a most important matter. The sap of a tree may contain a large quantity of caoutchouc, but the same may be associated with other principles contained in the same or other plant tissues, which completely modify its character. It is this consideration which would lead one to ask how far the treatment of the juice of the *Castilloa elastica* can be applied to another plant, the juice of which, though containing caoutchouc, has very marked chemical differences.

I am not aware of any native india-rubber with an acid reaction ; even the juice of the Para rubber tree, *Hevea brasiliensis*, is distinctly alkaline when drawn, and exhales a strong smell of ammonia. The rubber from this source is strongly acid. In roasting the nuts of the Urucari palms, a large quantity of acetic acid is given off, which probably, by neutralizing the ammonia, brings about the coagulation of the caoutchouc, the excess of acid from the roasting of the nuts may help to explain the acid reaction of the Para rubber, but as the Negrohead variety is obtained from the same source, and is *not* smoked although it is strongly acid, we must consider the generation of acid as due to fermentation, at least in a very great measure. The samples obtained from the "Abba" tree are not acid, but whether the product could be improved by precipitation with ordinary crude acetic acid, which at the same time would arrest those changes which are liable to go on afterwards to the detriment probably of the rubber, is worth finding out. I thought it would be important to ascertain whether the soft clammy condition of the samples was due to oxidation, or to the presence of resinous matter. A white pulverulent resin was obtained from sample No. 4, amounting to 24·48 per cent. of its weight. The caoutchouc, by destructive distillation, yielded caoutchucene and the other products obtained from india-rubber. When resins exist in the juices of india-rubber-yielding plants, as a rule they are combined with water, as hydrates, which is fatal to their use for vulcanizing, since such rubber blisters when cured. On boiling the resin with caustic potash, a large quantity of ammonia was given off. In the present case, although such a large quantity of resin is present, the rubber cures quite solid, but soft and short ; this may be due to the resinous matter. The oxidation of the rubber itself will not account for it. The rubber may be hardened by pigments, but its strength is still very low. It can be mixed with other low-class rubbers with a corresponding improvement in toughness and strength.

In a locality so favourable for the growth of india-rubber-producing plants, it would be interesting to know, whether any of the plants yielding good descriptions of rubber, could be acclimatised successfully without invalidating the product. Common alum is sometimes found in the Para rubber, being used as a medium for coagulating, perhaps it may be useful in the present case.

I was informed by a friend who spent some time in Africa, that a very large quantity of crude acetic acid was shipped to different parts on the East Coast some years ago and was evidently used in preparing india-rubber.

In smoking india-rubber, any plant may be used which yields acetic acid, but any plant yielding turpentine or similar products should be avoided.

The preservative action of the crude acid is enhanced by creosote and tarry matter present. Para rubber is flavoured with these.

While forming a favourable opinion of this gum, we cannot fix a value upon it, as everything will depend upon how far the experimental working can be verified in working on a larger quantity. As a supply of this is at present available, we would suggest that a larger quantity be sent over, say 100 pounds, so that we could test it in a practical manner, and thus give a better opinion as to its commercial value. We may observe that it is always more difficult to give a fair result on such small quantities, and it is therefore the more important that a supply sufficient for practical use should be sent.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS CO. (LIMITED),
Silvertown.

The results of the inquiry and the suggestions offered by this establishment are contained in the following letter addressed to the Colonial Office for communication to the Government of Lagos :—

ROYAL GARDENS, KEW, to COLONIAL OFFICE.

Royal Gardens, Kew,
September 11, 1888.

SIR,

I AM desired by Mr. Thiselton-Dyer to acknowledge the receipt of your letter of the 16th June last forwarding papers and specimens from the Government of Lagos, relative to some experiments which had been made by Mr. A. Millson on the preparation of rubber from the Abba tree.

From the botanical specimens forwarded by Mr. Millson, Professor Oliver has arrived at the conclusion that this particular "Abba" tree is probably *Ficus Vogelii*, Miq., a West African rubber tree first collected by Vogel at Grand Bassa. This determination, however, owing to the character of the specimens, is not quite conclusive. It is very desirable that a full set of material be sent in all cases of this kind, which should contain young terminal shoots, as well as portions of the branches, leaves, flowers, and fruits.

The various samples of rubber as received were forwarded, through S. W. Silver, Esq., F.L.S., to the India Rubber, Gutta Percha and Telegraph Company (Limited), at Silvertown. The samples have received a very careful and exhaustive examination at their hands, and we have received from Mr. Silver a full report, a copy of which is herewith enclosed.

It is necessary in the first place to point out that rubber from the Abba tree similar to that under notice has already been investigated at this establishment. In the Kew Report for the year

1878, p. 39, a notice appears of Liberian rubber, which was identified with *Ficus* (Urostigma) *Vogelii*. This rubber, a sample of which is in the Kew Museums (from Mr. Thomas Christy) is made up into balls about the size of a large orange. It was valued (in 1878) at 1*s*. 6*d*. per pound, but it is added that "if sent home cleaner it would command a higher price."

It will be noticed that in the report furnished by the India Rubber, Gutta Percha and Telegraph Works Company it is stated that the specimens received from Mr. Millson show an alkaline reaction, and that on this and other grounds, such as the presence of resin and its soft clammy condition, "it can evidently not be used by itself in any form."

Mr. Millson's experiments are evidently based on his knowledge and experience of Central American rubber the produce of *Castilloa elastica*. It is possible, however, that the treatment suitable to the juice of this plant cannot be applied to another plant the juice of which, although containing caoutchouc, has very marked chemical differences.

The result of the inquiry so carefully conducted by the India-rubber Company would appear to show that the juice of *Ficus Vogelii* does not lend itself satisfactorily to such treatment. It is said that the rubber hitherto prepared from this tree has been treated with acetic acid, and, if this is the case, possibly in this direction may be found a solution of the problems involved.

It is desirable in any future experiments carried on with india-rubber on the West Coast that larger samples be forwarded to this country for the purpose of testing the quality. In the report it is stated that about 100 pounds is necessary to test rubber in a thoroughly practical manner.

In order to afford every information to the Government of Lagos in its praiseworthy efforts to develop the rubber industry of the Colony there is forwarded herewith a parcel containing samples of "Abba" rubber in different stages of manufacture, together with specimens of commercial Para* and Accra rubbers now in large demand in this country.

If the experiments are continued, as it is hoped they will be, and if the valuable suggestions contained in the report are carefully carried out, it is pretty clear that Mr. Millson will be able to discover a practical and efficient method of preparing the juice of the Abba tree so as to produce commercial rubber.

There are few subjects at the present time of greater importance than a careful investigation of caoutchouc plants, and the extensive distribution of Abba trees in West Africa indicates a wide and useful field of inquiry.

I am, &c.

(Signed) D. MORRIS.

Sir R. G. W. Herbert, K.C.B.,
Colonial Office.

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* Para rubber is yielded by *Hevea brasiliensis* and Accra rubber by *Landolphia owariensis*.

Mr. ALVAN MILLSON to ROYAL GARDENS, KEW.

Badagry, West Africa,
August 16, 1888.

Your letter of the 4th ultimo reached me yesterday. I regret that the samples of rubber sent by me were—owing to the difficulty of obtaining pure milk—both small and of inferior quality to those which have since been made. I was sorry also not to have had an opportunity of correcting the notes for the press, as I noticed several misprints in them.

You were correct in your belief that the name "Abba" is applied to all arboreous fig-trees in this neighbourhood. Of these there is a remarkable variety. I will at a later date send specimens prepared as you so kindly direct me.

An enterpising firm of Lagos merchants, who have lately established a branch house in Badagry, have made a fair beginning in the rubber business.

So far as I can at present see West African rubber will never be reliable so long as the natives have the preparation in their own hands. The milk bears transport well, keeps well, and can easily be tested, by letting a sample (mixed with water) stand for twelve hours in a glass vessel. Unless merchants employ reliable men to buy and coagulate the milk, I fear that the trade will be of a very ephemeral nature. Yet on the other hand it seems clear, from the large numbers of rubber-giving fig-trees, that a properly conducted trade would be a considerable source of future prosperity to the whole coast. The present palm oil and kernel trade may be said to depend upon the continuance of slavery, and is indeed in many ways an injury to the people.

The Governor of the Colony, with his usual insight, is encouraging cocoa-nut planting and other similar industries, which will do much to improve the general prosperity. He has already proved that the india-rubber industry is by no means the least important of these branches of commerce.

ALVAN MILLSON.

XXX.—LAGOS RUBBER.

(*Ficus Vogelii*, Miq.)

[*K.B.*, 1890, pp. 89–93.]

In the *Kew Bulletin* for November 1888, page 253 [p. 141], an account was given of the attempt made to utilise the "Abba" trees of West Africa, for the purpose of yielding commercial rubber. The subject has been very enterprisingly taken up by Sir Alfred Moloney, K.C.M.G., Governor of Lagos, and at his request further attempts have been made by Mr. Walter Higginson, Inspector of Police and Acting Commissioner at Badagry, to prepare rubber from "Abba" trees in commercial quantities. The large amount of resin present in this particular rubber has hitherto prevented its extended use in this country. It is evident, however, that some advance has already been made to overcome this drawback, and if experiments are continued with the fresh latex it may be

possible to obtain a product comparatively free from resin. In the investigation of the recent specimens of rubber received from Lagos this establishment is greatly indebted to Mr. S. W. Silver, F.L.S., for an interesting report obtained from the India Rubber, Gutta Percha, and Telegraph Works Company (Limited), Silvertown.

COLONIAL OFFICE to ROYAL GARDENS, KEW.

SIR, Downing Street, January 22, 1890.

I AM directed by Lord Knutsford to transmit to you, for your information, a copy of a Despatch from the Officer Administering the Government of Lagos, reporting the despatch of 40 lbs. of rubber to the Crown Agents for transmission to your department, and I am to state that Lord Knutsford would be obliged if you could obtain a report as to the market value of this specimen.

I am, &c.
(Signed) R. H. MEADE.

The Director of Kew Gardens.

DISTRICT COMMISSIONER, BADAGRY, to COLONIAL SECRETARY.

SIR, Badagry, November 20, 1889.

I HAVE the honour to inform you that owing to the rains stopping and the sap of the trees drying up, I have only been able to obtain 40 lbs. of rubber instead of the 100 lbs. proposed in his Excellency's Minute.

The cost has been 1*l.* 19*s.* 8*d.*, or a fraction less than 1*s.* per lb. It is ready packed for shipment to England, and as no more can be obtained until the sap forms again in April, I would suggest its being forwarded at once, so that on my arrival in England I can be instructed to give the mode of working fully, should it prove successful. I could also attend at Silvertown and witness the working of the rubber, and be shown the best way of separating the natural acid from it.

This amount, although small, is I think, more than was supplied by Mr. Millson from one tree.

I have, &c.
(Signed) W. HIGGINSON,
Acting District Commissioner.

The Hon.
The Colonial Secretary, Lagos.

DISTRICT COMMISSIONER, BADAGRY, to the COLONIAL SECRETARY, LAGOS.

[Extract.] Badagry, December 10, 1889.

While in Lagos in October last, I had the honour to submit to his Excellency some specimens of rubber made by me on the Gold Coast plan, and he was pleased to direct me to obtain 100 lbs. at a cost not exceeding 5*l.* for export to England, for examination as to quality, etc., but up to the present I have only obtained 40 lbs. at a cost of a fraction under 1*s.* the lb.

I cannot of course say whether the little I have will turn out satisfactory or not, but I have taken the very greatest pains in its preparation, and I am sure it will be found quite free from dirt of all kinds, and I hope of acids.

Perhaps a few remarks as to the mode followed by me may be found useful, as it may not be well known in Lagos, although common on the Gold Coast.

When the milk is first brought to me in gin bottles, I at once strain it into perfectly clean bottles through a piece of muslin fixed in a frame. The bottles are then allowed to stand for 24 hours for the milk to rise. It is then poured into a large tin, and put on the fire to boil. If much water is seen with the milk, none is added ; but if only a little, about a pint of water is added to every six bottles. As the water and milk begin to boil, lime juice is added in the quantity of one lime to each bottle. This assists the rubber to coagulate. When all the rubber in the water has formed into a large lump, it is taken out and forced into tin moulds, perforated and fixed in wood cases. Heavy weights are then laid on for 12 or 24 hours, and then the rubber is taken out, when it will be found ready for shipment.

The muslin strainer is very easily washed, as it need only be turned over and water poured through it from a height.

At present, owing to the rains ceasing and the sap of the trees drying up, little or no milk can be obtained, although I have increased my price to 4*d*. a bottle ; what little I did get was not good, and I found it useless.

If one could only induce the natives to collect the milk, a large trade might be done ; but they are intolerably lazy, and do not care to attempt a new trade. At the least a man should be able to get eight or 12 bottles a day, for which he would receive 2*s*. or 3*s*., but the usual quantity brought me was four or six bottles, and then half of it was water. When I refused to take it or pay more than half price, they grumbled, and would not go again, saying it was too much trouble, and too little pay. Even the boys in the town declined to get it for 3*d*. per bottle, saying they preferred doing nothing at home ; and when I spoke to the Chiefs about their lazy habits, which could only lead them into mischief, they confessed that these young men and boys were quite beyond their control or that of their fathers. This is certainly a bad state of things for the district, and one which I have endeavoured to check as far as it lies in my power : but I fear, unless the Chiefs exercise their authority, and do their best to assist the District Commissioner, it will be hard work.

ROYAL GARDENS, KEW, to the COLONIAL OFFICE.

Royal Gardens, Kew, April 21, 1890.

SIR,

I AM desired by Mr. Thiselton-Dyer to acknowledge the receipt of your letter of the 22nd January last, forwarding a copy of a despatch from the Officer Administering the Government of Lagos, on the subject of forty pounds of rubber prepared from "Abba" trees by Mr. Higginson, and shipped to this country for valuation and report.

2. In reply, I am to state that this sample of rubber was prepared at the request of Sir Alfred Moloney, in continuation of experiments undertaken by Mr. Millson at Badagry, and discussed in my letter of the 11th September 1888. The previous history of the subject is given in the *Kew Bulletin* for November 1888, pp. 253–261 [p. 141]. The Abba trees of West Africa doubtless include several species of *Ficus*. From specimens forwarded to this country by Mr. Millson, it is pretty clearly shown that one at least of them is *Ficus Vogelii*, Miq. It is desirable for a fuller elucidation of the subject that herbarium specimens, including fruits, of all Abba trees used in the preparation of rubber, be forwarded to Kew for determination.

3. In the experiments undertaken by Mr. Higginson, this gentleman appears to have entered upon his investigations with commendable zeal and energy. He has fully realized the difficulties attending the preparation of rubber from Abba trees, and the methods adopted to overcome these difficulties, it will be noticed, have resulted in an article superior in many respects to former samples.

4. As on the former occasion the Abba rubber received from Lagos was forwarded through Mr. S. W. Silver, F.L.S., to the India Rubber, Gutta Percha, and Telegraph Works Co. (Limited), Silvertown, and a copy of the report received from this Company is enclosed. This report is on the whole favourable. The rubber was free from impurities, and had not suffered any deterioration in transit, two points of considerable importance in regard to African rubbers as usually received in this country. In the next place while former samples were reported as not suitable to be used alone in any form, and troublesome to work in the mixing machines, the present samples were free from these objections. In fact the Abba rubber, as prepared by Mr. Higginson, is now capable of being "used alone for many purposes."

5. As stated by Mr. Millson, the Abba trees of West Africa are widely distributed and are generally used as shade trees in market places, streets, and compounds. They can be propagated by "the simple method of cutting off a branch and pushing it "into the ground, and on account of the facility and rapidity "with which it grows, the natives use it largely for fence posts." Further, Mr. Millson states "from the trees already in full growth "in the bush and towns, a considerable export trade could be "readily established, and systematic planting [of Abba trees] "would develop this trade to almost an unlimited extent."

6. The conclusions to be drawn from the information contained in the last two paragraphs are obvious. Sir Alfred Moloney has evidently the opportunity of adding another important industry to West Africa. Mr. Higginson, while on leave in this country, has devoted attention to the chemical composition of rubber, and through the kindness of Mr. Silver, has obtained facilities for watching the treatment of the samples, prepared by him, at the Silvertown Works. On his return to Lagos, Mr. Higginson will be in a position to continue with a fuller and wider knowledge of the subject, the investigations into the preparations of Abba

rubber, and no doubt Sir Alfred Moloney will place him in a position to utilize this knowledge to the best advantage in the interest of the Colony.

7. Samples of prepared Abba rubber, manufactured at the Silvertown works, to illustrate the remarks contained in the report, are forwarded direct by parcel post to the address of the Governor at Lagos.

I have, &c.
(Signed) D. MORRIS.

The Hon. R. H. Meade, C.B.,
Colonial Office, S.W.

Mr. S. W. SILVER, F.L.S., to ROYAL GARDENS, KEW.

3, York Gate, Regent's Park, N.W.
March 21, 1890.

DEAR MR. MORRIS,

Some additional delay has taken place in forwarding the report, dated Silvertown, 20th inst., upon the last little consignment of Lagos rubber placed in my hands by you for examination, accompanied by results in the shape of samples in various stages.

I hope you will agree with me as to the tenor of it, and in due course I expect to hear that Mr. Higginson is encouraged to such an extent as to pursue diligently what I gathered from him, when I had the pleasure of seeing him at Silvertown, was his intention, viz., to make the rubber from Lagos sought after in the London market.

I am, &c.
(Signed) S. W. SILVER.

D. Morris, Esq., F.L.S.,
Royal Gardens, Kew.

REPORT ON LAGOS RUBBER.

India Rubber, Gutta Percha,
and Telegraph Works Co., Limited,
Silvertown, March 20, 1890.

THE form in which this rubber was received consisted principally of blocks or bricks, measuring on an average 6 in. × 5 in. × 2 in. They had blackened on the outside, from oxidation, which extended inwards. These blocks had adhered, but were easily separated. They showed no signs of deterioration in transit, such as are found in many kinds of African rubber. The absence of impurities deserves mention in comparison with rubber that may be classed with this.

Every care on the part of the collector should be taken in order that the "Lagos rubber" may become known for its superior quality.

The favourable opinion we expressed on the samples sent to Kew by Mr. Alvan Millson are fully sustained by this consignment.

In the report upon these samples it was stated that (*Kew Bulletin*, November 1888, pp. 257–8–9 [p. 146]), "Mixed with a "suitable proportion of sulphur, and vulcanized, they cured soft "and short, but were not blistered.

"It can evidently not be used by itself in any form. All the "samples were troublesome to work in the mixing machines."

Special attention has been paid to these points on this occasion, and whilst we are not able to modify what is expressed in the first paragraph, we find that this consignment is free from the objection referred to in the second paragraph.

The drying after washing is troublesome. The behaviour in the mixing machines is satisfactory, and admits of its being used alone for many purposes.

This consignment lost 10 per cent. in washing and drying, and 13 per cent. on treatment with alcohol, so as to take out resins, &c. Evidently the latter treatment, whilst adding considerably to the expense, is unnecessary, as no very marked improvement takes place.

XXXI.—INDIA-RUBBER IN UPPER BURMA.

[*K.B.*, 1888, pp. 217–220.]

The following "Particulars regarding the India-rubber Trade in the Mogaung District of the Upper Burma Forest Circle," extracted from the monthly proceedings of the Chief Commissioner, Burma, for May 1888, have been communicated for publication in the *Bulletin* by the Secretary of State for India.

Mr. Warry, the author of the paper, is a member of the Chinese Consular Service who has been sent to Burma for work among the Chinese emigrants.

From W. Warry, Esq., Political Officer, Bhamo, to the Chief Secretary to the Chief Commissioner, Burma, Bhamo, 9th April 1888:—

I have the honour to submit, for the information of the Chief Commissioner some particulars regarding the India-rubber trade in the Mogaung district.

India-rubber seems to have been first exported from Upper Burma to Rangoon about the year 1870. Up to 1873 the trade was free to all who chose to engage in it: since 1873 the forests have been worked under the monopoly system. For the first nine years five Chinese firms styled Mientsuan, Chengho, Fuhomei, Sunshenhsiang, and Paohsing respectively, were the joint concessionaires. The two first named were Fokienese merchants who supplied the bulk of the capital, and the three last were Yunnanese who superintended the actual operations. The price received by the Burmese Government was Rs. 60,000 for the first triennial term (1873–75), Rs. 70,000 for the second (1876–78), and Rs. 90,000 for the third (1879–81). In 1882 there was a split between the members of the syndicate, the result of which was that the monopoly for that one year sold for Rs. 70,000. During the next year business in India-rubber was at a standstill owing to local disturbances caused by the "Kachin revolt." In 1884 two Yunnanese firms agreed to pay Rs. 45,000 for a three years' lease

of the monopoly ; and when their term expired, the lease for one year from September last was put up to auction and realised a lac of rupees.

The forest officer attached to the Mogaung column has no doubt reported on the general distribution of the *Ficus elastica* and on the Kachin methods of tapping it. I shall, therefore touch very briefly upon these subjects. The Chinese say that the India-rubber tree occurs throughout a very extensive district stretching several hundred miles north of Mogaung and extending to the east far across the Chinese border. A fractional part only of this immense area has been worked. The largest and most regular supply of rubber seems to have been hitherto procured in forests distant from four to six days' journey north of Kamein. An equally large supply should soon, it is said, be obtained from the Endaw and Laotsun districts. On the recent expedition we met a few raft loads coming down the Endaw River, but there has, as yet, been no arrangement between the Chinese and the local tsawbwas under which the forests can be systematically worked.

The Kachins are described as exceedingly jealous of interference with their trees, and very careful in their methods of tapping them. What I myself observed on the march fully bore out the latter part of this statement. The few trees seen were strong and vigorous, and though covered with innumerable small incisions even up to the tiny topmost branches, they had obviously not been drained to the extent of one-half their power. In the early days the Kachins made the natural mistake, soon discovered and rectified, of over-bleeding the trees ; it was in this way ascertained that a large tree if bled to death would yield 500 viss of rubber in the course of a single season.

Mogaung is the headquarters of the India-rubber trade. Of the total yearly supply four-fifths are brought into Mogaung by Kachins, the majority of whom are in regular employ of the Chinese lessees, and one-fifth is purchased in the districts by Chinese agents of the lessees. Under the present system the Chinese manager at Mogaung. a man named Li, makes liberal advances to Kachins to defray their expenses during the collecting season, which lasts from September till June. These advances are made almost indiscriminately to any one who applies for them, no security is asked or given, and it very rarely happens that this confidence in Kachin honesty is misplaced. The Kachins having brought the rubber into Mogaung sell it to Li. All payments are now made in rupees. The price obtained when I was at Mogaung averaged Rs. 145 for a 100 viss, last year it varied from Rs. 120. to Rs. 130. Formly the Kachins used to be much cheated in the process of weighing, and they retaliated by passing off upon the purchasers India-rubber balls the centre of which consisted largely of stones and dirt. This system proving inconvenient to both parties was sometime since abandoned by mutual consent. The Kachin is now credited with the full weight or nearly the full weight of his rubber, which on its arrival at Mogaung is well washed, dried, and minutely examined, ball by ball, before it is scaled. Those Kachins who have received advances from Li make the refund by selling to him at half the current price, until the amount of the debt is cleared off. A small

quantity of rubber, as I have said, is collected by Chinese agents of the lessees. Up till quite recently there were only 10 or 12 of these agents. They travel from district to district making purchases from Kachins. The price paid is nominally the same as at Mogaung, but as the Kachins possess no standard weights they are usually cheated to the extent of about 70 per cent. This profit on the difference of weight more than pays all the expenses of the agents. In November of last year a new and hitherto unworked district was opened. Lin, one of the monopolists, arranged with an influential Chinese family named Chao (who reside at Tachiai and protect the Sima route into China), to hire some 400 Chinese and Shan coolies to work the forests in the neighbourhood of the Amber mines. Objection to this inroad was at once made by the local Kachin tsawbwas, who insisted on the right of working the forests themselves, and declined to admit other labour. After much discussion a compromise was arrived at on the following basis : Two hundred of the new coolies were to return at once, the remainder were to be allowed to collect rubber under the superintendence of the Kachins, to whom they were to pay 10 per cent. of the quantity collected. The place of the 200 dismissed coolies was to be taken by an equal number of Kachins, who were to be paid for what they collected at the rate current in other districts. Under this system matters have so far worked smoothly ; it was expected at Mogaung that at least 20,000 viss of rubber would be obtained from the new forests this season.

In most cases India-rubber is subject to certain charges whilst in transit through Kachin districts other than those in which it was produced. The tsawbwas of such places usually take a very moderate toll, perhaps two or three balls out of each hundred. So long as these charges do not amount in all to more than 10 per cent. no complaint is made. But this proportion is sometimes largely exceeded ; and in such cases a remonstrance, nearly always successful is made by the Chinese to the tsawbwa or tsawbwas who have helped themselves too liberally. Posaw, the ex-Myoôk of Mogaung, was of great service to the Chinese in arranging disputes of this nature between them and the Kachins ; since his flight a regular expenditure in presents to the tsawbwas has become necessary in order to keep the amount of transit dues at a reasonable level. Whatever may be the poll-tax paid on India-rubber coming down to Mogaung the Chinese manager and the Kachin owner bear the loss in equal shares. The Kachin, however, is amply compensated by being housed and fed at the expense of the Chinese during his stay in Mogaung.

The circumstances of the past year have been very favourable to the India-rubber trade. New producing districts have been opened, and old districts have been better worked than before. Owing to the apprehension caused by the visit of the British troops to the Jade country, little or no work was attempted at the mines till quite late in the season, and a number of Kachins and Shans usually employed at the mines were able to offer their services to the India-rubber traders, whose operations had at first been hampered by the scarcity of labour.

The profits realised this year by the lessees must be considerable. There are no means at Bhamo for ascertaining how much

India-rubber they have already sent down to Rangoon, but it is thought here that before the end of their term they will have collected at any rate, if not shipped, something over 150,000 viss. I estimate that a total collection of only 50,000 viss would pay them a handsome dividend on their outlay. The account may be stated thus :—

Payments.	Rs.	Receipts.	Rs.
Cost of License	1,00,000	Sale of 50,000 viss at Rangoon at Rs. 450 per 100 viss	2,25,000
Cost of 50,000 viss of rubber at Mogaung, at Rs. 145 per 100 viss	72,500		
Freight, Mogaung to Bhamo (say)	1,000		
Freight, Bhamo to Rangoon, at Rs. 6.8.0 per 100 viss ...	3,250		
Expenses of establishment at Bhamo, Mogaung, and Mandalay (say)	12,000		
Incidental expenses, such as presents to Kachin tsawbwas, &c.	2,000		
Total	1,90,750	Total	2,25,000

Which leaves a clear profit of Rs. 34,250, that is to say, over 17 per cent. on the capital invested, assuming that the whole outlay occurs at the commencement of the season, which is by no means the case. But there is little doubt that the lessees will collect a great deal more than 50,000 viss this season ; and on every extra 50,000 viss collected they will make a net profit of nearly a lac and a half of rupees.

From the foregoing calculation it seems clear that the public revenue derived from the India-rubber forests is far too small. It is not easy to indicate any sure plan by which it may be improved during the next year or two. It is possible, of course, that there may be keener competition when the monopoly is next put up to auction ; but it is quite as likely that a "ring" will be formed to keep the price at its present low level. The difficulty is that as matters now stand the Yunnanese are the only traders who can conduct business safely and profitably with the Kachins in the Mogaung district. With the single exception of Lœnpin, the Jade lessee, no native, even of another Chinese province, has yet attempted to compete with them in those regions. Indeed there are not half-a-dozen Cantonese or Fokienese, all told, at Mogaung, and these are all in partnership with natives of Yunnan, who require a larger capital than they can themselves command. The Yunnanese confess that not many even of their own traders possess the tact and patience essential to the preservation of continuous and satisfactory business relations with the Kachins. It is probable, therefore, judging from the present unfriendly attitude of the Kachins towards us that any attempt to buy rubber direct from them or to collect it in their forests, would be a failure. The Yunnanese, from interested motives, would be averse to assisting us in the task, and without their co-operation, or at least their good-will, it would be difficult, if not impossible, to secure a regular supply. With the complete pacification of the district this

difficulty will no doubt disappear ; in the meantime it might be found possible either by placing a reserve price on the monopoly when next put up to auction, or by abolishing the monopoly and taxing the India-rubber as it is brought down, or by effecting some arrangement with the Yunnanese traders, to make these fine forests yield something more than the nominal revenue heretofore derived from them.

XXXII.—ASSAM RUBBER FOR WEST AFRICA.

(*Ficus elastica*, Bl.)

[*K.B.*, 1891, pp. 97–102.]

COLONIAL OFFICE to ROYAL GARDENS, KEW.

Downing Street, 20th November, 1890.

SIR,

I AM directed by Lord Knutsford to transmit to you, for your information, a copy of a despatch from the Governor of Lagos on the subject of the *Ficus elastica* of Asia.

I am, &c.

(Signed) JOHN BRAMSTON.

The Director,
Royal Gardens, Kew.

[Enclosure.]

Sir ALFRED MOLONEY to LORD KNUTSFORD.

Government House, Lagos,
13th October, 1890.

MY LORD,

I HAVE the honour to acknowledge the receipt, direct from India, of three packets of seed of the *Ficus elastica*, as also of an account by Mr. Gustav Mann, Conservator of Forests, of the mode of culture pursued in Assam.

2. For their ready and practical co-operation, may I invite your Lordship to convey to the Government of India the thanks of this Colony.

3. The information supplied is of such general interest and value I have ventured to issue it in extenso as a circular, of which I would ask your Lordship to allow the Director of the Royal Gardens, Kew, to have some copies.

4. The seed received has been treated in accordance with the method employed in Assam in the cultivation of this rubber tree. I trust the experiment will prove a success and justify the trouble I have given.

I have, &c.

(Signed) ALFRED MOLONEY.

The Right Hon.
Lord Knutsford, G.C.M.G.
&c. &c. &c.

CIRCULAR.

Colonial Secretary's Office, Lagos,
30th September, 1890.

The following correspondence on the subject of the *Ficus elastica* of Asia has passed between his Excellency the Governor and the Right Honourable Secretary of State for the Colonies.

The *Ficus elastica* is distributed over Assam, Java, and probably other Malayan countries; it is cultivated in Malabar, and is the chief, if not the only, source of Assam and Java caoutchouc.

The caoutchouc supplied by this tree is only second in importance as an article of export to that of the celebrated *Hevea brasiliensis* of the Amazon Valley.

The tree is of similar growth in almost every respect to the "Abba" tree (*Ficus Vogelii*) of Yoruba, and would doubtless thrive excellently in the moist climate of the West Coast of Africa.

The preparation of the caoutchouc is similar to that of the "rubber" of the *Landolphia owariensis* of West Africa. Such of the milk as flows freely is coagulated by boiling, but the greater part is allowed to dry on the tree, from which it is stripped when sufficiently evaporated to bear handling.

The value of good and fine Assam caoutchouc was quoted in 1887 at from 2*s.* to 2*s.* 7*d.* per pound, and in the quantity annually shipped to the United Kingdom it would appear to compare favourably with the Para Rubber.

The seed of this valuable tree, which has been supplied through the kind offices of the Indian Government, is now being cultivated at the Botanic Station of this Colony, and young plants will be available for the public in a short time. As little or no skill is required in its cultivation it is to be hoped that it will soon establish itself in this Colony and the neighbouring States.

By Command:
ALVAN MILLSON,
Assistant Colonial Secretary,
pro Acting Colonial Secretary.

The UNDER SECRETARY OF STATE FOR THE COLONIES.

S.S. "Sherbro," at Sea.
29th January, 1890.

SIR,

I HAVE the honour to request that the Secretary of State for the Colonies may be pleased to invite the co-operation of the Indian Government in the direction of the supply to the Botanic Centre of the Colony of Lagos of some seed of the *Ficus elastica*, also a copy of instructions on the mode of its culture pursued in Malabar.

I have, &c.,
(Signed) ALFRED MOLONEY.

COLONIAL OFFICE to INDIA OFFICE.

Downing Street,
13th March, 1890.

SIR,

I AM directed by Lord Knutsford to transmit to you, to be laid before Viscount Cross, a copy of a letter from the Governor of Lagos on the subject of the "*Ficus elastica*."

Lord Knutsford would be glad if the seed required by Sir Alfred Moloney, together with the information regarding the culture of this plant in Malabar, could be supplied through your Department.

Any expense which may be incurred will of course be defrayed from Lagos funds, and upon application to this Department the Crown Agents will be directed to pay the amount in such manner as the Secretary of State for India may desire.

I am, &c.,
(Signed) ROBERT G. W. HERBERT.

The Under Secretary of State,
India Office.

INDIA OFFICE to COLONIAL OFFICE.

(R. & S. 354.)

India Office, Whitehall, S.W.,
24th April, 1890.

SIR,

I AM directed by the Secretary of State for India in Council to acknowledge the receipt of your letter of the 13th ultimo, enclosing a copy of a letter from Sir Alfred Moloney, and in reply to state that the Government of India have been requested to procure, if possible, 1 cwt. of the seed of *Ficus elastica*, and to forward the same to the Governor of Lagos together with the required information as to the culture of the plant.

I have, &c.,
(Signed) A. GODLEY.

The Under Secretary of State,
Colonial Office.

Local Form No. 1.

No. Kf. 134.

From GUSTAV MANN, Esq., Conservator of Forests, Assam,
to his Excellency the GOVERNOR OF LAGOS.

Dated Shillong, the 24th July, 1890.

SIR,

IN obedience to the orders received from the Government of India, I have the honour to advise your Excellency of the despatch of three small bags of rubber seed (*Ficus elastica*), containing about one pound of seed, by sample post, and to enclose a brief

account of the methods employed in cultivating this tree in Assam. I also enclose copy of a letter addressed to the Secretary to the Chief Commissioner of Assam, from which it will be seen that the seed is very small and light, so that probably a pound or two will be found sufficient instead of 1 cwt. as now ordered.

I have, &c.
(Signed) GUSTAV MANN,
Conservator of Forests, Assam.

COPY of LETTER No. Af. 73, dated Shillong, the 21st July, 1890, from the Conservator of Forests, Assam, to the Secretary to the Chief Commissioner of Assam.

I HAVE the honour to acknowledge receipt of your office Memo. No. 201/72, dated the 27th ultimo, forwarding to me a copy of the Government of India letter No. 494, and dated the 18th June, 1890, and directing me to send to his Excellency the Governor of Lagos, on the West Coast of Africa, 1 cwt. of seed of *Ficus elastica* for cultivation in that Colony.

2. With reference to these instructions, I beg to report that the seed of *Ficus elastica* ripens in February and March, and that I will make the arrangements, if necessary, to have it collected of good quality at that season, but before doing so, I beg to point out that this seed is extremely small and light, so probably a much smaller quantity will suffice to commence with, each of the figs contains about 75 seed, and as 90 figs go to one tolah it will make the number of seeds in one pound 270,000, which ought to be sufficient to begin experimenting with, even though there should be no skilled labour available for sowing it.

3. I have obtained about 1 lb. of seed from Kamrup, which I will send at once to his Excellency the Governor of Lagos by post, and I shall write direct advising the despatch of the seed, and giving a brief account of the methods employed in cultivating the rubber tree here in Assam ; the expenditure incurred is so trifling (six annas), that it is not worth while recovering ; the postage on two letters would exceed it.

4. I shall await further instructions before despatching more seed.

BRIEF ACCOUNT of how Rubber Trees (*Ficus elastica*) are grown in Assam.

The seed ripens from January to March, when it is collected as it falls off the trees, and afterwards dried in the sun.

It is, properly speaking, the fruit, and consists of small figs, the size of a pea. These at the time of sowing are broken between the hands, and the seed thus mixed with the particles of the fruit is sown without any attempt to clean or separate the seed.

2. Germination takes place sometimes only three months after the seed has been sown, and as it is very small it must be sown on the *surface* of the soil only, but otherwise just like the seed of any other plants, it requires as much light as possible from above ; side shade is an advantage. The seed can be sown on beds, or in

boxes or flower pots, but it is most essential that the drainage of the soil be perfect, and that the earth never becomes soaking wet, whilst on the other hand it should neither be allowed to become thoroughly dry, but be kept always moist.

3. As the seedlings are very small at first they must be treated with great care, and drip from trees above the seed bed must be guarded against; the soil must be kept loose, and open vegetable mould is the best soil.

4. When the seedlings are 2–3 inches high they have formed already a little thickened root something like a small carrot, and can then be transplanted very safely; this should be done on to a properly dug nursery bed, *well drained*, and the seedlings should there be placed about one foot in lines also a foot from each other.

5. After the seedlings have become 1–2 feet in height they are very hardy, and can be transplanted at any time of the year, but as the deer are very much after the leaves of the rubber trees, and to avoid the great expense of fencing in our plantation we have of late years transplanted the young trees a second time in nurseries giving them more room, say, 3–4 feet square each plant, and let them grow until 10 to 20 feet high, when they can be put out into the plantation without fear that the deer will destroy them; they require, however, a strong stake each, as the deer will bend the young trees down with their horns, if not staked.

6. The seed of *Ficus elastica*, where the tree grows naturally in the forests, germinates almost invariably in the forks of trees, 30 to 40 feet and more above the surface of the ground, and the young trees grow in consequence for some 6 to 10 years as epiphytes, after which the aerial roots reach the ground, and increase rapidly in size, until some of them reach a girth of from 4 to 6 feet; they are very numerous, and it is not uncommon at a later age that they are thrown out also from the upper branches 60 to 80 feet from the ground, being first as thin as whipcords, but very soon increasing in size after they have reached the ground; it thus frequently happens that the tree on which the young rubber seedling first germinated, is killed by the more vigorous growing *Ficus elastica*, which in this respect resembles the well know Banyan tree, and is one of the largest growing members of our mixed forest in Assam. It requires an exceedingly damp atmosphere to do well, and therefore thrives best at the foot of the mountains, or on the mountains themselves up to an elevation of 2,000 feet. It is met with also at a higher elevation, but not so vigorous, and at 5,000 feet it is liable to be injured or killed by frost.

7. Seedlings of *Ficus elastica* planted in the forks of trees in the forest are very difficult to attend to, and they in consequence often become dry about their roots, which retards their growth if it does not kill them; for these reasons the rubber trees planted on the ground have grown much better in the Assam plantations, and the latter mode of planting has therefore been adopted almost exclusively; they are not planted, however, on the ground in the common way but on small mounds, 3 to 4 feet high, of earth, and the cut-wood and rubbish close at hand, which suits the epiphytal habit of growth of this tree.

8. These rubber trees can also readily be propagated from cuttings if only perfectly ripe young branches or shoots are used; but young trees so raised never are so hardy as the seedlings, and do not make equally good growth afterwards.

9. To ensure the greatest possible amount of moisture in the atmosphere, the plantations of *Ficus elastica* have been made in the moist evergreen forest near the foot of the hills, through which lines 40 feet in width were cleared 100 feet apart from centre to centre of the lines, thus having 60 feet of forest standing between the lines; on these cleared lines the mounds for the planting of the seedlings or saplings are thrown up at distances of 25 feet apart, care has to be taken afterwards to prevent the forest trees left standing closing in above, over the lines, and the rubber trees planted on them, which they have always a tendency to do, and which, if not guarded against, is very detrimental to the growth of the young rubber trees. The undergrowth, which springs up on these lines and grows most vigorously has also to be cleared two or three times in the year for the first four or five years to admit air for the young rubber trees, but beyond this, and the putting occasionally some more earth into the mounds, nothing is necessary.

10. The lines on which the rubber trees are planted are cut in an east and west direction, so as to protect the young rubber trees against the strong sun in the middle of the day; the atmosphere also keeps moister in this case than if the lines were cut south and north.

11. High ground is always best, and swampy ground where water lodges should be avoided, but the tree grows very well on alluvial flats on the banks of rivers, even though this be inundated for a few days once or twice in the year.

GUSTAV MANN,
Conservator of Forests, Assam.

XXXIII.—CULTIVATION OF INDIA-RUBBER IN ASSAM.

[*K.B.*, 1896, pp. 171–174.]

The Assam rubber plant (*Ficus elastica*, Roxb.) is a large evergreen tree found in damp forests from the base of the Sikkim Himalaya eastward to Assam and Arracan. Kurz remarks that it is frequent in upper Burma where whole forests exist in the valley of Hookhoom. The Government of India has of late years attempted to establish regular plantations of rubber trees in Assam and Madras. A memorandum, by Mr. Gustav Mann, Conservator of Forests, Assam, describing the growth of trees from seeds, was given in the *Kew Bulletin*, 1891, pp. 100–2 [p. 162]. In the *Kew Bulletin*, 1892, p. 68, it was stated that the imports into this country of Assam and Rangoon rubber in 1891 amounted to 350 tons.

The Government of India issued directions in May, 1884, that for five years from that date the Assam plantations should be

increased by 200 acres a year. Part of this extension it was recommended should be situated on higher ground than hitherto planted. At the same time, it was added, endeavours should be made to induce private persons to plant india-rubber trees on their estates, seedlings being offered by the Forest Department at cost price. It was also suggested that the experimental planting of *Ficus elastica*, as an epiphyte might with advantage be undertaken by the Forest Department. In a state of nature this plant generally reproduces itself in this way, and although the growth of the seedlings thus raised is slow at first, the trees are said to grow to much larger dimensions ultimately. This method of reproduction is moreover inexpensive, as the seedlings do not require any attention after they have once been deposited in the upper forks of trees. The Government of India also desired that in order to test the financial results of the cultivation of this rubber 50 mature trees should be experimentally tapped annually. In the reports of subsequent years the results of these experiments are fully given. The amount of rubber obtained showed a singular irregularity year by year. It varied so greatly that while the yield in one year was as much as 26 pounds per tree, it would fall in another year to a little over two pounds. The value in money depended, of course, on the market, but at an average price of 1*s.* 6*d.* per pound the extreme yield per tree varied from 39*s.* to 3*s.*

The fluctuations in the yield of one and the same tree in different years are, therefore, very considerable, and they remain up to the present inexplicable, "since the officers under whose personal supervision these experiments were made have not been able to find out any reasons for, or causes of, these very material fluctuations."

There is another point of practical importance. It is well known that *Ficus elastica* will grow with undiminished rapidity and luxuriance in situations remote from the hills, but in such localities it fails to yield caoutchouc. Hence, Mr. Mann concludes that no greater mistake could be made than to start plantations of this tree in the plains of Bengal. This is true also of many parts of the world where the tree has been introduced. In spite of the abundance of the tree under cultivation in the tropics of both the Old and New World it has nowhere proved valuable for the production of rubber except in the mountainous parts of Assam.

Owing to doubt as to the financial results of the cultivation of *Ficus elastica*, even in Assam, the work undertaken by the Government of India has latterly been suspended. In fact, no extensions have been made since the year 1893-94. The total area of the plantations already established is estimated at about 2,000 acres, but it is admitted that many parts are not fully stocked.

Great difficulty has been experienced in preserving the trees from illicit tapping by the natives even in the reserves. "It is rare to find a vigorous tree of any sort, and then it is invariably too old to yield rubber in quantity." The present position of the rubber industry in Assam is very fully discussed in a "*Note on*

an Inspection of Certain Forests in Assam," by Mr. H. C. Hill, Officiating Inspector-General of Forests, dated the 31st March, 1896. From this note the following extracts are taken :—

The continued destruction of naturally-grown rubber trees and the impossibility of preserving them.—The illicit tapping of trees in reserves, sparsely scattered over miles of almost impenetrable evergreen forest with an undergrowth of cane, is easily explained. The roughly collected impure rubber sells at a rupee a seer, and to obtain a number of seers which are interchangeable for 12 times their weight of rice at the nearest Koya's shop, a man has only to make his way to a tree, make cuts in the roots, and returning three days later collect his spoil. No system of inspection paths or staff of patrols would render protection effective over a block of forest of 200 square miles, such as the Bálipara and Charduar reserves, south and west of the Bhoroli river, with perhaps 10 or 20 trees to the square mile in the richest parts, even if men could be got to stay in the forests in the rainy season. Under existing arrangements the tapper works in the rains when all guards are withdrawn. The northern boundary abuts the Akha and Duffla hills and is uninhabited and trackless except for wild elephant paths, therefore the rubber once collected is easily carried across the line to be reimported as foreign produce. Formerly, when the right to collect rubber within Government forests other than reserves and to import from foreign territory was leased, gangs of Nepalese employed to collect rubber beyond the Inner Line defied the forest staff, and, assembling in numbers within the reserves, tapped everything before them. This began the destruction. Now, with fewer trees to work on, and licensed purchasers who pay the royalty of Rs. 12 on foreign rubber, illicit tapping goes on and the rubber is passed off to licensed purchasers as foreign rubber. The result is the continued destruction of the trees in reserves as well as in unclassed forests. And, if this is the state of things within the Inner Line, it may be safely concluded that the trees are being generally killed off across the Line, unless the reported religious regard for the tree in the Abor hills is affording it protection in that country. . . .

Plantations are the only means of assuring a continuous rubber supply.—The quantity of rubber exported from Assam annually at present amounts, in round numbers, to 3,500 maunds, worth in Calcutta $3\frac{1}{2}$ lakhs of rupees (35,000*l.*). The Government royalty at Rs. 12 a maund amounts to Rs. 42,000 (4,200*l.*) a year, and it will, I think, be admitted that, with a view to making this supply continuous it behoves Government to invest a fair proportion of these receipts, if they can be profitably invested, with this object in view. The only prospect of success, financial or other, seems to be in the direction of artificial plantations, where the trees can be concentrated on a limited area, the effective protection and exploitation of which will be possible.

Financial prospects of the plantations.—Can these plantations be expected to become a profitable investment ? Hitherto the Government of India, acting on the advice of the Inspector-General of Forests, who had consulted the local officers (Messrs. McKee

and Campbell), decided in 1894, that the further extension of the plantation was not advisable because a considerable amount of expense would be incurred, and there was a great doubt whether the expenditure would prove remunerative ; and further because, even if it were remunerative, many years must elapse before any profits could be obtained. My observations and an examination of the plantation and of the facts connected with the rubber supply of the future may not justify the expectation that the Government will reconsider their decision of 1894 ; but as both Mr. Smythies and Mr. Home, who have followed Mr. McKee as Conservator in Assam, are more hopeful of the financial prospects of the plantation and express doubts as to the wisdom of the orders passed, I venture to put forward a further forecast of results which it seems to me may be safely anticipated.

In the first place, the cost of establishing the plantation was estimated in 1879 at Rs. 36 per acre. Mr. McKee's estimate of 1893 was Rs. 50. Mr. Smythies was of opinion that Rs. 20 would suffice for planting out an acre, and adding Rs. 10 for maintenance the cost would be Rs. 30. Mr Home's estimate is Rs. 40 an acre for planting with maintenance. In my opinion this cost-rate will suffice and should not be exceeded, and where open lands are planted as in 1892–93, the cost may be estimated at Rs. 30. Mr. Home is able to show that, exclusive of Rs. 34,000 spent on experiments, the existing plantation has cost Rs. 50 per acre, and with the experience gained there can be little doubt but that operations will be cheaper in the future.

The prospective yield of the plantation is discussed at length in paragraphs 9 to 15 of Mr. McKee's report, but it would seem that some assumptions have been made too unfavourable to the plantation.

Trees have been put out in the older compartments 100 feet by 25 feet apart or to the number of 17 trees to the acre. In the younger compartments the trees are spaced 70 feet by 35 feet or 18 to the acre. It has been assumed that half the trees would disappear and only seven or eight remain per acre, on the score that the average lateral spread of 50 natural trees being 94 feet, they cover an average of 980 square yards. This is apparently a mistake for 770 square yards, and as now planted, the trees might have an average diameter of crown of $\frac{70' + 35'}{2} = 53$ feet and cover 245 square yards. I think it may reasonably be held that more than eight trees, but with a less superficial area than $\frac{4840}{8} = 605$ square yards, will be permanently maintained. But admitting that an acre with eight trees or more will only yield 40 seers at a tapping, which may be repeated every five years, the net value of the rubber is very much understated by Mr. McKee. Instead of Rs. 50 it should be Rs. 80 per maund, and the return per acre per annum thus becomes Rs. 16 instead of Rs. 10. If the Rs. 40 initial outlay are taken at 50 years at $3\frac{1}{2}$ per cent. compound interest to mount up to Rs. 220 and interest at $3\frac{1}{2}$ per cent. paid on this out of the Rs. 16, there would still be a net return of Rs. 8 per acre per annum.

In order to ascertain what prospect of yield the plantation gives at present, I had four good trees tapped. Their age is 18 or possibly 20 years, as the old trees date from 1875, and the first compartments were only successfully planted in their present completeness in 1877–8. They yielded respectively 23, 21, 11 and 41 chittacks (approximately equivalent to 3, 3, $1\frac{1}{2}$ and 6 lbs.).

This was valued locally at Rs. 97 a maund, and allowing for some further drying and a fair rate for collection, the net value may be taken at Rs. 80 (a little over 1*s*. per pound).

The rubber was sent to Dr. Watt with a view to his obtaining an independent valuation in Calcutta. The result of this valuation is Rs. 105 to Rs. 108, Rs. 100 to Rs. 105, Rs. 110 to Rs. 115, Rs. 110 to 112 respectively, per bazaar maund landed in Calcutta (equivalent to an average price of 1*s*. 6*d*. per lb.).

One man taps three trees in a day or collects the rubber from two trees, so that 15 men would tap and collect the rubber from an acre containing 18 trees. Allowing a margin, the collection should be done for Rs. 10 a maund. The yield varies with the spread of the crowns and the more or less openness of the situation. The smallest yield was obtained from an enclosed tree in the middle of the compartment; the largest from a tree open on two sides situated on the bank of the Mansiri river. Previous tappings had been confined to the least vigorous and most suppressed trees in the lines, and hence the rubber obtained gave no indication of the yield of the plantation, the dominant vigorous trees of which alone yield rubber freely.

I think the yield obtained from these few trees justifies the assumption that 20 seers (41 lbs.) could even now be obtained from an acre, and that it is reasonable to suppose a maund will be readily obtained at or before the age of 50 years, and that Rs. 16 per acre per annum can be counted upon.

Extension of plantation work.—If these views are accepted, there would seem to be a good case for extending the plantation by 250 acres a year, at a cost of Rs. 10,000, for the next 12 years at least. By this time it will cover an area of 5,000 acres, the prospective yield of which would be, even according to Mr. McKee's estimate, 1,000 maunds of rubber per annum, adding a net income of at least Rs. 80,000 to the forest revenues of the province.

Cost to Government and the possibility of increasing the duty.—As already shown, Government is only required to forego 25 per cent. of the revenue it is now deriving from the extermination of the natural rubber trees.

Considering that men are ready to pay up to Rs. 38 a maund for rubber collected from the forests in the Tezpur district, with a guaranteed yield of 168 maunds from one of the two mahals (eastern) into which the district has been divided, it may be desirable to raise the royalty from Rs. 12 to Rs. 20 a maund. This would still leave an ample margin for profit, since the cost of collection and carriage varies from Rs. 16–8 in the Garo Hills to Rs. 30 paid by mahaldars.

XXXIV.—ASSAM RUBBER IN EGYPT.

[*K.B.*, 1897, pp. 429–430, & 1899, p. 87.]

The following correspondence gives the promising result of an attempt to produce rubber from *Ficus elastica* in Egypt :—

Mr. FLOYER to ROYAL GARDENS, KEW.

Cairo, May 2, 1897.

SIR,

THANK you very much for the seeds of *Ficus elastica*. I have put in this spring some 50,000 cuttings, and about 96 per cent. are doing well, owing to favourable weather. But, according to Indian experience, the tree does better from seed.

We need millions of trees as shade for the new agricultural roads, and some of them may well be rubber producers, in view of the fact that the present supply is obtained in great measure through the destruction of the trees.

The trees here yield more freely than those of the Chardwar experiment. I have posted a small sample of the India-rubber. The product is very uniform, and a small sample is as good as a large one.

Will send you shortly some gutta from *Calotropis*.

Yours, &c.,
(Signed) ERNEST A. FLOYER.

Messrs. HECHT, LEVIS, and KAHN to ROYAL GARDENS, KEW.

21, Mincing Lane, London, E.C.,
May 19, 1897.

DEAR SIR,

WE have your favour of yesterday ; also a sample of rubber. It is equal in quality to the fine Darjeeling Assam, and if it comes here exactly like this sample, equally strong and pure, it would at the present moment sell at 2*s.* 6*d.* per lb., and such rubber could be readily sold at any time.

Always at your service, we are, dear Sir,
Yours, &c.,
(Signed) HECHT, LEVIS, and KAHN.

A short note in the *Kew Bulletin*, 1897, p. 429, announced the commencement of an attempt to produce rubber from *Ficus elastica* in Egypt. The following two supplementary letters show the promise that Mr. Floyer has met with in continuing the experiment :—

Mr. E. A. FLOYER to ROYAL GARDENS, KEW,

Cairo, July 17, 1898.

SIR,

THANK you for sending me the *Bulletin* about our India-rubber.

This year we are trying the yield of each tree. Mr. Luiji Heinschneider, of the Gezira Palace, has placed some trees 28–30

years old at our disposal. So far two are tapped. No. 1 gave $2\frac{1}{2}$ lbs.; No. 2, $5\frac{1}{2}$ lbs. The tapping is conducted with a view of getting another yield next year from the same trees.

The year's crop of cuttings will be about 7,000 only. We are still unsuccessful with seed.

Yours truly,
(Signed) ERNEST A. FLOYER.

Cairo, June 12, 1899.

DEAR SIR WILLIAM,

THE three trees, *Ficus elastica*, which I tapped last year, and which yielded $10\frac{1}{2}$ lbs. of rubber, sold at 3*s.* 3*d.* per lb., have been tapped again this spring. They yielded $5\frac{3}{4}$ lbs. of rubber, the principal falling off being in tree No. 2, which is much overgrown by tree No. 1.

I have put out this spring nearly 3,000 *Ficus*, and hope in due time a rubber industry may be started.

Yours truly,
(Signed) ERNEST A. FLOYER.

XXXV.—INDIA-RUBBER: BRITISH SOLOMON ISLANDS.

[*K.B.*, 1897, pp. 419, 420.]

"During the present visit to the Protectorate I made several experiments with a view to the production of india-rubber, the trees experimented upon being chiefly various species of parasitical *Ficus*. I regret to say that my experiments were unsuccessful. I was, however, shown by one of the Aola traders, who had just returned from British New Guinea, some samples of rubber now being procured there by the natives. The man who showed me the samples said that he had seen the same tree as that from which they were produced growing in the Solomons, and from his description it appears to be also a species of *Ficus*. The natives of New Guinea, the trader told me, allowed the sap of the tree to run over their arms and body and when it was sufficiently solid removed it and rolled it up into lumps. The lumps were rather larger than a cricket ball and it was worth to the New Guinea traders from 2*s.* 6*d.* to 3*s.* per lb."

XXXVI.—CASTILLOA RUBBER OF CENTRAL AMERICA.

(*Castilloa elastica*, Cerv.)

[*K.B.*, 1887, Dec., pp. 13–16.]

This is one of the earliest described of rubber-yielding plants, but according to Sir Joseph Hooker (Trans. Linn. Society, Vol. II., pt. 9, p. 209), it is probable that more than one rubber-bearing species exists in Central America under this name.

The Ule of British Honduras and Nicaragua is no doubt *Castilloa elastica* of Cervantes, but what is known locally as Tunu and said to yield a "gutta-percha," is so far undetermined owing to the absence of good specimens of the leaves and flowers. The species named *Castilloa markhamiana* (Collins, Report on the Caoutchouc of Commerce, 1872, p. 12, t. 3) has been shown to belong to another genus, viz., *Perebea* (Genera Plantarum, Vol. III., p. 372).

Plants of *Castilloa* have been widely distributed from Kew to various tropical colonies, and seed-bearing trees are now found in Ceylon, Singapore, Mauritius, Jamaica, Trinidad, and the west and east coasts of tropical Africa.

The original stock of Kew plants was obtained by Mr. R. Cross in 1875 for the India Office from the Isthmus of Panama, under the name of Caucho. The identity of the Ule of British Honduras with the Caucho of Darien appears to be not fully established. The points of difference so far noticed are, however, very slight. With regard to Ule, Sir Joseph Hooker mentions that "all the "branchlets are clothed densely with substrigose buff-coloured "hairs; the leaves are scabrid above, and densely hirsute or "hirsutely tomentose beneath. On the other hand, Cross's "indigenous specimens of Caucho, and those cultivated in Ceylon "(derived from the same source), have the branchlets less clothed "with hairs and the under surface of the leaves less thickly "tomentose."

The above brief statement respecting the determination of the rubber-yielding plants of Central America will serve to show the present position of our knowledge of the subject.

The plants distributed from Kew, and now under cultivation in various tropical colonies, would be more correctly termed according to the place of origin *Darien Castilloa*. This would distinguish them from the Ule of Mexico, British Honduras, and Nicaragua, and sufficiently indicate their history. As regards the quality of rubber yielded by the Darien Castilloa, the Kew Report for 1882, p. 40, gives an account of the first sample of caoutchouc obtained from this plant in the Old World.

"In October 1882, the Director of the Royal Botanic Gardens, "Peradeniya, Dr. Trimen, forwarded to Kew a sample of the "rubber of *Castilloa elastica* grown in the Experimental Gardens "at Heneratgodde, Ceylon. This was sent from Kew in 1876 (*see* "Kew Report, 1876, p. 9). The sample was submitted to S. W. "Silver, Esq., F.L.S., who very kindly reported upon it :—'On "' working and drying a portion of this sample, the loss is 12·3 "' per cent.; it is necessary to use warm water in washing this "' rubber; it becomes, on drying, much darker and shorter than "' Para rubber. It has a bitter taste, which is not removed on "' washing. The unwashed sample yields 1·9 per cent. ash, the "' washed sample gives 1·2 per cent. The shortness of this "' rubber would restrict its use to some extent where tensile "' strength or tenacity is required.' It was valued, Dec. 8, 1882, "as worth 2*s.* 9*d.* to 3*s.* per pound."

The collection and preparation of rubbers as a forest product has hitherto been almost exclusively in the hands of natives,

whose only object has been to obtain as large a quantity as possible of a marketable character, without any regard to the permanency of the industry or the quality of the article produced. In many localities the rubber trees have been so ruthlessly cut down or tapped, that they have been almost annihilated. In others, the preparation of the rubber is of so rude and unsatisfactory a character, that the waste must be enormous. Under these circumstances it is most important to extend knowledge of the subject, and it is to be hoped where rubber trees still exist under British influence, that careful steps will be taken to regulate the tapping or bleeding, and to replant areas already denuded of trees.

In the special instance of the rubber industry at British Honduras we have been lately favoured with the following correspondence :—

COLONIAL OFFICE to ROYAL GARDENS, KEW.

"Colonial Office, Downing Street,
11th November, 1887.

"SIR,

"I AM directed by Secretary Sir Henry Holland to transmit "to you a memorandum on the cultivation and preparation of "india-rubber, which has been prepared by Mr. Alvan Millson, "who was formerly a district magistrate in British Honduras, and "has now been appointed to be a district commissioner in the "colony of Lagos.

* * *

"I am to request that the memorandum, which is sent in original, may be returned with your reply.

"I am, &c.,

D. Morris, Esq. (Signed) JOHN BRAMSTON."

NOTES on CASTILLOA RUBBER TREE of BRITISH HONDURAS, by MR. ALVAN MILLSON.

There is but little to be added to the admirable account given by Mr. Morris (now of Kew) of the *Castilloa elastica* in his book on the colony of British Honduras; but the cultivation and preparation of india-rubber is of daily increasing importance, and there is little doubt that information which in any way lessens the difficulties at present encountered in dealing with this article is worthy of statement and examination.

Cultivation.—The details I am able to give with regard to the cultivation of the rubber tree are mainly founded on hearsay evidence, but many of them have also come under my own observation. The present methods may be classified under two heads :—

(i.) Cultivation as a shade tree for other crops, and

(ii.) Cultivation for its own sake.

(i.) The rubber tree is a tap-rooted tree, of small foliage area, a lover of deep moist, clayey loam, well shaded by undergrowth, and appears to need surrounding low bush to force it to its full height.

The natural deductions from the above facts are that while it does not exhaust the soil in which the surface-rooting crop underneath it may be planted, it gives but little shade unless planted at very short distances. Until it has attained sufficient dimensions to shade *itself* (for it will not grow well if the sun gets at its trunk) and the plants beneath its branches, it must be protected by some other shade tree, its natural habitat, like that of the Jamaica pimento, being in old plantations among the under-brush that so rapidly springs up in humid soils. If planted sufficiently closely to shade its own stems, without which both the growth and flow of milk will be checked by the heat of the sun, it must of course ultimately damage the crop beneath it, and, in the case of cacao, when both crops come to maturity about the same time, both crops would be injured to an almost equal extent.

(ii.) If grown as a special crop, the seeds should be planted, I believe, at a distance not exceeding 15 feet from one another, should be left for a year or two in uncleaned ground so as to allow the under-bush to shade them and stimulate their growth—a small area of about a foot in diameter being kept clear round each plant—and only when sufficiently large to shade one another to a certain extent should the plantation be thoroughly brushed with a machete.

On the plantation of M. Lefebvre (No. 7, Rue des Petits Hôtels, Paris), in the western district of British Honduras, several trees planted and treated as just described reached a diameter of nine inches at a height of four feet from the ground, and flowered and fruited in less than four years. Others in well-cleaned land did not make half this progress.

Stakes, if set in the ground, make more apparent progress than seeds (seedlings should not, I think, be planted, on account of the extreme length and delicacy of their tap roots), but two or three years suffice to show that the seeds make more certain and rapid progress.

I have reason to believe that the *Castilloa elastica* affects the neighbourhood of rivers chiefly, because the bush in such places is always stunted by the floods so as to allow the rubber trees to have full growth, and is yet sufficient to give the ground and stems full shade. Under these circumstances the trees will reach a great size, while in identical soil in the open savannah they make no apparent progress.

Preparation.—A great difficulty has hitherto been found in extracting the milk from the tree in a satisfactory manner. The method now employed is wasteful both of time and of the quantity and quality of the milk extracted. I append a rough sketch of a machine* invented by Mr. Blancaneaux, of the Cayo, British Honduras, which avoids all these disadvantages.

Coagulation.—The methods which at present prevail for coagulating the milk are well described by Mr. Morris. I cannot

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* Not reproduced.

but think, however, that a plan suggested to M. Lefebvre by a series of experiments in the spring of this year (sample of the result of which I possess, and will forward at a later date,) offers decided advantages over any other.

M. Lefebvre's method.—The milk is put into a barrel with a tap at the bottom, and three parts of pure limeless water are added to every part of milk. After standing for twenty-four hours the water is drawn off through the tap and the process repeated twice more. The well washed milk is then pressed slowly in a finely perforated vessel and yields a quality of rubber free alike from undue viscosity and brittleness. A sample of rubber thus prepared is difficult to distinguish from the smoke-coagulated Pará rubber which at present leads the market.

The above account, given by Mr. Millson, is printed without any expression of opinion as regards the value of the suggestions made. Experience alone can decide the circumstances best suited to the cultivation of this tree in different tropical colonies. There is also much more to be learnt and worked out as regards the best means to be adopted for tapping rubber trees, and for preparing the milk so as to yield the largest available amount of marketable rubber.

The preparation of Castilloa rubber is described by Morris (Colony of British Honduras, p. 76), as follows :—

"At the close of the day the rubber-gatherer collects all the "milk, washes it by means of water, and leaves it standing till the "next morning. He now procures a quantity of the stem of "the moon-plant (*Calonictyon speciosum*), pounds it into a mass, "and throws it into a bucket of water. After this decoction has "been strained, it is added to the rubber-milk, in the proportion "of one pint to a gallon, or until, after brisk stirring, the whole of "the milk is coagulated. The masses of rubber floating on the "surface are now strained from the liquid, kneaded into cakes, "and placed under heavy weights to get rid of all watery particles. "When perfectly drained and dry, the rubber cakes are fit for the "market, and exported generally in casks."

The idea respecting the preparation of rubber, as suggested above by Mr. Millson, without the aid of the moon plant or of alum, which latter is also sometimes used, would appear to be not entirely new. In the Report on the Caoutchouc of Commerce, by Collins, published in 1872, it is stated that if the juice of plants is not procurable "about two parts of water are added to one part of "milk, and allowed to stand for 12 hours. The residue which "separates from the water is poured into vats made in the ground "and left to dry. This drying takes from 12 to 14 days. "Sometimes the milk is simply poured on prepared ground, and "the watery portion allowed to evaporate or otherwise disappear. "The rubber, when dry, is subjected to pressure in order to get "rid of the *bolsas* or pockets of watery liquid."

D. M.

XXXVII.—CENTRAL AMERICAN RUBBER.

(*Castilloa elastica*, Cerv.)

[*K.B.*, 1899., pp. 159–164.]

Some account of *Castilloa* rubber, and of the species producing it, was given in the *Kew Bulletin* for December, 1887, pp. 13–16 [p. 170]. Since then its cultivation as a source of rubber-supply has attracted some attention in Mexico and the West Indies. It has not, however, been easy to obtain any trustworthy data as to the practical methods to pursue or as to the cost and return to be expected. The following account is therefore reprinted from the United States Consular Reports (May, 1899, pp. 147–151). It appears to have been drawn up by a man conversant with the subject and with a good deal of care :—

"Consul-General Beaupré sends from Guatemala, under date of January 28, 1899, a translation of an article on rubber prepared by Mr. José Horta, of the city of Guatemala. Mr. Horta, adds the Consul-General, is an experienced agriculturist, and has handled the subject ably. Extracts from his report are given below.

"In Guatemala *Castilloa elastica*, Cerv., is found in the wild state, and covers an immense zone in Central America ; the rubber which this tree produces is one of the best and most valuable for the industry.

"The *Castilloa elastica* is a tall, well-shaped tree, with smooth, greenish-white bark. At a height of from 15 to 20 yards from the ground there start from the trunk (of spongy and porous wood) large and almost horizontal branches, from which hang two rows of leaves, long, oval in shape, and smooth edged (not toothed).

"The milk of the rubber tree, or its mercantile product, is contained principally in the fibres between the woody portion of the tree and the bark. This fibrous part is a vital portion of the tree. For this reason, in making incisions in the bark to obtain the milk, it is necessary to proceed with great caution and according to the method described further on.

"The milk contains more or less water, according to the time of its extraction ; on an average it can be calculated to hold about 60 per cent. water and other substances, and 40 per cent. saleable product ; of this, approximately 33 per cent. is rubber of superior quality.

"The climate most appropriate for rubber is the hot or coastal, with a temperature of from 25° to 35° Celsius (93° to 103° F.) and the altitude above sea level up to 1,500 feet. The ground should be moist, deep, and loose ; neither clay nor stone. Rubber should not be planted in the sun. We found our opinion upon the following reasons :—

"(1.) The nature of the rubber tree.

"(2.) The trials made in Guatemala since 1872.

"(3.) The consideration that, planting in the shade, there is absolute certainty of a satisfactory result.

"If the wild tree always seeks the shade of trees of greater growth in the natural forests, it is because, by the help of these, its sap remains in the state imposed by nature as a condition of its proper growth and production. It is not the desire here to make a detailed study of the tree; but we wish to note that its leaves do not resist the sun, nor do they, by the nature of their surface, oppose evaporation. It is clear that without shade there is an evaporation which must exercise a harmful influence upon the production of the milk of the tree. It should also not be lost sight of that on the Pacific Coast we have a dry season for six consecutive months, very prejudicial to plantations in the sun. Allow the rubber tree a high and well-distributed shade, without undergrowth or brush, and the result will be healthy and robust trees of rapid growth, long life, and abundant yield. It is a mistake to wish to cultivate plants, such as coffee and rubber, requiring distinct climatical conditions, soil, and atmospheres, with the desire of obtaining good yields in both. The result is that neither one nor the other finds the requirements necessary for proper development. It would appear much more feasible to conduct the cultivation of vanilla simultaneously with that of rubber, utilizing the trees for shade.

"Advocating the planting in the shade is equivalent, in a country like Guatemala, still possessing so much virgin forest, to planting in the woods. There are thousands of acres of land where it would be sufficient to clear the forest (cutting down part and removing the low branches and undergrowth) in order to obtain ground sufficiently shaded and with the necessary ventilation, the latter a condition of the greatest importance. The trees and undergrowth cut down could be spread over the ground to prevent the growth of weeds, as well as to serve as manure. In planting the rubber tree the ground should be perfectly cleaned for a circle at least a yard in diameter and the tree placed in the centre. We advise the planting of trees taken from a nursery, as incomparably better results will be obtained than by planting by seed. The nursery is formed in damp ground, shaded and well worked, and the seed (which is gathered here in March and April) planted at intervals of about a foot. The seed is planted just as gathered, with gum and all; washing may injure the later growth and may even prevent sprouting. After a year in the nursery the trees are taken out with great care (it is best if the earth adheres to the roots) and transplanted.

"The least distance at which rubber trees should be set out is 6 yards apart, and they should be in straight rows so far as possible; if a choice can be made, 8 to 10 yards would be preferable. During each of the first two years, from three to four cleanings should be made, these to consist principally of cutting with the machete the undergrowth which has sprouted, and covering the ground as has previously been explained. In the third and fourth years, two to three cleanings per year should be made; and from the fifth year, one cleaning annually will suffice until the growth of the tree impedes the further development of weeds. Before beginning to exploit, the trunk of the tree should measure at least 12 inches in diameter, and from 12 to 15 yards in height, for which from 9 to 10 years is necessary.

"The milk may be extracted from the trees twice each year, during the rainy season; about two months after its commencement and towards the termination, the most propitious time being when the tree has dropped its leaves.

"A tree planted and cultivated under good conditions will give an annual product, after nine or ten years, of 1 pound of rubber, or, say 2½ to 3 pounds of milk. With proper study of the nature of the rubber tree, the progress of its sap, and the fertilizers that might be best for it, it is very probable that this yield would be greatly increased.

"EXTRACTION OF RUBBER.

"Until now, the machete has been used in Guatemala to make the incisions in the bark, incisions in the form of small canals about three-fourths of an inch wide, which receive the milk. In other countries (as in the East Indies) there is employed a kind of knife, which allows the making of an incision which is cleaner and better directed.

"To extract a good quantity of milk it is not sufficient to make only one incision at the foot of the tree. Care should be taken that the bark of the tree remains intact in one continuous strip the entire height of one side of the tree; if the entire circumference of the trunk were cut (even by incisions situated at different heights), the tree would die within a few days. To avoid this danger we have seen the following modes employed:—

"(1.) From a certain height above the roots, incisions are made in the trunk every metre or metre and a quarter approximately, until within two metres of the first branches. Each incision consists of two symmetrical cuts, which together will cover two-thirds of the circumference of the tree, and will form an angle of 45°, in order that the milk may run freely to the lowest point. The points of all the incisions must be in a perpendicular line, so that the milk from the highest incision, after concentrating in the angle formed by the two cuts, may run to the lowest point of the next lower incision, and from there on to the following, etc., until reaching the lowest, where it is collected, as explained further on.

"(2.) The incision is extended to the same height of the trunk as indicated in the first method, but is continuous, and consists of cuts, one perpendicular to the other, always taking care never to cut into more than two-thirds of the tree's circumference, thus leaving one-third of the bark intact.

"It is useless and even dangerous to make the incisions so deep as to penetrate the woody part of the tree. On the contrary, great caution should be exercised to preserve the fibres closest to the wood.

"From the point of the incision nearest the ground the milk is conducted by a canal to a receptacle of clay or wood. When collected thus, the milk must be coagulated to obtain the solid marketable product. This part of the process merits a serious study, as the best mode of obtaining the finest and most abundant product has not been decided. We limit ourselves to indicating the principal processes we have seen employed.

"The most rudimentary consists in collecting the milk in a trough, or even a hole excavated in the ground (which detracts from its value), and employing in its coagulation the juice of the vine, here called 'Quiebra-Cajete' (an infusion of the leaves of the vine). Alum can also be employed, and exercises a very rapid action on the milk. The water contained in the milk may be evaporated by indirectly applied heat, taking care that the receptacle does not communicate a bad colour to the rubber; or, the milk may be mixed with water, which is poured off at intervals, until all impurities are removed. The clean rubber, which presents the aspect of a spongy mass, is passed through a press to expel the water, thus obtaining a white product of superior quality, which is left to dry in the shade, in order that it may not show on the outside a glutinous liquid, which detracts from its market value.

"COST AND PROBABLE PRODUCTION OF A PLANTATION.

"This calculation must naturally be incomplete, as the cost will depend in great part on the price of the lands, on the greater or less facilities for obtaining workmen, the mode of paying them (by day, by task, with advances, etc.), on the distance apart that trees are to be planted, whether the land is to be used exclusively for rubber or not, and on many other considerations.

"The figures expressed herewith, therefore, do not pretend to a rigorous exactitude, but will serve as a guide for the agriculturist.

"We will suppose that the trees are to be planted at 8 varas (1 vara = 33 English inches) distance, so that each will have an approximate area (with space occupied by shade trees) of 64 square varas, which we believe necessary for their proper development, thus allowing approximately 10,000 trees to the caballeria (112 acres); cost of land at $400 ($175.60 in United States currency)* per caballeria, a price somewhat high, as some coast land (hot) adequate for this cultivation can be purchased in Guatemala for less; but we have adopted this figure, as, according to existing laws, it is the average cost of public lands in the Republic.

	Guatemalan currency.		United States currency.
	$		$
Cost per manzana†	6.25	...	2.74
Fencing per manzana...	10.00	...	4.39
Nursery, at $10 per 1,000, say, for 159 plants...	1.59	...	.69
Preparation of ground and arranging natural shade, per manzana ...	8.00	...	3.51
Planting 159 trees to the manzana ...	3.00	...	1.32
Cleaning by machete, four in first year	16.00	...	7.02
Three cleanings in second year ...	12.00	...	5.27
Two cleanings in third year	8.00	...	3.51

* The value of the Central American peso, or dollar, was estimated by the United States Director of the Mint, January 1st, 1899, at 43.9 cents.

† Square of 100 varas, or 275 feet.

	Guatemalan currency.		United States currency.
	$		$
One cleaning each year from fourth to sixth, inclusive	12.00	...	5.27
Interest on invested capital, at 10 per cent. for ten years	68.78	...	30.19
Management, etc.	4.38	...	1.92
Total cost in Guatemala (200 per cent. premium is ruling rate on gold to-day) of 159 trees occupying a manzana of ground, and 10 years old	150.00	...	66.00

"From the foregoing calculation it may be seen that a plantation of, say, 100,000 trees requires 10 caballerias of ground (besides that which may be necessary for buildings, huts, etc.), and would cost, after ten years, about $95,000 ($41,700).

"If the annual yield of each tree after ten years is 1 pound of rubber of good class, 100,000 trees would give 1,000 centals per year of good rubber. At present price of the article, these 1,000 would be valued in Guatemalan money at to-day's exchange $262,500 ($115,238). There is to be deducted from this :—

	Guatemalan currency.		United States currency.
	$		$
Cost of extraction and collection of the milk and manufacture of product (which together may be calculated at 30 cents per pound of rubber) for 1,000 centals	30,000	...	13,170
Expense of transportation to point of shipment (which varies in each case, but can be calculated in lands situated on the Pacific coast at $1.50 to $2 per cental) for 1,000 centals	1,750	...	768
Expense for embarking, more or less, 80 cents per cental, or, for 1,000 centals	809	...	355
Ocean freight, insurance, commission on sales, and other expenses, approximately	40,000	...	17,560
Total	72,559	...	31,853

"Deducting the cost of $72,559 ($31,853) from the income, leaves a balance of $189,941 ($83,385).

"According to these calculations, one crop, after ten years, will produce double the amount expended during that time. Even reducing these figures (which are not too high) to one-half, in order to be free from any exaggeration, and supposing a yield per tree of 6 ounces of good product, the net annual product will be incomparably more remunerative than that which coffee under the best and most favourable circumstances can yield."

XXXVIII.—PERUVIAN RUBBER.

[*K.B.*, 1899, pp. 68–72.]

Up to the present time little or nothing has been known botanically with respect to Peruvian rubber. Our knowledge, in point of fact, was pretty well limited to the following statement reprinted in the *Kew Bulletin* for 1892, p. 69, from a valuable article in *The India-rubber and Gutta Percha and Electrical Trades Journal*:—

"There comes from Peru, at the sources of the Amazon and its tributaries, a rubber resembling the Nicaragua Sheet, and called Caucho. This rubber is very wet, and consequently shrinks very much, which is a serious drawback. It is considered a good strong rubber, and it is utilised to a considerable extent by the boot and shoe manufacturers."

The following correspondence supplies the first information as to the actual source of Peruvian rubber.

FOREIGN OFFICE to ROYAL GARDENS, KEW.

The Under Secretary of State for Foreign Affairs presents his compliments to the Director of the Royal Gardens, Kew, and is directed by the Secretary of State for Foreign Affairs to transmit to him the accompanying paper noted in the margin, respecting a tree which grows in Peru and produces the quality of India-rubber known as "Caucho."

Foreign Office,
May 17, 1899.

MR. CONSUL CHURCHILL to FOREIGN OFFICE.

Her Majesty's Consulate, Pará,
April 28, 1899.

MY LORD,

IT may interest those concerned to know that the tree which produces the quality of India-rubber exported from Peru, through Pará, under the name of Caucho, has recently been determined by Monsieur Huber, a botanist, who is on the scientific staff of the Museum of Pará.

Monsieur Huber lately visited the Ucayali region in Peru, and discovered that the tree was a *Castilloa*.

He will shortly be able to decide, by comparison, whether it is the same as the *Castilloa elastica* of Central America, or a species of the same genus. It had been surmised previously that the tree might be a *Castilloa*, but I believe Monsieur Huber is the first authority who has settled the point. With this knowledge it results that the distribution of the *Castilloa* is wider than was previously thought to be the case.

"Caucho" is also produced in the neighbourhood of the Bolivian tributaries of the River Amazon, and from parts near the said tributaries that pass through Brazilian territory.

A sample of "Caucho" exists, in the Museum of this City, that came from the banks of the River Tocantins.

It is said that "Caucho" is also produced near Macapa and Mazagao, on the north bank of the River Amazon, near its estuary.

A recent statistical return on the exports of the State of Pará reports that this produce was exported in small quantities (altogether about 10 tons) from Aveiros (River Tapajos), Santarem, Alemquer and Obidos on the River Amazon. The total shipments of "Caucho" from Amazonian ports amount to about 2,000 tons annually.

Monsieur Huber describes the process of tapping as follows:— "The trunk is almost severed in two at a distance of about 3 feet from the ground, and the tree is allowed to fall in such a manner that it is supported in an inclined position by its branches, and still holds on to the part that is left standing. The sap is collected and poured into a hole made in the ground, and is coagulated by means of the juice of certain local lianas. The natives state that this is the best method of tapping, and that if the trees were treated in the same manner as the Heveas they would soon be destroyed by insects which would attack them where the bark would be injured by incision. This may be only an excuse for unnecessary destruction which might be avoided. However, it must be considered that as these trees grow far apart from each other in their native state it must be inconvenient, if not impossible, to attend to more than one tree at a time.

Trees that have been tapped in the manner described do not survive the operation. In the course of time their places are, no doubt, taken by young trees that grow from seeds.

The Amazonian Castilloas are found on elevated land that is beyond the reach of floods, whereas the Heveas thrive best in the lowlands that are periodically inundated by the River Amazon."

I have, &c.,

(Signed) Wm. A. Churchill.

The Marquess of Salisbury, K.G.,
&c., &c., &c.

Royal Botanic Gardens, Kew, to Foreign Office.

Royal Gardens, Kew,
May 23, 1899.

Sir,

I have the honour to acknowledge the receipt of your letter of May 17, transmitting a copy of Consul Churchill's report on a kind of India-rubber exported from Peru, through Pará, under the name of Caucho.

2. Caucho, of which Caoutchouc is probably an expanded form, has been hitherto identified with "India-rubber" *par excellence*, the produce of one or more species of *Hevea* indigenous to the basin of the Amazons, and exported from Pará. According to the information now received, the Caucho tree of Peru is a *Castilloa*. One or more species of this genus produces the india-rubber of Central America. In South America *Castilloa* has been

known to extend as far as Ecuador, where it is called Jebe, otherwise Jeve or Heve. According to Aublet this latter name was given in Northern Ecuador to a species of *Hevea*, and in founding that genus he derived its name accordingly. In the Amazon basin the name for the species of *Hevea* is "Seringa," and in Central America for those of *Castilloa* "Ule" or "Tunu" (see *Kew Bulletin*, 1898, pp. 141, 142). Perhaps in Western South America the names Caucho and Jebe are applied indiscriminately to rubber-producing trees.

3. According to a report by Mr. D. B. Adamson, H.B.M. Consul at Iquitos, dated December 24, 1898, and published in the *Transactions of the Liverpool Geographical Society* for the same year, Peru has two kinds of rubber-producing trees: Caucho, which appears to belong to *Castilloa*, and Jebe to *Hevea* (pp. 39–40). Both Mr. Adamson and Mr. Churchill agree that the rubber is extracted from the Caucho tree by felling. The Jebe is always tapped. The former process results in a district being "worked out." In consequence, according to Mr. Adamson, "many of the 'Caucheros' [or rubber collectors] are working on Brazilian rivers, where the supply is yet more plentiful."

4. It is not, however, necessary to fell the *Castilloa* trees to collect the rubber. The method of tapping is minutely described in a report by the United States Consul-General Beaupré, published in the United States *Consular Reports* for May, 1899, pp. 147–151. The estimated yield per tree is much smaller than that given in Sir Henry Derling's report, as to which I addressed some enquiries to the Foreign Office in my letter of April 14, 1897.

I am, Sir,

Your obedient Servant,

W. T. THISELTON-DYER.

The Under Secretary of State
for Foreign Affairs,
Foreign Office, Downing Street, S.W.

EXTRACT from Report by Consul D. B. Adamson in *Transactions Liverpool Geographical Society*, 1898, pp. 39–40.

"As you are aware, rubber is the chief article of export, and hitherto has been practically the only one of any importance. Its extraction from the trees and preparation for the market is principally in the hands of Peruvians, assisted by Indian labour. The work is rough, and the hardships connected with gathering are very great. The kind exported from here in past years has been chiefly Caucho, the gatherers of which are known as Caucheros. The wasteful method adopted is, however, beginning to tell adversely as far as this particular class of rubber is concerned. This can be understood when it is explained that Caucho is gathered by cutting down the trees to collect the sap. As it is said that it takes from 15 to 20 years to arrive at a fit state to be worth cutting down, it can easily be seen that those in accessible positions are continually growing scarcer. As none are planted to supply the loss, when a district has been worked

thoroughly, nothing can be done till nature re-asserts herself. Of course the young trees are constantly growing, and places that have been worked out will, in course of time, yield again in quantity, but meanwhile the yield in them is so small that it is not worth while to collect. It must be remembered that it is only possible to collect near the rivers, on account of the difficulties of transport overland. In the interior, or rather inland from navigable waters, probably there are plenty of Caucho-yielding trees still, for there are vast tracts of land absolutely unexplored. These, however, are either inaccessible or would be unremunerative to work.

"It is much to be desired that some more economical method of gathering Caucho could be introduced, one which would allow the sap to be got without destroying the trees, as the timber is worthless. This is done in other parts of the world where more economical conditions prevail. At present many of the Caucheros are working on Brazilian Rivers, where the supply is as yet more plentiful. The heavier export duties of Brazil will cause the Caucheros to return to Peru, when, in the absence of Caucho, they will devote themselves either to its cultivation, which is scarcely likely to any large extent, or gathering the other chief kind of rubber, known as Jebe.

"This is of considerably higher value than Caucho, being worth from 70 per cent. to 90 per cent. more, according to ruling prices here. The method of gathering it, however, has not been so well understood by the native labourers, or they have not found the work so much to their taste.

"In gathering Jebe the tree is simply tapped, the sap being collected in small pans, which are emptied daily or periodically. This class of rubber collecting is conducted mainly by settlers, as distinguished from the wandering Caucheros."

To complete the available information on the subject, the following extract from Mr. Consul Adamson's Report on the Trade of Iquitos is reprinted from the Foreign Office *Report on the Trade and Finances of Peru* (1898, p. 13, No. 2,298) :—

"Rubber forms the chief article of export. Most of it goes to Europe, and very little attention is given to other productions of the district. The chief classes are Caucho and Jebe, the present prices of which may be taken as 30 and 50 soles per arroba of 15 kilos. respectively. It may be stated that these figures show a marked increase during the year. The average for 1898 is given as 26 soles per arroba for Caucho and 49 soles per arroba for Jebe. A slightly lower grade of this may be named as about 2 soles lower in price. There is also Sernamoi or scrap rubber, both of Jebe and Caucho, the average price of which during the year is given as 37 soles per arroba. The total value of all classes during the year is given as £202,916, as compared with £206,047 the year before, the quantities being 1,140,523 kilos. in 1897, and 829,935 kilos. in 1898. This falling-off may be accounted for by the increasing inaccessibility of the Caucho-bearing trees, those within easy reach having become scarce owing to the wasteful method of gathering the gum. The process has been to cut down the tree instead of merely tapping it.

"The trees are all wild, and it will take some years to allow them to grow sufficiently to gather from again. Another reason for the falling-off last year, and one of perhaps equal weight with the former, is that a large number of the Caucheros, or rubber gatherers, have gone to the Jurua and other Brazilian rivers, whence, however, there are grounds for saying the bulk of them will return. As a rule the Caucheros are not familiar with the collection of Jebe, or fine rubber, but they are learning, and when they return to Peru will probably devote more attention to it.

"The proportion of this to Caucho has considerably increased lately. Jebe is gathered by tapping the trees, a certain number of which are placed under the control of a gatherer, who visits them daily to collect the yields."

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