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All About

RUBBER

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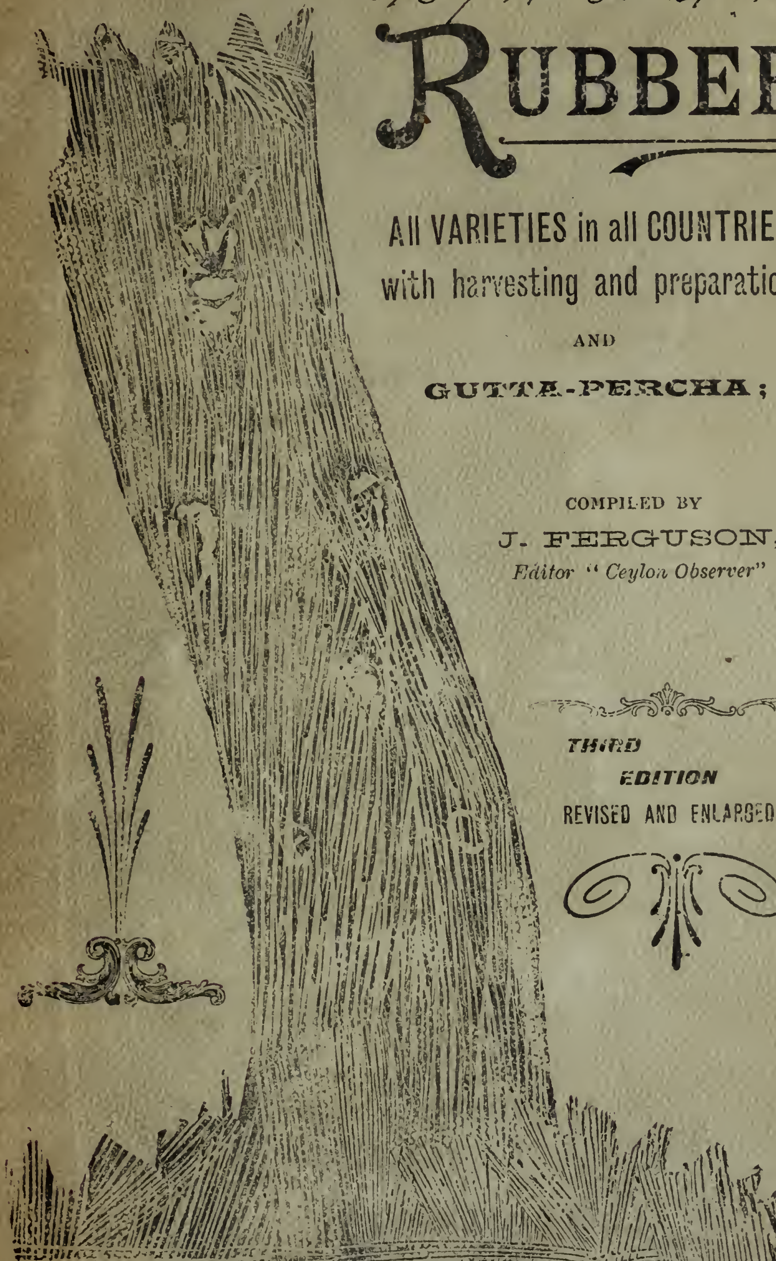
AND

GUTTA-PERCHA;



COMPILED BY

J. FERGUSON,
Editor "Ceylon Observer"

THIRD EDITION
REVISED AND ENLARGED.

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A. M. & J. FERGUSON, "*Ceylon Observer*" and "*Tropical Agriculturist.*"
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1847 Gutta-percha was suggested for electrical use by Faraday."

ALL ABOUT
RUBBER AND GUTTA-PERCHA.

THE INDIARUBBER PLANTER'S MANUAL

WITH THE LATEST STATISTICS AND INFORMATION,

More Particularly in Regard to Cultivation

AND

Scientific Experiments in Trinidad and Ceylon.

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INTRODUCTION.

Our first compilation of an "INDIARUBBER PLANTER'S MANUAL" was prepared some sixteen years ago; and a second edition, after considerable enlargement, appeared in 1887. The latter volume has now been out of print for several years, and the enquiry for a successor has been very constant not only in Ceylon, but from many quarters of the world.

We have, therefore, now brought together all the information available to us in the latest authorities on Rubber, and more especially have we utilised the valuable Circulars issued by the DIRECTOR OF THE ROYAL BOTANIC GARDENS, CEYLON; while supplementing these by all we could gather from practical CEYLON PLANTERS of RUBBER and from the Reports of the Indian and Ceylon FOREST DEPARTMENTS. We also give brief summaries of Dr. MORRIS'S useful Cantor lectures. Our estimate is that there are from 1,500 to 1,600 acres covered with rubber trees of all kinds and ages—from those newly-planted to trees 16 years old—at the present time in Ceylon.

Then in an Appendix we afford a large amount of varied reading from a scientific and practical point of view on the subject of plants yielding INDIARUBBER and GUTTA-PERCHA in all the countries where they are found. The Reports of the important experiments made by Messrs. Biffen and Hart (of Trinidad) in reference to "coagulation" and rubber preparation, are also given. We further give interesting translations from French periodicals devoted to tropical agriculture.

The rubber-yielding plants actually known are very numerous. They belong to the four families of the Euphorbiaceæ, Artocarpaceæ, Asclepiadaceæ and Apocynaceæ, and are as follows :—

Amongst the EUPHORBIACEÆ: *Hevea brasiliensis* Muell. Arg.; *Hevea guyanensis* Aubl.; *Hevea lutea* Muell. Arg.; *Hevea Benthamiana* Muell. Arg.; *Hevea pauciflora* Muell. Arg.; *Hevea rigidifolia* Muell. Arg; *Hevea discolor* Muell. Arg.; *Hevea Spruceana* Muell. Arg.

Manihot Glaziovii Muell. Arg.;
Excœcaria gigantea Posada Arango ;
Euphorbia Tirucalli L.;
Sapium biglandulosum Müll.

Amongst the ARTOCARPACEÆ: *Ficus elastica* Roxb. ; *Ficus glomerata* Willd. ; *Ficus Holstii* Warb.; *Ficus oppositifolia* Willd. ; *Ficus macrophylla* Roxb.; *Ficus laccifera* Roxb. ; *Ficus indica* Linn. ; *Ficus annulata* Bl.; *Ficus religiosa* Linn.; *Ficus prolixa* Forst. ; *Ficus altissima* Bl.; *Ficus obtusifolia* Roxb.; *Ficus prinoides* Willd.; *Ficus rubiginosa* Desf.; *Ficus Vogelii* Miq.; *Ficus Sycomorus* Linn. ; *Ficus Brazii* Brown ; *Ficus Vohsenii* Warb ; *Ficus Preussii* Warb ; *Ficus usambarensis* Warb.; *Ficus mysorensis* Heyne (*Ficus Karet*) ; *Ficus Tsiela* Roxb.;

Cecropia peltata Meyer ; *Cecropia adenopus* Mars,;
Castilloa elastica Cerv.; *Castilloa Markhamiana* Collins.;
Artocarpus elastica Reinw.;
Brosimum alicastrum Swartz.

Amongst the ASCLEPIADACEÆ : *Calotropis procera* R. Brown ;
Cynanchum ovalifolium Wight ;
Periploca græca Linn. ; *Cryptostegia grandiflora* Br.

Among the APOCYNACEÆ :

Landolphia comorensis Boj ; *Landolphia madgascariensis* Boj. ; *Landolphia Lecomtei* Dew. ; *Landolphia bracteata* Dew. ; *Landolphia Petersiana* Th. Dyer ; *Landolphia lucida* K. Schum. ; *Landolphia senegalensis* D. C. ; *Landolphia owariensis* Pal. de Beauv. ; *Landolphia Foreti* Jum. ; *Landolpia Michelini* Benth. ; *Landolphia Traunii* Sadeb. ; *Landolphia Heudelotii* D. C. ; *Landolphia tomentosa* Dew. ; *Landolphia crassipes* Radlk, ; *Landolphia Kirkii* Th. Dyer ; *Landolphia parvifolia* K. Schum ; *Landolphia Thollonii* Dew. ; *Landolphia capensis* Oliv. ; *Landolphia angustifolia* K. Schum etc.

Carpodinus dulcis Don ; *Carpodinus acida* Don.; *Carpodinus uniflorus* Stapf ; *Carpodinus Foretiana Carpodinus Jumellei* Pierre ; *etc.*

Cleghornia cymosa Wight (*Baissea acuminata* Benth.) ;

Different species not carefully described of *Clitandra* ;
Kickxia africana Benth. ;
Urceola elastica Roxb ; *Urceola esculenta* Benth ;
Hancornia speciosa Muell. Arg. ; *Hancornia floribunda* Pœppig et Endl, ;

Willughbeia edulis Roxb. ; *Willughbeia firma* Blume ; *Willughbeia Treacheri* Dyer ;

Tabernæmontana coronaria Br. ; *Tabernæmontana Stenosiphon* Stap. ; *Tabernæmontana Crassa* Benth. ;

Plumeria lancifolia Mart. ; *Plumeria phagedenica* Mart. ; *Plumeria drastica* Mart. ; *Plumeria acutifolia* Poir. ; etc. ;

Parameria glandulifera Benth. ;
Alstonia plumosa Labill. ;
Alyxia disphærocarpa Heurk et Muell. Arg. ;
Dyera costulata Hooker. ; *Dyera Lowii* Hook, ;

Camèraria lucida Jacq. *Cameraria latifolia* Jacq.;
Pacouria guyanensis Aubl ;
Nouettea cochinchinensis Pierre ;
Kopsia cochinchinensis O. K ; *Kopsia Harmandiana* Pierre ;
Melodinus monogynus Roxb. ;
Chonemorpha macrophylla G. Don.

As regards the STATISTICS of the RUBBER TRADE there is the broad fact that the world's requirements in raw rubber is fast rising from 120 to 130 million lb. a year, costing not less than 150 million pounds sterling. In confirmation, we give an Estimate of the World's Production and Consumption of Rubber, supported by such detailed figures as are available :—

INDIA-RUBBER :—THE WORLDS

Production.	cwt.
Brazil, Peru, &c. (Pará) ...	450,000*a*
,, (Ceará, &c)	94,000
,, (Mangabeira) ...	65,000
Guiana	6,000
Bolivia	30,000
Rest of South America ...	40,000
Central America and Mexico	50,000
Java, Borneo & Eastern Archipelago	20,000*d*
East and West Africa ...	480,000
Madagascar and Mauritius...	10,000
India and Burma ...	8,000*e*
Ceylon	150*f*
Australia	———
Cwt.	1,250,150

Consumption.	cwt.
America (United States and Canada)	*b*400,000
United Kingdom & Dependencies save Canada	*c*450,000
Continent of Europe	400,000
Cwt.	1,250,000

a In the official reports from Brazil, the value of caoutchouc exported is generally given at between 1 and 1½ million £ sterling; although one year (1882) Pará would seem to have sent away over £2,000,000 worth. Since then, a total export in one year of 266,000 cwt. from Brazil has been reported ; and harvest receipts equal to 24,000 tons from Paras and 14,000 from Amazonas: evidently the annual gatherings are very unequal. In 1890, the exports of caoutchouc to Great Britain alone were valued at £2 million sterling. In 1898, to Europe of Para rubber=12,078,744 kilos (about 240,000 cwt.); to United States=9,830,265 kilos (about 200,000 cwt.) 897' s export was larger by 14,000 cwt.

b 20,000 to 25,000 tons of raw rubber may be put down as the quantity used in the States.

c In 1894=303,156 cwt., imported £3,279,147; re-exported 149,203 cwt. one-third U. S., ¼ each Germany and Russia. The demand for rubber outstrips the supply. According to the "Encyclopædia Britannica," there were in 1870 in Europe and America, over 150 rubber manufactories with 75,000 hands consuming 10 millions lb. of caoutchouc or 5,000 tons. But the consumption has more than quadrupled since. Of Guttapercha in 1894, 48,846 cwt.=£446 279 imported to U. K., of which 7,975 re-exported. In 1897, the rubber requirements of the United Kingdom were put at 20,000 tons a year and that Africa supplies half of this.

d The Dutch Indies are crediting with exporting one year 65,000 cwt. guttapercha. 12,000 cwt. India rubber were imported into England from the Straits Settlements in 1888. Singapore exports 50,000 cwt. Guttapercha in a year.

e The export in 1882-3 was 10,558 cwt; in 1883-4 it was 9,173; in 1884-5 it was 8,117 cwt.; 1865-6 it was 6,553 ; 1886-7 = 7,598 cwt. ; 1887-8 it was 9,228 cwt. in 1888-9 = 8,673 cwt.; in 1889-90 = 9,934 cwt.; in 1890-1=9,212 ; in 1891-2=9,334; in 1892-3=9,972 cwt, of which 4,712 to United Kingdom ; in 1893-4=9,616 cwt. ; in 1894-5 =9.270 (f wh ch 6,695 cwt, to U. K.) ; 1895-6=7,154 1896-7=6,213 1897-8= 5,563 cwt. (3,017 to U.K). In 1898-9 = 8,020 (3,015 to U. K.)

f 65 cwt. in 1892 ; only 5,880 lb. in 1893 ; 9,198 lb, in 1894 ; 1,753 lb. in 1895 ; 17,591 lb. in 1896; 8,981 lb. in 1897; and 2,800 lb. in 1898.

Dr. Morris gives the *Rubber Imports into England* in, 1897 as 19,816 tons; and in regard to the gross value of the turn-over in the rubber trade, the figures for the year 1896 he gives as follows :—

Imports of raw india-rubber	£4,990,122
Re-exports	£2,643,782
Export of manufactures of caoutchouc ...	£1,261,774
Total trade	£8,895,678

Total Imports of Caoutchouc into the United Kingdom, distinguishing between those from Foreign Countries and British Possessions :—

	1888.		1896.	
	Tons.	Value.	Tons.	Value.
Foreign countries	... 8,509	... £2,132,662	15,465	... £3,956,126
British possessions	... 2,509	... £422,679	6,093	... £1,034,996
Total	...11,018	... £2,555,341	21,558	... £4,991,122

TOTAL TRADE.

The principal European countries together with the United States of America imported caoutchouc in 1896-7 to the following approximate amount and value :—

Countries	Years.	Quantity. Tons.	Value. £
Great Britain	... 1896	... 21,558	4,991,122
France	... 1896	... 5,177	1,111,256
Germany	... 1897	... 8,436	2,320,150
Belgium	... 1897	.. 2,236	545,835
Holland	... 1897	... 1,672	141,667
Austria-Hungary	... 1897	... 2,109	811,415
U.S. America	... 1897	... 18,821	4,514,587
Total	...	... 60,009	14,436,032

PRICES OF INDIA-RUBBER.

(*From S. Figgis & Co.'s Fortnightly Price Current*, 15*th June* 1899.)

		s.	d.		s.	d
INDIA RUBBER ...	Red hard clean ball	...3	2	to	3	6
East African Ports, Zanzibar and Mozambique Coast	White softish ditto	...2	8		3	0
	Unripe root	...1	2		2	1
	Liver and Lamu ball	...2	8		3	0
	Sausage, ordinary to fine ...	...3	0		3	4½
	without sticks ...	...3	3		3	6
INDIA RUBBER, Assam ..	Good to fine ...	..2	8		3	3
	Common foul and middling ...	...1	10		2	5
Rangoon ...	Fair to good clean ...	...2	11		3	1
Madagascar, Tamatave, Majunga and Nossibe	Good to fine pinky and white	...3	2		3	4½
	Fair to good black ...	..1	8		2	6
	Fair to fine nigger ball ..	..1	5		2	7
INDIA RUBBER, Borneo ...	Fair to fine clean	1	9		2	5
	Mixed, part dead ...	.. 1	1		1	6½
Java, Singapore & Penang	Good to fine red selected ...	...2	8		3	1
	Mixed part soft ...	...1	7		1	10½
	Pickings, part common ...	..0	9		1	3
GUTTA PERCHA, gen. ...	Fine clean Banj. & Macasar ...	...3	3		5	6
Sumatra ...	Barky to fair	...1	0		3	0
Reboiled ...	Common to fine clean ..	...0	2		1	3
White Borneo ...	Inferior to fine clean hard ...	...0	3		3	0
Manilla ...	.. ..	...0	2		0	9

During the next few years we may expect to see several inventions adapted to the use of Rubber planters in the harvesting and preparation of their produce. Mr. Biffen and Mr. Hart of Trinidad have already experimented in this direction and we hear of a Rubber Machine invented by Mr. T. Christy, F.L.S., of Lime Street, London, an account of which we have not yet been able to get, although we believe one of the machines will soon be at work in Ceylon.

It is interesting here to mention that the largest Para Rubber tree on Culloden estate in the Kalutara district has a girth of about 8½ feet at three feet from the ground. This tree is some fourteen years old and others of about the same age are well over 7 feet in circumference.

In the hope that our Compilation may prove of service to the pioneers in what we trust will yet prove an important industry in Ceylon, Southern India and the Straits Settlements, we commend this Manual to the attention of all interested in the subject treated, and especially of all INDIA RUBBER PLANTERS.

Ceylon Observer Office:
Colombo, 1st August, 1899.

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Caoutchouc or Indiarubber Yielding Trees.

We need scarcely enter on the importance of the Rubber industry or of the great trade in rubber which has now developed with all countries supplying the raw material and the growing need there is for supplementing such supplies by cultivating the more suitable kinds of rubber-yielding trees, more especially in the West Indies, some parts of Africa, Ceylon, Southern India and the Straits Settlements. Suffice it to say that we are dealing with a trade in crude rubber which now amounts to fully a million tons, worth more than ten millions sterling, a year, the greater part of which is still Para from the valley of the Amazon, though West African and Central Americau supplies are increasing. But we do not pursue this subject farther for the present. We begin rather by dealing with the industry as introduced and so far carried on in Ceylon of the cultivation of rubber-yielding trees.

The Industry in Ceylon.

When the great calamity of leaf-disease (*Hemileia vastatrix*) was realized to be fatal to coffee growing in Ceylon, such planters as did not clear out of the Colony turned their attention to new products, and among the rest Indiarubber-yielding trees attracted a good deal of attention. The virtues of the Para (*Hevea Brasiliensis*), of the Panama or Mexican (*Castilloa elastica*) and of certain African creepers (*Landolphia*) were freely discussed; but, unfortunately, attention was at length concentrated on the Ceara (*Manihot Glaziovii*) as being the quickest growing and which promised at the time not only early but handsome returns. It was proved, indeed, that the tree grew very rapidly; but the yield of rubber was found to be distinctly disappointing in the great majority of Ceara trees. Nevertheless, the cultivation and harvesting were persevered with in the Dumbara Valley, and the returns of rubber were said to be profitable, until it was found that the Ceara trees and their shade were inimical to the more important Cacao trees underneath. In the same way the culture of Ceara has been abandoned in the Java Botanical Gardens because "the promised magnificent results have in no respect been fulfilled." In the case of Ceylon we may as well extract from our "Ceylon Handbook and Directory" the consecutive account of the industry from the day in 1876 when seeds were first obtained from Kew of the *Hevea Brasiliensis* (Para) rubber-yielding tree. We quote now as follows:—

In August 1876, 38 wardian cases with 1,900 of *Hevea brasiliensis* plants were transmitted from Kew to Ceylon, where 90 per cent arrived safely and were to be nursed and established in the Government Gardens here for subsequent transmission through the Indian Gardens to Assam, Burma and other hot damp provinces of India proper.

But although the successful growth of both *Hevea* and *Castilloa* was reported from our Botanic Gardens and elsewhere, the kind which very soon more particularly secured the attention of Ceylon coffee planters was the Ceará rubber. The growth of this description was equal to two feet per month at Henaratgoda; it also flourished exceedingly on comparatively poor soil in many districts, and indeed planting experience went to shew that it would grow almost anywhere under 3,000 feet in Ceylon, with the very minimum of trouble, seeds even which are dropped or thrown about, germinating and springing up, but the germination takes a considerable time even in regular nurseries, unless artificial aid is used, by filing the end of the seed or putting it in hot water.* Dr. Trimen told us about the experiments so far made in his Reports for 1883 and 1884: in the former he wrote:—

"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 a Peradeniya Gardens' Report a year later, he told us:—

"*India-rubber. Ceara.*—I have nothing further of a practical nature to report as to any method of collecting the Ceara-rubber at a cost sufficiently low to make it profitable to the European planter. It is, however, clear, that as the trees attain a larger size and greater age, there is a more copious flow of milk, and the tears of rubber obtained by leaving it to dry on the trees are larger and more solid. One of the original trees in Peradeniya, nearly 8 years old, and about 14 inches in diameter, has lately been cut down in making a new path; this tree had been thoroughly drained of milk in 1882, but on now repeating the operation, nearly 1½ lb. of dry rubber was obtained."

In Dr. Trimen's Reports for later years, no reference is made to Ceara, though much to other kinds of rubber (see further on) until in his Report for 1890, we have the following:—

"Ceara Rubber (*Manihot Glaziovii*).—Interest in this plant 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, howeverr, 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

---

* A coconut planter in the Jaffna peninsula wrote some years ago:—"I am trying Ceará rubber up here and, as far as I have gone, have found it a decided success. I have about an acre of plants just three months old *from seed*, and two of the larger ones now measure 6 *feet* and 5 *feet* 10 *in.* in height respectively; the seed began to germinate in *six days* from date of sowing, and the *majority* of the plants were above ground in less than a *fortnight*!"—Bennett in 1843 strongly recommended the Kalutara district, from its shade and moisture, for the growth of caoutchouc (*Ignatia elastica*).

† This is to be expected; for it should be recollected that the "milk" in plants is quite distinct from their sap, and is contained in special channels. It has no nutritive function, but, like the alkaloids in cinchona, is rather of the nature of an excretion. Its removal, therefore, *per se*, inflicts little or no injury on the plant.—Dr. T.

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 oz., 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 likely the 'Ceara Scrap' of commerce, but in smaller 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 also 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."

In Dr. Trimen's Report on the Peradeniya Gardens for 1883 we had the following reference to the rubbers other than Ceará (already quoted):—

"*Castilloa Rubber.*—From a single tree at Peradeniya a considerable crop of seedlings was raised. The fruits ripened at the end of May; they are little, white, pointed nuts, about half-an-inch long, covered by a bright orange pulp, and some 20 to 30 are crowded together on the fleshy flattened scaly receptacle, forming collectively what is called a compound fruit: about half of the fruits ripen and contain each a single seed. I have already expressed my opinion as to the suitability of this tree for cultivation by a Forest Department as a source of prospective revenue; and as comparatively few of the plants were disposed of to private persons, I made an endeavour to get plantations of this valuable tree formed at Ratnapura and Kalutara. The plan was sanctioned by the Governor, and I gave the necessary instructions: but after three months' delay it was discovered that the trifling sum necessary could not be provided.

"The growth of the largest *Castilloa* tree at Henaratgoda is, at a yard from the ground, 30¼ inches, an increase of 4¼ inches during the year.

"*Para Rubber.*—Nine trees flowered at Henaratgoda in March, and the fruit ripened in August. About 260 seedling plants were raised, many of which have been disposed of to persons desirous to try the cultivation. Our largest tree is now 30 inches in circumference, an increase of 4½ inches in the year. Eighteen plants of another species of Hevea, *H. Spruceana*, were received from Kew in October. This is a native of British Guiana where it is generally known by its Arawack name 'Hatie.' It has been studied in its native forests by Mr. Jenman, who sent us a plant in 1884, which unfortunately died. Dr. Spruce also collected it on the Amazons. It is closely allied to *H. Brasiliensis*, and grows under quite similar conditions. The specimen of the rubber sent home by Mr. Jenman for report appears to have been unfortunately mixed with some impurity which prevented its value being accurately ascertained. The plants have been put out mostly at Henaratgoda, and are doing well. Some seeds of this species were also kindly sent to the garden by the Manager of the Ceylon Company, Limited, in July, but were quite dead. It is useless to attempt to import seeds of this description from any distance, as they lose their vitality in a few days.

"*Other Rubber Plants.—Landolphia Petersiana*, one of the E. African rubbers has flowered during the year, and *L Kirkii* is now in bud at Henaratgoda. Two plants of *Tabernæmontana crassa* are now doing well. Among seed received from Mr. L. Wray, of Perak, were some of 'Gutta Singret' which appears from leaf specimens, also sent, to be a species of *Chilocarpus*, another climbing apocynaceous genus. Its rubber is not of a good quality, and is chiefly used for adulteration. A few plants were raised and are planted at Henaratgoda."

From Dr. Trimen's Report for 1884, issued at the beginning of 1885, we learned:—

"*Castilloa Rubber.*—On application from the Superintendent of the Model Farm at Kalutara, I supplied 300 large seedling plants to that institution, and I am glad to learn that they are growing well and have proved vigorous young plants. The measurement of the largest tree, 43 feet high, of the species at Henaratgoda is 32½ inches in circumference at a yard from the ground.

"*Para Rubber*:—A good crop of seeds was produced at Henaratgoda, and over 1,000 seedlings were raised; most of these were distributed to officals in suitable parts of the Colony. A few seeds were also produced for the first time at Peradeniya in August. In March a case of 26 plants was sent to Calicut for the Madras Government. A box of seed sent in July appears to have not reached its destination. Our largest tree of *Hevea Brasiliensis* is now 63 feet high and

36 inches in circumference at a yard from the ground. *Hevea pruceana*, has not succeeded as well as its more important congener. The only two plants remaining at Henaratgoda are not in good health.

"*Other Rubber-yielding Species.*—*Tabernæmontana crassa* has grown up to 8½ feet high with very handsome leaves 15 by 9½ inches, a striking plant. The oldest plant of *Landolphia Kirkii* is in flower all through the year, but has produced no fruit; its main stem is nearly 6 inches in circumference. *Urceola esculenta* from Burmah (see Report for 1882, p. 13) has become an unmanageable climber of large size growing rapidly and spreading widely. The leaves on the older branches are now quite smooth; it flowers very freely, and has formed abundance of ripe fruit. It is difficult to understand how these can be edible as is said to be the case—Nine plants of the 'Talaing Milk Oreeper' of Burmah, have been received from Col. Seaton of the Indian Forest Department, and a few more from the Calcutta Botanic Garden. This is *Parameria glandulifera*, another Apocynacous rubber-yielding vine. Attention was first called to it by Dr. Pierre, late Directoe of the Saigon Botanic Garden. He introduced it from the forest into that garden in 1874, but it grows throughout the Malay Peniusula.* The rubber which is said to be of very superior quality is prepared by heating with water. The plant is found from sea-level up to 3000 feet; like other rubber-yielding climbers of this family, large forest trees are necessary to afford it a proper opportunity for growth, and thus they are all unsuitable for ordinary estate cultivation, but would be valuable as forest products."

In his Report for 1886, Dr. Trimen had the following references :—

"India-rubber Trees.—The Para rubbers (*Hevea brasiliensis*) are now over ten years old, and the largest tree has a girth of 49 in. at a yard from the ground. Some plants have been sent to Queensland.

"The *Castilloa elastica* trees are the same age. They are not now growing so rapidly as at first; the largest is 38 inches in circumference at a yard from the ground. A Wardian case with 250 seed of this was sent in May to the Conservator of Forests, Tavoy, and fifty young trees have been planted at Kandy. The paper by Sir J. D. Hooker referred to in my last report, has been published.† It is illustrated by a fine, coloured plate of the tree cultivated here, drawn by W. de Alwis, the draughtsman of the gardens. Sir Joseph points out that our plant, which it will be remembered is the "Caucho" tree collected by Cross in Darien in 1875, differs slightly from the original *Castilloa elastica*, Cav. (the "Ule" tree of Mexico and Central America), in having the leaves less hairy beneath, and the seeds of a somewhat different shape. He does not, however, apparently consider these differences sufficient to warrant another specific name, and our plant may continue to be called *C. elastica*.

"Of the East African rubbers, the oldest plant of *Landolphia Kirkii*, the climbing stem of which is now about 10 in. in circumference, produced fruits this year for the first time. The seeds are few in number, and contained in a thin-coated globular berry, and each is covered with a sweet orange-coloured pulp."

From the same writer's Report for 1887, we quote as follows:—

"Indian-rubber Trees: *Hevea brasiliensis.*—Since the plantation of this tree at Henaratgoda was thinned out and the poorer and stunted specimens removed, the remainder have thriven remarkably. There are now 457 fine trees, the largest with a stem 53½ inches in circumference at a yard from the ground. A very large crop of seed was produced in June and July, and a case containing 2,000 was sent to Kew for transmission to Jamaica, as well as smaller quantities to Madras, Rangoon, Penang, and Buitenzorg. A request for seed in quantity from the Straits was received too late, but will be complied with next season.

"*Hevea Spruceana.*—As recorded in my reports for 1884, 1885, all of a previous consignment of this rubber died. I have this year received from Kew six more plants, but I regret to have to report that only one has survived.

"*Castilloa elastica.*—The trees of this rubber now grow very slowly: the largest tree at Henaratgoda has scarcely increased an inch in circumference during the year, being now 39 in. Some further information as to the method of extracting Caoutchouc from this tree followed in British Honduras will be found in the Kew 'Bulletin' for December last. Young plants of this as well as of the climbing Rubbers, *Landolphia Kirkii* and *Urceola esculenta*, are on sale at Henaratgoda.

"*Sapium biglandulosum.*—Seeds of this rubber-producing plant, the 'Touckpong' of British Guiana, were received from Mr Jenman in May and germinated well. He reports of this tree: 'It is quite hardy, of rapid growth, yields abundant milk, and the rubber is of high-class quality.' Samples of the rubber were shown at the Colonial and Indian Exhibition of 1886, and very favourably reported on."

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* It has not been found in the Indian Peninsula and in Ceylon

† Trans. Linnean Soc., ser. 2, 11, page 209.

In Dr. Trimen's Report for 1888, the following very important and encouraging information was given :—

"*Indian-Rubber Trees.*—The Para rubber plantation at Henaratgoda now consists mostly of fine trees, the largest being 5 ft. in circumference at a yard from the ground. A good crop of over 20,000 seeds was ripened here in July to September, and of these 11,500 were sent in bags to the Straits Settlements and 1,000, sown in the soil of a Wardian case, to Fiji. Several indents for seed were received from stations in India, but mostly in climatic districts quite unsuited to this tree of the wet tropics; parts of Burma and the Malabar Coast appear to be the only portions of British India suitable. As the seeds lose their vitality in a very short time, there is no way of sending them any distance save by sowing them in a Wardian case and allowing germination and growth *en route.*

"One of the Henaratgoda trees has been subjected to experiment with the view of ascertaining the amount of rubber that could be obtained in the course of one year. The tree is now eleven years old and has a stem-circumference of 4ft. $2\frac{1}{2}$ in. at a yard above the ground. It was tapped at three periods of dry weather—namely, on seven days between January 25 and February 15, on six days between July 20 and August 29, and four days between December 6 and 20. During the first period $17\frac{1}{4}$ oz. of dry rubber was obtained, during the second 7 oz., and during the third $4\frac{1}{2}$ oz.; in all, 1 lb. $12\frac{3}{4}$ oz. The plan followed was to scrape off the rough outer bark and make small incisions in the inner stratum ; the tree seems none the worse for the operation. The rubber is in tears, thick strings, and small sheets, and appears to be of fine quality. The time occupied was in all about twenty hours, and the whole cost is estimated at 62 cents.

And this is followed by equally gratifying intelligence in his Report for 1889 :—

"*Caoutchouc Trees.*—With reference to the remarks I offered in my last Report as to the great desirability of Government taking up the cultivation of *Hevea* (Para Rubber) on a large scale, I have now the satisfaction of being able to record that the Forest Department has made a commencement by the selection of land near Nambapana in the Western Province, a portion of which is to be cleared and planted during the ensuing season. This decision was not come to till too late a period to enable the seed of 1889 to be used for the purpose. We had a large crop at Heneratgoda, and a smaller one at Peradeniya. As I have often had occasion to point out these seeds quickly lose their vitality and have to be sown immediately. It may be useful, as showing the rate of growth, to bring together the records taken at the end of each year of one tree at Heneratgoda for the past ten years. The tree was four years old in 1880, the circumference is taken at 3 feet from the ground :—

	ft.	in.		ft.	in.
1880 ...	1	4	1885 ...	3	7
1881 ...	1	9	1886 ...	4	1
1882 ...	2	$1\frac{1}{2}$	1887 ...	4	$5\frac{1}{2}$
1883 ...	2	6	1888 ...	5	0
1884 ...	3	0	1889 ...	5	5

"The Panama Rubber trees (Castilloa) do not now grow rapidly ; the best tree at Heneratgoda has increased during the year half-an-inch only being now 3 ft. 5 in. in circumference. At Peradeniya the trees of this species are not looking healthy or thriving well. In March last the Conductor at Henaratgoda experimented on the rapidity of the flow of rubber from a Para, a Castilloa and a Ceara tree respectively and reports that to obtain 4oz. rubber it took from a Para tree $3\frac{1}{2}$ hours from Castilloa 2 hours, and from Ceara 5 hours.

"To illustrate the importance of the Caoutchouc trade I may quote some figures of the imports from Brazil into the United Kingdom. In 1887 no less than 113,955 cwt. were imported, valued at £1,605,115 or about £14 per cwt.; the greater part of this is Para Rubber, the price of which during the past three years has varied between 2s. 0d. and 3s. 6*d.* per lb. This enormous quantity is wholly obtained from wild trees, and additions to the sources of supply are urgently needed ; indeed there is every probability that in the long run, as with Cinchona so with Caoutchouc, it is upon systematic plantations in the old World that we shall have to depend for our supply." * [Brazil rubber-gatherers find it more and more difficult to keep up the supply.]

* The only plantation in India, at present is that under the Indian Forest Department at Mergui, Lower Burma. According to one Report (1888-89) there are here 49 large trees—probably the survivors of the 500 sent from Ceylon in 1878—6,538 put out in 1887 and 1888, and 5,607 in nurseries.—In Ceylon, the Forest Department has now two Rubber Plantations under its care at Edangoda (trees planted 1890 over 20 feet high in 3 years,) and Yattipowa in Sabaragamuwa, altogether about 80 acres of rubbers besides jak trees (which grow well on poor chena land). Rubber seed put out in supply baskets do best. Trees planted in 1891 gave seed in 1894, and measured 12·12 inches average girth.

From his Report for 1890, we quote Dr. Trimen as follows:—

"*Caoutchouc Trees.*—Para Rubber (*Havea Brasiliensis*). The Forest Department has planted land at Edangoda, in Sabaragamuwa, with 9,000 seeds supplied from Heneratgoda at the end of August. They germinated freely, but I understand that some of the land being subsequently flooded, many of the young seedlings were drowned. To supply these vacancies I prepared in October several thousand "stumps" (the seeding time being past), but these, though applied for, were never fetched away. A very small commencement has thus at length been effected in the cultivation by Government of this valuable tree, but it is to be hoped that it will be more vigorously carried onward, and that a very much larger area will be devoted to it, as on a large scare it must prove highly remunerative.

"That the yield of rubber is improving as our trees get older, is evidenced by a further experiment made at Henaratgoda during the past year by the conductor. The tree selected was the same one as was tapped in 1888, the results of which were recorded in my report for that year. This is now 13 years old, and its stem girths 4 ft. 11 in. at a yard above ground. It was tapped on 17 days: on 7 in January and February, on 6 in July and August, and on 4 in November and December. The method followed was to smooth the surface by scraping off a little of the outer bark to a height easily reached, and then to make, with a ¾ in. chisel, numerous V-shaped incisions. At the foot of the trunk coconut cups were fastened with clay, and the milk conducted into them by little ridges of clay. Most of the milk however, dried on the tree in tears. The tapping was done in the afternoon and the rubber collected in the morning. From this tree (which yielded nearly 2 lb. in 1888) we obtained this year 2 lb. 10 oz. of good dry rubber, partly in sheet but mostly in tears. The tree appears none the worse for the operation, and I consider the result very encouraging. The whole cost of collection was under a rupee, and of course in operating on a large number of trees in a plantation this would be very greatly reduced. Our largest tree of Hevea is now 5 ft. 9¾ in. in circumference at a yard from the ground.

"*Castilloa* does not answer expectations as to growth; our largest tree now girths only 3 ft. 6½ in."

From his Report for 1891 we quote—

"Para Rubber.—I was able to supply the Forest Department with 20,000 seeds and 2,000 stumps for the plantations near Nambapana, in Sabaragamuwa, alluded to in my last report; and it is hoped there will be at least as large a quantity of seed to spare in 1892."

And from Dr. Trimen's Report for last year (1892) we take the following:—

"Para Rubber *(Hevea)*. Our plantation at Henaratgoda supplied the Forest Department* with 30,000 seeds for the extension of the experimental plot in Sabaragamuwa, and about 16,000 more seeds were sold to private purchasers. A further bleeding was made this year of the tree at Henaratgoda which was tapped in 1888 and 1890. The mode of procedure was the same as on those occasions, and the amount of dry rubber obtained was 2 lb. 13 oz. This tree is now fifteen years old, and has a circumference of 6 ft. 5 in. at a yard from the ground. Its yield has been as follows:—

In 1888 1 lb. 11¾ oz.; in 1890 2 lb. 10 oz.; and in 1892 2 lb 13 oz. giving a total of 7 lb. 2¾ oz. in six years. The tree is in vigorous health, and in no respect the worse for the treatment. The interval of two years between the tappings allows the bark to completely heal over the incisions. I have sent home 2 lb. of the rubber that its present market value may be ascertained.*

"Panama Rubber (*Castilloa*).—This is not so promising in Ceylon as *Hevea*. The largest tree at Henaratgoda is but 3 ft. 7¼ in. in circumference, and its yield of rubber is here much less than that of *Hevea*. We had occasion in March to cut down a tree at Péradeniya—a healthy male specimen which had been planted as a cutting in 1882, and had a circumference of stem of about 3 ft. 7 in.—and the opportunity was taken to obtain from it as much rubber as possible. The result was very disappointing: very little "milk" could be obtained, and this consisted chiefly of a black watery fluid in which was suspended a white flocculent matter which did not solidify. From this a small quantity of caoutchouc spontaneously separated, but we could not get half a pound from the whole tree. The little obtained, however, appears to be of first-rate quality,

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* The Report of Messrs. Hecht, Levis, & Kahn, dated 7th February 1893:—"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 today 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*."

very pure and elastic, but has a very dark colour. This result is much the same as that at Henaratgoda recorded in my last Report."

In 1893, Dr. Trimen sold 90,000 seeds of Hevea Braziliensis to Kalutara and other planters at R5 per 1000. He reckoned 12 years to wait and annual profits then for 75 to 100 years. Seeds have since been sold year by year at from R3 rising to R10 and even R27 per 1000.—Of other kinds Dr. Trimen reported:—

CASTILLOA ELASTICA.—A sample of this rubber sent home on trial, grown on an estate in Matale was favourably reported on, being valued at 2s. 3d. to 2s. 7d. per pound The quality of this kind of rubber produced in Ceylon has always been excellent, but my experience hitherto has been that the amount of caoutchouc obtained from the milk is too little to make it a profitable cultivation; the yield per tree seems very small.

MANIHOT GLAZIOVII.—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 lb. of dry rubber is at that age obtained from each tree.

In 1894, his report was:—

PARA INDIARUBBER.—A distribution of 86,000 seeds was made to planters in the low country, being nearly the whole crop of our trees (424 at Heneratgoda and 30 at Peradeniya). Each tree does not produce a great number of capsules, and (as in other *Euphorbiaceæ*) three seeds only are found in each. When mature the capsule bursts and the seeds fall to the ground; they have to be collected daily, as they quickly germinate. Some get overlooked, and a little crop of seedlings always comes up beneath the tree. With proper packing, however, I find that the seeds can be made to keep their vitality without germination for a longer period than I had supposed. Thus 200 were sent to Kew in September, of which every one germinated after being a month in the post.

I continued the tapping or bleeding of the tree already experimented on in the alternate years 1888, 1890, 1892, and it afforded this year as much as 3 lb, 3 oz. of dry rubber. Thus in seven years (from its twelfth to its nineteenth year) the tree has given 10½ lb. of clean first-class rubber, without in any way suffering, and I have little doubt that it would have borne tapping every year. This may be regarded as quite satisfactory, and sets at rest any doubt as to future successful cultivation of this kind of rubber here. By referring to my past reports it will be seen how steadily the yield has increased on each occasion. I do not think it desirable, or indeed of any use, to commence bleeding the trees before they are at least ten years old.

From Dr. Trimen's Hand Guide to the Peradeniya Gardens, we may also quote the following references:—

"On the right hand side in front of entrance the magnificent grove of Assam India-rubber trees (*Ficus elastica*) cannot fail to attract attention. There were planted about 1833; their singular laterally flattened roots meandering over the surface of the ground suggest huge saurians. It is this tree in its young state which is so commonly grown in pots in European houses. The rubber forms a large export from Assam, where the trees are the subject of careful conservation by the Indian Government. * * *

"On the river bank may be seen examples of Para India-rubber (*Hevea brasiliensis*), which affords the most valuable kind of rubber, and young trees of two kinds of gutta-percha from Perak (*Payena Leerii* and *Dichopsis sp.*) affording 'Gattah Sundek' and 'Gatah Taban Putih' respectively. (Examples of 'Gatah Taban Merah' (*Dichopsis Gutta*) may be seen in D.) * * *

"Near here, also, will be noticed with interest the three kinds of India-rubber trees introduced from South America in 1876 at the expense of the Indian Government. The branched tree with papery bark (*Manihot Glaziovii*) affords the Ceara rubber, and is already common in Ceylon. The five large-leaved trees next to them are *Castilloa elastica* (already mentioned), yielding Central American and Panama rubber. The other (*Hevea brasiliensis*), giving Para rubber and esteemed the best sort, is represented by the group of slender-stemmed unbranched trees with small heads at a little distance off. All these have afforded here rubber of as good a qualty as in their native countries."

In his Report for 1895, Dr. Trimen stated:—

Para Indiarubber (*Hevea brasiliensis*).—The very hot weather in March caused a good many of the blossoms to wither, and as the bad weather in May and June accompanied by high winds caused considerable damage to the young capsules, it was expected that the crop would be a poor one. However, owing to many more trees flowering this year, and the favourable weather in July, August, and September, we were able to supply all demands for seeds, and had a large quantity over for the nursery. The total crop was very nearly 100,000, 76,750 of which were sold, being advertised in the newspapers at Rs. 10 per 1,000; 2,000 were sent to Badulla Garden nursery and 1,000 to Anuradhapura, and the rest (20,000) were sown in the nursery here. These have grown into fine healthy plants, and are now ready for distribution. None of the trees have been tapped this year.

In the Report for 1896, the new Director, Mr. Willis stated:—

The tree of Para rubber (*Hevea brasiliensis*) which was tapped in 1894 was again tapped this year, yielding 3 lb. ¼ oz. of dry rubber, or rather less than in 1894.

The yield of this tree has been 27¾ oz. in 1888, 42 oz. in 1890, 45 oz. in 1892, 51 oz. in 1894, 48¼ oz. in 1896; total in nine years 13 lb. 6 oz., or about 1½ lb. per annum, the tree is now twenty-one years old, and should bear tapping every year. I desire to call special attention to this yield, for many persons entertain the most exaggerated ideas of the rubber-yielding capabilities of this and other trees. Of course a much larger yield can be obtained for one or two years, but it is at the sacrifice of the life of the tree. If the results of the tapping of this tree be taken as a basis, the yield of a rubber plantation after the tenth year (fifty trees to an acre) should be perhaps 100 lb. of rubber per acre per year, worth about £12 or £13 in London. In comparing this with other products, it should be remembered that the labour cost of rubber is very small. The cultivation of Para rubber seems likely to succeed in the low-lying wet districts of Ceylon. There seems little likelihood at present of any serious fall in the supply of rubber from wild sources, but the demand is increasing, and by the time that he private plantations in the East come into full bearing, it is quite probable hat the easily accessible native sources will be becoming exhausted.

Several plants of Lagos rubber (*Kickxia africana*, Benth.) were received from Kew in 1896, but are not doing well. This species forms a stout tree, and is therefore uited to cultivation, but it will be a long time before seed is available in quantity.

In the Report for 1897 Mr. Willis states :—

The interest taken in the cultivation of Para rubber has received a very great impetus during the year, and the demand for seed has been enormously larger than the supply. The total crop this year was rather over 100,000 seeds, of which 88,500 were sold to planters in Ceylon. As mentioned in last year's report, experiments in tapping the trees at Henaratgoda have been carried on throughout the year.

But apart from this, Mr. Willis has issued a valuable Circular with results of Tapping Experiments (see *T. A*, March 1898) and also a Report dated 14th April 1898 on his visit to the Government (Ratnapura) and Kalutara Rubber Plantations. For the latter in full, see *Tropical Agriculturist* (page 832, June 1898), but we quote as follows :—

"During the week ended April 2 last, I visited the plantations of Para india-rubber at Edangdoa and Yattipowa made in 1890-93 by the Forest Department. They are in very good order, and in a year or two many of the trees will be in condition to allow of experiments in tapping being made on them.— On Culloden estate near Neboda, there are about 30,000 or more trees in very fine order. The older trees were grown from seed or cuttings obtained from Henaratgoda garden. The oldest trees are only fourteen years old, but rival the trees twenty-one years old at Henaratgoda. This is partly due to the fact that the Culloden trees are more widely separated than those at Heneratgoda, being planted among tea at distances of about 30 feet, partly to the more favourable soil and conditions of the Kalutara District. A few experimental tappings have been made on the older trees on this estate and have shown very good results, better than those obtained at Henaratgoda, on which the data of profit and loss given in the Circular recently issued by this Department were based. As at present the demand for seed makes it more profitable to keep the trees for seed, these experiments are not being continued just now. From what I saw of the condition of the trees and the results of these tappings, I am strongly confirmed in my previous opinion that the cultivation of rubber bids fair to prove a profitable industry in Ceylon and a useful adjunct to the larger industry of tea and coconut cultivation.

Mr. Willis estimates that 750 acres are planted with Rubber; but that refers probably to Para kind only. We expected to find a larger area under Rubber of all kinds on Ceylon plantations as a whole, than the 1,071 acres in our Directory returns; but in many cases, probably where small patches or detached rows are on estates, no return has been made, and that has been the case also where the planter absorbed in tea has neglected and forgotten his rubber field or trees, several ignoring the "rubber" they have, and others uprooting it as inimical to full-grown cacao. When it is once fully realized that the cultivation will prove a profitable one, the extent and number of trees planted in various parts of Ceylon will very quickly be multiplied indefinitely; but the tropical planter, as a rule, objects to waiting so long (8 to 10 years) as rubber cultivation requires for his returns. At first Cara rubber trees were supposed to do well as shade for cacao: trees growing 30 feet high and 4½ in circumference very rapidly; when tapped ½ lb. rubber was readily got from each; but afterwards objection was taken to them as injurious for shade and in Dumbara, many have been cut down. Later experience in Dumbara shows a lb. per cooly per day can be gathered worth 3s 9d per lb. in London. An authoritative report received from Messrs. Lewis & Peat valued a sample consignment of Ceylon Ceará at from 2s 9d to

2s 10d a lb; the best Pará being then 4s.* The total demand, these gentlemen add, is enormous; but before the market can be properly tested for the Ceylon produce a shipment of a ton, or at any rate several cwt. ought to be available. The practical problem at present is how to get the trees to yield a sufficient quantity of the rubber milk to cover the cost of cultivation, collection, and interest on outlay; but the experiments and results at Henaratgoda and on Culloden estate, Kalutara, seem to solve this question.† Novel and ingenious contrivances for milking the trees have been invented and it is evident that if rubber-yielding trees can anywhere be grown to a profit, Ceylon ought to lead the way, and now that a check is given to tea through a fall in prices and the fear of overproduction we should find renewed attention given to rubber as to other minor products in many quarters. Within the past six years a great many of Para rubber trees have been planted by tea estate owners in lowcountry districts, the Government Gardens alone selling 400,000 to 500,000 seeds apart from what Culloden and other estates have sold. In Perak, we hear of a plantation of 500 acres, and more than one Ceylon planter has gone to the Straits for land for rubber; but surely in the South-Western districts of Ceylon between the Kelani and the Galle and Matara rivers much suitable and even rich swampy land can be got. In S. India attention has been given to Ceara Rubber and there are valuable Reports by the Forest Department.

Our Exports of Rubber from Ceylon are so far trifling, thus:—

Exports in 1889, 11 cwt. rubber; in 1890, 39 packages value at R1,067; in 1891 = 78 Packages R2,000; 1892 = 65 cwt. R3,225; 1893 = 5,880 lb. R1,600; 1894 = 9,198 lb. R4 440; 1895 = 1,753 lb., R1,290; 1896 = 17,591 lb., R8,760½; 1897 = one package 8981 lb. R7,458.

Sample parcels of Ceylon Ceara rubber were sold as high in London as 4s. per lb. The rush into tea however—together with the acknowledged difficulty of harvesting the rubber in paying quantities, turned the planters' attention from the latter very speedily, and now though there are a few fields of Ceara rubber, still cultivated, we hear very little of results.—A report came from Dumbara (page 730, *T.A.* 1889-90) where a planter was getting 1 lb. rubber per cooly per day worth 3*s* 9*d* in England: 10 years' old trees give ¾ lb. daily. In Madulsima to, there were favourable experiments.

From the same source we quote here what is said about Gutta-Percha:—

Guttas and Pseudo Guttas form no unimportant trade with the Eastern Archipelago and South America. In 1891, the Straits' export to U. K = £623,659. Dr. Trimen. has received gutta plants from the Malayan peninsula which he is cultivating in the Gardens, and we see it stated that Ceylon has many species of *Dichopsis Isonandra* and the closely allied species which are likely to yield a gutta-like substance. Certainly he climate of Ceylon in many parts ought to suit the true Gutapercha admirably. Dr. Trimen in his Reports for 1883 and 1884 says:—

"*Gutta Percha.*—The best and most frequent sort of gutta percha of commerce, 'Gutta Taban merah,' is the produce of *Dichopsis Gutta.* Our trees of this are now nine years old, but the tallest is but nine feet high. According to Mr. Wray, this tree attains 100 to 200 feet in height, with a clean straight trunk of four to five feet diameter, flanked at the base with large thin buttresses; the bark is one-third to half-an-inch thick, brown-red in colour, and flakes off; the leaves are much narrower on young plants than old ones, the flowers are white, and the seeds yield an oil solid at ordinary temperatures, but used for cooking. The gutta is at first white and cream-like but becomes pink and ultimately brownish-red ('merah'= red), and this colour is strongly imparted to the water in which it is washed. There is a variety of this species affording a paler gutta called "Gutta Taban sutra" ('sutra '= silk), which is found at a higher elevation (500 to 600 feet.) Other sapotaceous trees affording gutta, of which specimens have been sent by Mr. Wray, are 'Gutta Taban simpoo,' *Dichopsis Maingayi*, Clarke—the product of which is

* Samples have been forwarded from Colombo to London it was found necessary to wet the rubber every day or two (to prevent its oxidating), a practice generally adopted in Singapore with rubber waiting for shipment. A wooden box which admits of some air entering into it would seem to be best for the transmission of rubber samples to Europe. Mr. W. B. Lamont when at Mirigama estimated a return in the lowcountry of R50 per acre after 5 years, 100 trees to an acre of Ceara rubber.

† One experiment pointed to 3 to 4 lb. Para rubber per tree per annum after 10 years of age. This would pay very handsomely.

also sold as 'gutta putih'—and 'gutta garu,' *Bassia Mottleyana*, De Vriese, which gives a white hard sort, only used for mixing with other kinds. He also sends examples of the curious substance called 'Gutta Jelutong,' used for adulterating gutta percha. It is obtained from a very lofty apocynaceous tree allied to our 'Rukattana' (*Alstonia scholaris*),* and recently named *Dyera costulata* by Sir J. Hooker.

"The yield of the gutta percha trees seems to be very small—less even than the rubber trees. Thus, from a tree of *D. Gutta*, thought to be over 100 years old, and over 100 feet high, Mr. Wray succeeded in extracting, by the ordinary native method of felling and ringing the trunk and branches, only 2 lb. 5 oz. of clean gutta. Of 'Gutta Taban putih,' a tree ten inches in diameter, gave 2 lb. 11 oz., and one of *Payena Leerii*, 2 feet 8 inches in circumference, only 6½ oz. Mr. Wray has satisfied himself that only about 1-38th part of the gutta percha actually in the bark is extracted by this method, and he believes that by pounding and boiling the bark the whole could be obtained. As the question of the supply of gutta percha is becoming a pressing one, it is to be hoped that experiments on a large scale may confirm this opinion. To quote Sir J. Hooker (Kew Report 1881, p. 38), 'the time cannot be far distant when the natural sources of gutta percha will be definitely used up.' In view of this contingency it behoves the Governments of those few British colonies —Ceylon being one—in which the trees will grow to lose no time in establishing plantations, which must in the future become a valuable source of revenue. But in this Colony neither in this case nor in the case of India rubber can anything be done until a proper forest conservancy is established."

For 1884, Dr. Trimen reports :—

"*Gutta Percha.*—The young trees of Gutta Taban Putih continue their natural slow growth, the largest (at Péradeniya) is now 2 feet 10 inches thigh. From the dried specimens sent by Mr. Wray from Perak, I was not able to determine this species of *Dichopsis*; but Mr. Thiselton Dyer now informs me that it is, he believes identical with *Palaquium* (=*Dichopsis*) *pustulatum* Pierre. The determinations of the other Perak species of 'Gutta' given in my Report for last year (p. 14) are further corroborated by Mr. Dyer, who has been carefully examining the series of Mr. Wray's plants sent to Kew.

"Gutta Sundek (*Payena Leerii*) has made good growth this year, some of the young trees being now 12 feet high, I am indebted to Kew for plants of the trees affording the peculiar variety of Gutta Percha known as Gum Balata. This is *Mimusops globosa* and a native of Guiana, Trinidad, and some of the West Indian islands. It is a large tree occurring under two forms (species), and its product appears likely to become of increasing use in various ways."

In 1886 and 1887, Dr. Trimen had the following remarks:—

"GUTTA-PERCHA TREES —The 'Gutta Taban Patih' (*Dichopsis pustulata*) have attained 12 ft. in height at Peradeniya, and the 'Gutta Sundek' (*Payena Leerii*), which does better at Heneratgoda, are now about 16 feet high at that Garden."

"GUTTA-PERCHA TREES.—All the sorts we have are doing well, but the plants of this family are all of very slow growth. The 'Gutta Sundek' trees (*PayenaLeerii*) at Henaratgoda are now 18 ft. in height."

In 1888 and 1889 Reports, Dr. Trimen remarks :—

"*Gutta-Percha.*—Our various Gutta trees are making progress. Gutta Sundek (*Payena Leerii)* at Henaratgoda are now nice little trees 28 ft. high and 16 in. in stem-circumference, and Gutta Taban Puteh (*Dichopsis pustulata*), which grown best at Peradeniya, has attained there a height of 13 ft. 10 in., and a circumference of stem of 8¼ in. What is said with regard to Para rubber applies with even greater force to the Gutta-Percha trees. To neglect to make forest plantations now is to forego a large prospective revenue when the natural sources of this necessity of modern industry shall be definitely used up, a state of affairs which cannot be very far off."

In his Report for 1890, Dr. Trimen states :—

"*Gutta Percha Trees.*—One of our trees of *Payena Leerii* flowered for the first time in December at Peradeniya, and finally settled any doubt still felt as to the correct determination of the "Gutta Sundek" of Perak. The trees of this at Henaratgoda are now 25 ft. high, and nearly a foot in circumference."

For 1894, Dr. Trimen reports :—

"GUTTAPERCHA.—The trees of *Payena Leerii* (Gutta Sundek) at Henaratgoda yielded a large crop of fruit in October for the first time. The seeds from which these trees were raised were received from Perak in 1880. This tree affords the second best quality of guttapercha of that district."

For 1895 Dr. Trimen says :—

Payena Leerii.—This, besides giving Guttapercha ("Gutta Sundek"), is re-

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* This appears to yield a somewhat similar substance at Singapore called Gutta Pulle.

markable in appearance, and will be valuable as an ornamental tree for planting at low elevations. It did not flower at all this year at Henaratgoda, but shows signs of flowering again next year. So far we have not been able to propagate from cuttings. The largest tree is 40 ft. high.

GUMS AND RESINS.

A good deal more might be done with Gums and Resins in Ceylon: the true gum arabic (*Mimosa nilotica*) is produced in abundance, according to Bennett. The cashew tree yields a beautifully transparent gum in large masses from its trunk and branches, while its bark contains a large proportion of tannin. The *Styrax benzoin* from Sumatra which affords the fragrant gum-resin known as "Gum Benjamin" much used in incense, flourishes as small trees in the Peradeniya Gardens. India annually exports from 200,000 to 300,000 cwt. of gums and resins (chiefly cutch and gambier) valued at from £300,000 to £400,000. The cutch is chiefly brought from Burma.

In Dr. Trimen's report for 1884 we have the following interesting reference:—

"*Gamboge.*—It is worth a note that a consignment of the Ceylon product exported in the natural tears has fetched £44 5s a cwt. in the home market. This is afforded only by *Garcinia Morella* (the 'gokatu' or 'kana goraka' of the Sinhalese) of which the tree (*G. Hanburii*), giving the Siam gamboge of commerce is probably a mere variety.

"The principal *Resins* ('dummala') of Ceylon, as to which several inquiries have been addressed to me, are obtained from 'Hal' (*Vateria acuminata*), a good clear white dammar resin; 'Hora' (*Dipterocarpus Zeylanicus*), 'Dun' (*Doona zeylanica*), 'Na' (*Mesua ferrea*), 'Kekuna' (*Canarium Zeylanicum*), a fine white resin; and a resin, the origin of which is uncertain, called 'Bin-dummala' from being dug out of the ground, generally during the cultivation of paddy land."

The Chemist and Druggist reports (June 1888) Gamboge as up to £12 and £15 per cwt., and makes the following remarks: —

"There are also plenty of gamboge trees in Burmah, and a closely-allied variety yielding very good gum, is found in Southern India and Ceylon; but hitherto the value of gamboge in Europe has never been high enough to tempt traders in the latter country to have it collected. Thirty years ago fair gamboge was only worth from 80*s.* to 90*s.* per cwt., and the general tendency of the article appears to be to advance in price by easy stages. An average gamboge tree is said to yield annually a quantity sufficient to fill three bamboo cylinders, each about 18 to 20 inches long and 1½ inch in diameter. The gamboge issues very slowly out of the incision which is made in the tree, and it takes about a month to fill a cylinder. When full the bamboo is rotated over a fire to allow the moisture to escape and the gum resin to harden sufficiently to admit of the bamboo being loosened from it. The best time for collecting gamboge is in February and March"

Respecting Gambier we have the following reference in Dr. Trimen's Report for 1887:—

"*Gambier.*—This is another great cultivation at Singapore, and, like pepper, is mainly in the hands of the Chinese. Between 25,000 and 30,000 tons of this tanning material are annually exported thence, much of it of a very inferior quality. I have found it most difficult to obtain living specimens of the plant (*Uncaria Gambier*(from which this extract is prepared.

In his Report for 1890, we have the following:—

"*Gambier* (*Uncaria Gambier*).—A Wardian case containing nineteen plants of this was received from Singapore at the end of May; five were dead on arrival. Of the rest, three were planted out at Peradeniya, where they have all gradually died, and eleven sent to Henaratgoda, where there seemed a better chance of their surviving. At the end of the year there remained six plants living, of which five are healthy and likely to do well."

In his Report for 1891, Dr. Trimen gave an account of what he saw at Singapore: we quote part as follows:—

"The five plants at Henaratgoda are very healthy and have grown rapidly. Two flowered freely in April, and produced a few seed-pods. There will apparently be no difficulty in propagating this plant in the Colony. I took the opportunity whilst at Singapore of witnessing the manufacture of this curious product. Accompanied by Mr. Ridley, the Director of the Botanic Gardens, I visited on 11th March a Chinese plantation at Chung-chu-kong, a few miles out of Singapore where the cultivation and manufacture is carried on. The whole industry is in the hands of the Chinese, who grow the plant—it can scarcely be said to be cultivated—on the exposed slopes amid a tangled mass of weeds a ana, and alang-grass; the last is occasionally cut away, but no other help is given. The bushes on this plantation were five years old, and the plant lives from thirteen to fifteen years, flowering all the year round. The manufacture is carried on only when the pepper a more valuable product, is not ready for picking. Only one sort is grown in Singapore, and whether the *U. acida* said to afford Gambier in Penang, is really different, is very doubtful. *U. Gambier* does not seem to be known in a wild state, but Mr. Ridley tells me that the wild *U. ovalifolia* is very close, and may possibly be the same."

Reporting for 1892, Dr. Trimen has the following:—

"The plants at Henaratgoda have flowered well, but little seed was matured owing, I think, to their being in too shaded a situation. This can be easily remedied, and I hope to form a nursery of seedlings soon. I may call attention to a very useful and nearly exhaustive account of this product by Mr. Ridley, Director of Gardens and Forests at Singapore, which was published as No. 2 of the 'Agricultural Bulletin of the Malay Peninsula,' dated February, 1892. [Reprinted in *Tropical Agriculturist*, March-June 1893.]

Dr. Trimen's report for 1893:—

GAMBIR.—I am unable to report at present any success with this. None of the seed produced germinated, and we have still only five bushes, which do not grow rapidly here. Out of many attempts we succeeded in getting from these only three more plants by layering. I fear our climate is unsuitable. In North Borneo this product is reported to have done very well in the Government Garden at Sandakan under the care of a Chinaman; and a sample analyzed by Messrs. Huttenback & Co. was all that could be desired in tannin strength—27·83 per cent. It seems likely that this will become a large export from the new colony in time.

For 1894:—

GAMBIR.—Very slow progress in the propagation of this is made at Henaratgoda. None of the seeds produced germinated, and only seven more plants were obtained by layering. Some conditions seem wanting here for the satisfactory growth of this species.

For 1895,—

Uncaria Gambier.—A few seeds of this, from our own plants, were sown at the beginning of the year at Henaratgoda and germinated in March. The growth at first was very slow, but they made a start at the latter part of the year, and we have now twenty-five healthy plants 4 ft. 6 in. high so that at last there seems a chance of getting this acclimatized here. Some seed received from Kew did not germinate.

An account of extracting guttapercha from leaves will be found in *T. A.*, page 452, vol. 1897-98. From Java and the Straits, large exports of 'gums' of different kinds, gut apercha gambir and some rubber take place.

In 1887, 4 packages Rubber valued at R110 were sent from Ceylon to London, also 24 cwt. Gum R470 and 45¼ cwt. Dammar R770. In 1888, Ceylon shipped 11½ cwt. gum, R1,363; 83½ cwt. dammer, R1,784; 11 packages rubber R727. In 1889, the exports were;—8 packages, gum R310; 6 cwt. dammer R1,100; and 11 cwt. rubber R542. In 1890, we shipped 39 packages Rubber valued at R11,067; 10 packages 30 cwt. (besides 137 cwt. re-exported) of dammer value R580; 1 package gum R20; in 1891=61 cwt. dammar; R60 gum R2,000 rubber; 1892=145 cwt. dammar; 1893=167 cwt.; 1894=76½ cwt. 1897=dammar 94 cwt. R2606; rubber 8181 lb.

Our little Handbook "All about Fibres, Gums, Dyes, &c." contains useful information under these heads.

We now proceed to give the latest information from the Ceylon Planting Districts, and a practical letter from an experienced Inspector of Estates :—

RUBBER CULTIVATION IN CEYLON:

THE LATEST INFORMATION AS TO CASTILLOA, PARA AND CEARA KINDS; ABOUT 1,500 ACRES NOW COVERED WITH RUBBER TREES IN CEYLON; THE APPROACHING REVOLUTION:—NOT ONLY IN THE SYSTEM OF SEPARATING CAOUTCHOUC FROM MILK; BUT ALSO IN EXTRACTING RUBBER FROM THE STEMS OF YOUNG TREES.

We direct attention to a very important letter on local Rubber cultivation, above the well-known signature of "E.S.G." on page 17. The writer will be admitted to have had exceptional means of forming reliable opinions on the points he discusses, and where these differ from any in the official "Rubber" Circulars, we believe it will be safer to follow the lead of the practical planter. "E.S.G.", then, for good reasons given, rehabilitates Para rubber to a very great extent; and, indeed, we have never seen good reason for the rush from one extreme to the other in reference to the cultivation of this variety, nor could Mr. Willis mean that his latest views in favour of Castilloa should be construed to the deprecation of the continued cultivation of Para, where such had been established. We may even go farther and say that there is scope and fair encouragement for the continued planting of Para outside of the limited region between Kalutara and Ratnapura, which is considered most favourable for its growth; and in which, perhaps, the Castilloa tree would not prosper so well Nevertheless, the latter, as "E.S.G." and Mr. Willis both show, has an extensive field for its production; and there is no reason why, as soon as seed is available, it (the Mexican tree) should not grow very freely both up and down country.

It will be observed that "E.S.G.," although in possession of the results of tapping experiments, does not give us estimates or figures, in the meantime, though he promises to do so at no distant date. On the other hand, there has been some instructive and even amusing correspondence in a local contemporary's columns on the subject. "J.M.", who was one of the first to plant "Castilloa", has shewn how, even in the face of a splendid valuation for the resulting rubber —which passed through our hands—he was officially discouraged from continuing the cultivation! "The whirligig of time" has indeed brought about "its revenge." Major Gordon Reeves, who now owns the Wiharegama estate and the trees planted by "J.M.", reports of the several old trees of Castilloa and his harvesting, as follows:—

There is no difficulty whatever in raising plants, and in a wet district I should imagine that any sized plants from seedlings of 3 inches to stumps of 2 feet will grow readily. In our climate, which is rather a dry one, I think there is no doubt that good sized stumps do best. The old trees on Wiharegama must have a girth of quite 30 inches at 3 feet, and are probably 30 feet high and of spreading habit and rather resembling a teak tree: these are planted through the cacao, and do not seem to have any injurious effect on the latter, and we are now extending plantations of cacao, with *Castilloa* 20 feet apart, and *Erythrina* as a temporary shade. I had two of the old *Castilloa* experimentally tapped, taking only about 1½ lb. of rubber, though a great deal more could, of course, have been taken: the milk was simply run into butter tins without any cleansing, and dried chiefly in the sun, which is we *now* know an injurious process. The samples were forwarded to Messrs. W. Wright and Co., the principal India-rubber brokers in Liverpool, and are reported on as follows:—

No. 1.—Good, clean, strong, dry rubber, value about 3s 6½d per lb.

No. 2.—Good, clean, fairly strong rubber, but very wet, value about 2/11 ℔ lb.

A very satisfactory report, considering how little we then knew about curing. *Fine* Para rubber is only worth 4s 2d.

Next "J.M." recalls estimates for a Castilloa plantation in Nicaragua, which were given in the *Observer* and which can readily be found in full detail in the *Tropical Agriculturist* or still more conveniently in this Manual; but a few figures may be quoted if only to make the mouths water of some of our planting readers, in anticipa- tion of a good time coming! Here is "J.M." quoting Mr. Cator:—

Cost of 500 acres of land at 5s per acre	£ 125	
,, survey and titles	100	
,, clearing land	1,000	
,, collecting seed, and planting ...	500	
,, 8 years' weedings at £200 ..	1,600	£
,, tools, &c.	300	3,625
Interest on £3,625 for 8 years at 5 per cent. ...	1,450	
Superintendent's expenses, 8 years, at £200 ...	1,600	
Cost of gathering the 8th year's crop ...	1,500	4,550
		£8,175

He estimates a profit at the 8th year as follows, *per acre*:

Dr.	£ s d	Cr.	£ s d
Cost of cultivation per acre	7 4 9	Government premium	2 8 3
Cost of tapping	3 0 0	Crop, 965 lbs., at 2s	96 10 0
Balance of profit per acre	88 13 6		
	£98 18 3		£98 18 3

Thus, 500 acres at £88 13s 6d = £44,337 10s profit on a capital of about £8,000; and, as if that was not sufficiently sanguine, take the 9th year by itself:—

	£		£
Expenditure for weeding	200	Value of crop in 9th year	50,000
,, harvesting	1,500		
,, planting	500		
Interest	180		
Profit	47,620		
	£50,000		£50,000

Here, indeed, seems room for enterprize, even taken midway between the utterances of the sanguine "man on the spot" and the pessimistic reports from the Peradeniya Gardens Director.

How this reminds us of the golden days of "Cinchona"!—when William Smith of Craigie Lea proved to a demonstration how foolish his partners, Colonel Byrde and Mr. John Davidson, were when they refused their consent to 150,000 cinchonas offered by Dr. Thwaites free from Hakgala ("a medicine tree" as Col. Byrde rather contemptuously called it) being put out on Craigie Lea then being opened for coffee as the pioneer estate of Dimbula Felix in the early "sixties." Poor Smith—15 years afterwards when cinchona was booming and Nanuoya netted more than 10s a tree for some hundreds of mature trees cut down—used to say that his partners had thrown away £37,500, realizable by taking half of the 150,000 plants as coming to maturity at 10s a tree! No single proprietor in Ceylon, we fear, ever realized as much as a few thousands of pounds sterling from cinchona, although we got up to a shipment of 15 million lb. of bark in one year.

To return to Rubber: we may mention that we attempted some months ago to get an approximate idea of the extent to which the various kinds of rubber were cultivated on estates. First, we wished to see how far "Ceara" rubber, which was the earliest to be boomed, had been continued in cultivation; but our responses were but few; for, in most cases, the Ceara had been rooted out as inimical to cacao, or to give place to tea. We may quote a few illustrations: here, for instance, is a report from Crystal Hill estate, Matale:—

What kinds of Rubber are now growing? Three Ceara trees only remain out of several hundreds planted in 1878. A few hundreds of Castilloa were planted in October 1897 along with coconuts and are doing well.

Approximate age of oldest, Ceara 20 years.

Size of largest trees—circumference, height (actual or approximate), Ceara circumference 2 feet 4 inches, height about 30 feet.

Result of tapping, Nil.

Injuries or otherwise to plants underneath or near to the Cacao? Underneath the Ceara gave little or no crop. Wild pigs that had been attracted by the yam-like roots of the Ceara began to eat the Cacao pods, and the Cearas had therefore to be destroyed.

Going to the other end of the country in Madulsima, from an estate where there were 30 acres of rubber growing in 1886, the following was our latest report:—

What kinds of Rubber are now growing?—Ceara. Approximate age of oldest? About 18 years. Size of largest trees—circumference, height (actual or approximate.?) About 50 feet high, $4\frac{1}{2}$ feet below lowest branch, 5 feet at the ground, branched out about 15 feet from ground.

There is only about one acre of rubber trees on estate now. Spread about. The rest have been cut out. I can't say what damage they would do to any other plants as they are near none.

Next from a Hantane estate that had ten acres of Ceara in 1886, we are told it was all rooted out and there are no rubber trees growing now. Again, the well-known Kandenewera estate, Matale, had 6,000 Ceara trees a dozen years ago; but Mr. Gordon replied in answer to our circular some months ago:—

The Ceara rubber trees on this estate have all been cut out, some of the largest were tapped four years ago experimentally, but the yield of rubber was very poor and watery. Certainly no success commercially. As shade trees to either Cacao or Cardamoms they are harmful, and being greedy feeders are undesirable cultivations with mixed products.

Sanquhar estate, Gampola, has still 80 Ceara rubber trees growing alongside a road, but we have no particulars as to size. On Hurstpierpoint in the Galle district, of 5,000 Ceara trees in 1886, there are still a few left about 17 years old, 30 to 40feet high and 1½ to 2 feet in circumference.

Of reports on other Rubbers, we have a few to present. The Manager of Daisy Valley, Kurunegala, has put out a good deal of Para rubber from seed got in the Peradeniya Gardens. From Mr. P. D. Clark, Manager of Rasagalla, Balangoda, we have a satisfactory report as to Para, showing, apparently, how much wider is the sphere for its successful growth, than Mr. Willis has conceived, when he confined it to the lowcountry between Kalutara and Ratnapura:—

What kind of Rubbers are now growing? Para rubber, Hevea Braziliensis, about 35,000 very promising trees. Cultivation to be extended. Approximate age of oldest, two years. Size of largest trees—circumference, height (actual or approximate,) 18 feet high, expected to tap from 8-10 year judging from present growth. Injuries or otherwise to plants underneath or near to? Apparently not injurious to tea.

Mr. Corrie was good enough, some months ago, to report from Gikiyanakanda in the Kalutara district as follows ;—

What kinds of Rubber are now growing? Para and Castilloa. Approximate age of oldest, six years. Size of largest trees—circumference, height (actual, or approximate,) 9 inches diameter, 3 feet from bottom, height say 30 feet. Injuries or otherwise to plants underneath or near to? All our Rubber but a new clearing just planted is growing through tea. No damage to tea at present.

There are a few Ceara trees growing about 15 years old, but we do not tap them, not considering it worth while as the yield at this variety is so small.

From Mr. J. A. Storey, on Igalkanda estate, Elpitiya, we learn of Para rubber trees, six years old, doing well, the size being given as follows :—

Largest measured 33½ inches circumference at one yard from ground, several others over 30 inches. Height (approximate,) 35 feet.

And then we have what Major Gordon Reeves wrote to us at the time of our circular in regard to Wiharegama, which, of course, must be modified by his more recent information :—

What kinds of Rubber are now growing? Ceara Para, Castilloa, Approximate age of oldest, Ceara about 15 years, Para 5-6 years, Castilloa 8-10 years. Size of largest trees—circumference, height (actual or approximate.) Ceara, no measurement taken, Para circumference 2 feet to 2 feet 6 inches, height say 30 feet. Castilloa cir. 2 feet 6 inch to 3 feet, height say 25 feet. Result of tapping? In tapping experiments now being made (will report) with Para and Castilloa, but *not with Ceara*. Injuries or otherwise to plants underneath or near to Para rubber trees planted over nine acres of Cacao as shade. No injury apparent ; on the contrary forms good shade at 20 to 25 feet apart. I proposed to plant as shade over a large extent of Cacao field.

So far three kinds of Rubber—Para, Castilloa and Ceara—have been mentioned. On a little estate in the Kelani Valley, there were, 12 years ago, some 500 specimens (creepers) of the East African rubber-yielding plant, Landolphia Kirkii, equal to four years' growth then, and kept as show stems and to see if they would seed. Unfortunately, these creepers no longer exist and this is the explanation offered by the proprietor, Mr. James Gibson :—

I regret that during my absence in India 1887 and 1888, that the man in charge cut out all the Landolphia Kirkii trees from Pleasure Ground which is mine still and the few I also put in on Kennington were destroyed also. I do not know of any others on any estate; I was grieved at the destruction.

The above estate reports can, of course, be only taken as indicative of what is going on in many other estates in the planting districts, Twelve years ago we estimated 600 acres were covered with Indiarubber trees, chiefly Ceara. Last year Mr. Willis estimated 750 acres of Para rubber alone; while our Directory returns in August last showed an aggregate of 1,071 acres, notwithstanding all that had been cleared out of Ceara. With all that has since been put out, of Para especially, we reckon that these figures may safely be increased to 1,500 acres. But we may be told that quantity or area does not matter so much as quality, and just as Ceara rubber—so rushed after at one time—was cast aside in Ceylon as well as Java in favour of the "Hevea" or Para, so is the latter about to be superseded by the Mexican or Castilloa tree. Now in all these conclusions, we think too much haste is manifested. We fear, indeed, that those who have abandoned even Ceara clearings, will live to regret their action. We can recall when samples of Ceara rubber from Ceylon realized 4s per lb., and now that we are on the eve of a revolution in the means of "harvesting" the crop, as well as of separating the caoutchouc, we say that every man who owns a rubber-yielding tree, whatever be the species, ought to carefully conserve it. In January, 1898, Mr. Willis told the world that the only important rubber for Ceylon was the "Para," and at the time he was, no doubt, acting up to the best light. But a good deal has been learned since; and in his Circular of April last, facts and figures are given to show that preference should be given to the Mexican or Panama *Castilloa* tree. Now we have not a word to say against this preference, nor do we fail to recognise the special importance of the invention of Messrs. Howard and Biffen in their "Caoutchouc Separator" as still further demonstrated, if not improved, by Mr. Hart of Trinidad. But while lately compiling from available literature for our "All About Rubber" Manual, we have been much struck with information reproduced in our own *Tropical Agriculturist* so far back as December last, which attracted too little attention at the time. From it we learn that, among other inventions or experimental applications on the *tapis*, is ONE FOR EXTRACTING CAOUTCHOUC PROFITABLY FROM THE YOUNG STEMS OF RUBBER-YIELDING TREES; AND WE VENTURE TO INFER THAT, ULTIMATELY, YOUNG TREES OF CEARA, PARA OR CASTILLOA MAY ALL BE FOUND AVAILABLE FOR THIS PURPOSE. Surely here we have the elements of a great revolution in Rubber cultivation? In case we may be supposed to write without chapter and verse, we refer to the article in the *Tropical Agriculturist* for December last entitled "Some Recent Developments in Rubber Cultivation," and we quote the writer as follows, premising that so far he gives the preference to young Castilloa trees:—

During a trip of several months through the old rubber-producing regions of Central America and the northern states of South America, I found a great interest in rubber cultivation, and preparations were being made to start very considerable undertakings, particularly in the British West Indies, where the fact that rubber never has been indigenous to those islands is not considered in the enthusiasm of the people. On the island of Trinidad I found this enthusiasm increased to a substantial boom. Rubber seeds were selling at five cents each, and young trees were wanted at fifty cents, through owners were refusing to sell year-old trees about two feet high for less than a dollar a piece. It was reported that two English companies were about to begin operations in Trinidad and were proposing to invest a combined capital of $5,000,000, while private enterprise would probably brings $2,000,000 more to the island, making a total of $7,000,000 prospective capital to be invested in that one locality. Other islands were becoming interested. In Grenada seeds were in demand with the prospect that a very considerable acreage will be set out.

The most interesting point under discussion in relation to rubber-planting in the British West Indies is a series of experiments now being carried on in London and Trinidad, by which it is proposed to secure rubber from year-old trees of the *Castilloa elastica*. It has been found that seeds sown broadcast over a prepared field will yield an abundant crop of young trees, which at about a year old can be cut and sent to a factory where, with ordinary machinery operating a simple process, 8 per cent. of fine rubber can be extracted from the young shoots. This can be done in the laboratory. It is claimed that the process is a simple one, that but little machinery is necessary, and that in future the world's rubber supply will be secured from an annual crop of young trees sown on cultivated estates, and not from remote forests at present. A series of experiments has shown that the young tree contains about 8 per cent. of rubber, which would at present prices return an estimated profit of $200 to $400 per acre. The extraction of rubber from young shoots has been accomplished chemically in the laboratory, but whether it can be applied to the economic production of rubber on a large scale remains to be seen.

And then the writer goes on to discuss the conditions under which "Castilloa" will grow. Every planter and merchant interested should read the paper in full, and decide whether we may not be on the eve of a boom in Rubber planting after the fashion of cinchona in the early "eighties"; but, we trust, with better results. Of course, the advice so far is to sow broadcast Castilloa seeds; but we cannot at all believe that the experiments dealing with year-old twigs of that variety, may not ultimately be extended to other varieties—not only to Para, but to the despised Ceara; and as we said above, we may shortly find branches or bark from every rubber-yielding tree or plant—even from many of our indigenous Ceylon species —in demand in connection with the very important experiments now being made in London and Trinidad—not only to separate the Caoutchouc from the milk, but to extract Rubber from the stems. True, this is only said to be realized so far from the stems of young Castilloa trees; but we cannot but anticipate a far wider application of the experiments ere long. Meantime, therefore, let all who can, plant Castilloa seed; and where that cannot be got, put in Para; and yet again, if such seed is not available, do not hesitate to multiply Ceara if the opportunity offer, rather than have no rubber trees at all; and very soon we shall see—what we shall see—possibly a demand for the stems of all three of these rubber-yielding trees.

RUBBER CULTIVATION IN CEYLON: PARA *versus* CASTILLOA; CEYLON *versus* THE STRAITS.

To the Editor "Tropical Agriculturist."

Dear Sir,—In reply to your enquiry as to the relative merits of Castilloa and Para Rubber cultivation in Ceylon, I think, and always have thought, that the former is adapted to a wider stretch of country than Para, and it will moreover grow and flourish at a much higher elevation; but the tree (in Ceylon at all events) is slow in developing, requires a good soil, and seed is very difficult to get: in fact unless a quantity can be imported into the country, it will be a long time before we have any appreciable acreage of this class of rubber growing here. I doubt, if there are more than 50 or 60 full-grown trees in the island at the present time, and it is only *some* of these that bear fruit. Those in the Peradeniya Gardens, for instance, though well matured, I am informed, give no seed. What Mr. Willis says about Para rubber growing in Ceylon may be briefly summarized thus:—

(1). That there is only a limited area available for its successful cultivation, probably about *10,000* acres in all; the land being situated between Kalutara and Ratnapura.

(2). If planted outside this zone, the trees, although they may grow well and develope a good girth, are not likely to yield a sufficient quantity of rubber to make the industry a remunerative one by itself.

(3). That the tree will do very much better in the Straits than in Ceylon, both as regards growth and productiveness.

As regards the area available for Para cultivation in Ceylon, I am inclined to agree with Mr. Willis that it is not very extensive if the *best* results are expected, and there is no doubt that well-grown trees in the locality he speaks of will produce very much better returns than in less favoured districts where the rainfall is deficient and the soil inferior. Experiments I have made fully bear this out : the yield from trees of varying ages in the Kalutara district being largely in excess of what would be expected in a drier climate. But when Mr. Willis implies that we must not look for a satisfactory yield *outside* this zone, I join issue with him at once and inquire how about Heneratgoda and the trees that have been tapped there?

Here we have a dry, hard, cabooky soil with a scanty rainfall, —conditions altogether unfavourable for such cultivation,—and yet the trees are well grown for their age and according to the published returns the tappings have been successful, both as regards the quantity and quality of the produce. The prospects of Para cultivation in Ceylon have been based exclusively on data supplied from Heneratgoda Gardens, and it says a good deal for the future of the enterprise that the returns should have been so satisfactory, seeing that according to Mr. Willis the trees are growing in a neighbourhood which may be described as wholly unsuited to their requirements. I have always myself thought it a great pity that the Heneratgoda Gardens were chosen as a home for the Para trees, for the reason that amidst such surroundings it seemed almost impossible that results could be otherwise than unsatisfactory. The published records of the yield, however, shew to the surprise of everybody, a very good margin for profit, even if the price of rubber were to fall considerably below present quotations ; and in more favoured localities, there is every reason to be well satisfied with the prospects of the enterprise.

I agree with Mr. Willis that the tree might be planted with advantage through fields of tea, and I am of opinion also that if placed at wide distances apart, the shade would be beneficial rather than otherwise to the tea underneath, but the trees would have to be kept well lopped up.

The statement made by Mr. Willis that Para rubber can be grown to better advantage in the Straits than in Ceylon applies to many other Products besides Rubber, and if we are to wait until we find something that will produce better results in Ceylon than any where else we shall have to wait for a very long time.

Take Rice, for instance. Is this cultivation to be discouraged because it grows better in India and Burma than it does here?

Are we to cease growing Cacao because the trees give better returns in the West Indies?

Is the cultivation of Tea to be discontinued because we cannot get the flavour of Darjeeling or the strength of Assam?

In Ceylon we have labour and transport facilities which counterbalance to a great extent the drawbacks associated with an inferior soil and, what we are chiefly concerned in knowing, is not whether tropical products can be cultivated to greater advantage in other countries, but whether there is a fair prospect of making them remunerative here.

In the case of Para rubber the only figures that have as yet been made public in Ceylon go to shew that satisfactory returns can be obtained from trees growing under all the disadvantages of soil and climate, and such being the case the presumption is that very much better results may be expected when the trees that have been planted in other parts of the country have reached full maturity.

I have figures at my disposal which point to excellent returns from this cultivation ; but in view of the fact that more extensive tappings are now in progress it may be well to withhold these statistics in the meantime, though in due course the information may be imparted to those interested in the cultivation of Rubber in Ceylon.

The yield from Rubber trees in the Straits is considerably in excess of the best returns in Ceylon ; but as a set-off against this, labour is twice as expensive there as it is here ; and there are other disadvantages to contend with, though none that are very serious as am aware.—Yours faithfully, E. S. G.

Next we reproduce three Rubber Circulars issued from the Royal Botanic Gardens, Peradeniya, by the Director Mr. J. C. Willis, M.A. :—

RUBBER CULTIVATION IN CEYLON.

(January 27, 1898.)

The growth of the cycling trade, and other industries in which rubber is used, has caused a great increase in the demand for rubber. That the price has not correspondingly increased is chiefly due to the discovery in West Africa of a new rubber-yielding tree, *Kickxia africana.* The collection of rubber from wild trees is carried on in a reckless manner, and the trees are being gradually exterminated. The rubber collectors have thus to go further and further inland every year for their supplies, and the cost of the rubber is thus increased by the difficulties of transport. There seems therefore a likelihood that the planting of the best kinds of rubber may prove a profitable industry.

The World's annual consumption of rubber is now over 100,000,000, lb., worth more than £10,000,000 sterling. Of this, from one-third to one-half comes from Para, which exported in 1895, 45,788, 613 lb.

There are many trees which yield rubber in different parts of the world. Most of them, however, are unsuited for cultivation for various reasons: some are climbers requiring large trees as supports, some yield very little rubber or rubber of poor quantity, and other do not yield rubber until they are twenty-five or more years old. The chief kinds likely to be useful in cultivation are Ceara rubber *(Manihot Glaziovii)*, Panama rubber (*Castilloa elastica*), Para rubber (*Hevea Brasiliensis*) and perhaps African or Lagos rubber (*Kickxia africana*).

The cultivation of Ceara rubber was energetically taken up in Ceylon about twelve or fourteen years ago, but the returns were found unsatisfactory, although the plant grew very well indeed. There are but few trees now in cultivation. Panama rubber is also scarce in Ceylon, and has not given very satisfactory results. The only important rubber at the moment is the Para kind, which alone is dealt with in the remainder of this Circular. This tree is well suited to the climate of the low-country in the south-west of Ceylon, is readily cultivated, and gives a fair yield of rubber. Para rubber is the best quality upon the maket, and obtains the highest and most uniform prices.

The town of Para occupies a position near the mouth of one of the vast embouchures of the Amazons, 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, *Hevea brasiliensis* and allied species are abundantly found. The climate is remarkable for its uniformity of temperature, usually not exceeding 87° F. at midday, 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 in. 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 Amazons' mouth 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 ft. 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 frequently be subject to be partially covered with water.—Trimen, *Notes on Rubber-yielding Plants.*

Para rubber was introduced into Ceylon in 1876, when the young plants obtained from Brazil at the expense of the Indian Government were planted in Henaratgoda Garden. These are now very fine trees, with an average height of about 60 ft., and 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 Batanic 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.

CLIMATE.—From the description of the climate of Para quoted above, it will at once be evident that only the wet, low-lying country in the south-west of Ceylon is suitable for the growth of *Hevea.* The best climate is probably that of the country lying between Kalutara and Ratnapura. Whilst the tree will grow at Peradeniya (elevation 1,576 ft.) it suffers much from cold, and grows very much more slowly than in the low-country. Probably about 500 ft. or 600 ft. will be found to be the maximum elevation for successful culture. The tree is quite unsuited for cultivation in the dry regions of the Island.

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 also has 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 coconuts.

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 (twelve 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 in. to 24 in. high they may be planted out. Good results are also obtained by stumping, the plants being allowed to grow about 3 ft. 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 ft. or 30 ft. 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 ft. apart. Their average girth is now about 30 in., 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 ft. apart. On the contrary, the best results have been obtained by planting 8 or 10 ft. 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 sandy soils.

Rate of Growth.—The tree grows very rapidly in height. The original trees, planted at Henaratgoda in 1876, were about 30 ft. high and 14 in. in girth two years later. In 1882 the largest tree was 50 ft. high and 25 in. 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 in. 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 in.

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 ft. apart. The girth was taken at the height of the eye, about 5 ft. 6 in. above the ground. The largest tree was 7 ft. 5 in., the smallest 2 ft. 1 in. in girth. The mean girth was 4 ft. ⅓ in.

In the plantations made by the Forest Department near Ratnapura measurements were taken in December, 1894, of the mean girth of trees at 3 ft. from the ground, with the following results:—

At Edangoda	(4 years old),	mean of	100 trees	12·96 in.
Do	(3 years old),	do	50 trees	8·75 in.
Do	(2 years old),	do	20 trees	4·96 in.
At Yattipowa	(3 years old),	do	108 trees	9·37 in.
Do	(3 years old),	do	108 trees	9·13 in.

The larger measurement at Yattipowa is that of trees on the western slope, the smaller that of trees on the eastern slope. The difference appears to be due to the fact that the latter are exposed to wind.

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 two 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 three 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 subsquent Circular. At present we shall only describe the methods which has been employed for some years in the tappings carried on at Henaratgoda.

The requisites for the work are a ¾-in. chisel, a wooden mallet, a number of clean coconut 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 ft. 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 six 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 coconut shells placed below. Three shells are sufficient for a tree of 2 ft. 6 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, and forming the channel against the bark by 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 aimed at is 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 peneterates this layer, and enters the wood, the healing of the wound is much slower, and at the same time risk is run of introducing parastic 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. Cousiderable 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 shold be made about a foot below the first, and others at similar distances down to the gutter at the base of the the tree. Another set of incisions may then be made parallel to the first, at about ten or twelve inches from them, and other vertical rows of cuts may be made if there be sufficient room for them. On a tree of 2 ft. 6 in. 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 ft. mean girth, the average yield per tree of the successive weekly tappings was as follows:—

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

YIELD.—The statements as to yield of rubber found in books of travel and popular articles are very unreliable, and experients 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 in. in girth a yard from the ground.

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

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

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 ft. 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 ft. 6 in. from the ground, of 225 of these trees was 2 ft. 4½ in. 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 ft. 10½ in., six 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 ft. 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:—

	R.
Felling and clearing at R12 per acre	3,600
Lining, 10 ft. by 10 ft., at R2 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 battacola roof, at R30 per room	300
Roads for inspection, 2 miles	160
Plant nursery, including watering	150
Weeding at R1 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 R40 per acre. A return of R4,200 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 R20 per 1,000). These items will probably bring up the total cost for the first year to at least R125 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 extimates the expenditure on weeding and supplying at R12, R8, and R5, respectively. Assuming that the expenditure in the years following is at the rate of R5 per acre, the cost of the plantation up to and including the tenth year, might work out as follows:—

	R.
Cost of land, 300 acres at R75	22,500
Cost of seed, says	3,600
First year's cost, as above	11,927
Weeding and supplying, second year ...	3,600
Do. third year ...	2,400
Do. fourth year ...	1,500
Do. 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 ...	R75,777

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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 R110,000, or R366·66 per acre.

RETURN.—The value of Para rubber in the London market varies between two and four shillings 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 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 R150 per acre. The cost of harvesting should not be more than R50 per acre, including carriage to London. This leaves a margin of R100 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.

PANAMA RUBBER (CASTILLOA).

(*Circular No. 11, April 1899.*)

In Circular No. 4 of this Series the cultivation of Para rubber was dealt with somewhat fully. It was pointed out that there is not very much suitable land in the Colony on which this cultivation was likely to prove really successful. The growth, cultivation, and yield of trees were considered, and a prospect of a moderately remunerative return in favourable places for the cultivation was shown to exist. Since the time of publication of these statements, however, the question of which rubber tree to plant with the most favourable prospects of profitable return has been considerably altered by the publication of the discovery of a machine for the preparation of rubber from the raw milk of the tree. By the aid of a machine on the principle of the centrifugal cream separator, Mr. Biffen has succeeded in preparing almost pure caoutchouc from any milk (*latex*) which contains it. This is done in a few minutes at a very small cost, and the resulting product is almost free from impurity, and does not decay or smell like the ordinarily-prepared raw rubber. The best rubber hitherto sent into the market contains at least 10 per cent. of impurity, and many kinds contain as much as 30 to 40 per cent. The importance of this discovery is manifest. The chief advantage of Para and Panama rubbers, as at present prepared, is their great freedom from impurity, due largely to the composition of the milks, and partly to the methods of preparation. Under the new conditions, however, this advantage is lost, for the machine will prepare from the poorest and most impure milk a rubber superior to the best Para now on the market. The first question therefore before the would-be grower of rubber trees is now no longer, "Which tree gives the best result as to quantity and quality combined?" but rather, "Which tree gives the greatest yield of caoutchouc?" The former question had been practically answered for Ceylon in favour of the Para rubber (*Hevea brasiliensis*). The latter has still to be answered, but there is great probability, if not almost certainty, that it must ultimately be answered in favour of *Castilloa*, and hence the publication of this Circular in which it is proposed to deal with the whole question so far as present existing data allow of conclusions. The tree has been so little cultivated in the East that reliable data in sufficient numbers are not to be had, and it is hoped that the publication of this paper will induce those who may have experimented with this tree to communicate the results of their work.

Another important bearing of the discovery above-mentioned must also be pointed out. At present the best natural rubbers obtain about 4*s*. per lb. in the London market. When the machine-prepared article first comes upon the market it will doubtless obtain a higer price than this, but this will not long be the case. Inevitably the price of the best machine rubber will fall to about that of the best natural of today, while the latter will only fetch perhaps 3s. per lb., and the poorer grades will also fall in price correspondingly. For profitable cultivation, that is, the machine methods must be used. Now, for this purpose it s necessary that the milk be collected in vessels and not allowed to dry on the tree. We have seen in dealing with Para rubber that in Ceylon, at any rate, the milk is very thick, almost like syrup. It quickly coagulates, and in all cases a lot of it dries on the tree. Before the recent discovery this mattered less, for this scrap rubber would sell for 1*s.* 6*d.* to 2*s.* 6*d.* per lb. Now, however, as we have just seen, this price is likely to fall by 1*s.* or more. This will materially alter the figures of return given in the last paragraph of the Circular referred to. Instead of the average price being 2*s.* per lb., it is more likely to be 1*s* 6*d.*, and this will reduce the yield per acre to Rs. 112 say. This reduces the margin of Rs. 100 there given to Rs. 62 leaving considerable uncertainty as to whether the cultivation is likely to pay at all well enough to be worth attention from European planters who would probably find the trees yield much better in the Straits or America. *Caitilloa* milk flows very much more freely and does not soon coagulate, so that the same objection does not apply to it. Practically the whole of the milk from a tree can be collected without any difficulty from coagulation beginning in it.

The practical corollary of these remarks, so far as Ceylon is concerned, is this. Para rubber will do fairly well at low elevations in certain districts, though probably at the best it will never do so well as in the Straits Settlements or America. Owing to the introduction of the machine methods it will in future be necessary to collect the milk in vessels. Now, the Para rubber tree, when tapped at a girth of 2 feet, as recommended in the previous Circular, does not lend itself to this condition, much of the rubber dries on the tree. It will thus be necessary for planters either to content themselves with the old process, thus getting a lower average price for their product, or to wait till the trees get to a larger size, say in fifteen years on the average. It follows from this that private planters here will hardly find it worth while to establish plantations of Para rubber only. Probably the best thing to do will be to plant out the tree among tea or other products at considerable distances apart. The trees will then grow to a large size in less time than if kept in plantations of rubber only, and their rubber will form a useful minor product. The tree is a handsome tree when well grown apart from others, and might well be used as shade for roads or as an ornamental tree.

Those who intend to make plantations of rubber only would do better to use *Castilloa*, which yields much more fluid and easily collected milk, but even here no return can be got in much less than eight years. This tree may also be planted out as a bye product on estates, and will probably be found in the end the more profitable of the two. Ceylon seems an unfavourable country for yield, though highly favourable for growth, of rubber trees. Consequently, only the very best localities should be chosen for planting.

BOTANY.—*Castilloa* is a genus of the family *Moracæ* (often inluded in *Urticaceæ*), and belongs to that section of the family which includes the jak and breadfruit (*Artocarpus*), the upas (*Antiaris*), the milk tree (*Brosimum*), and the many plants of the genus *Ficus*, which include among others the Bo and the Assam rubber (*F. elastica*). The genus has two or three species. Of these, the most important is *C. elastica*, Cervantes, the Ulé of the Spaniards, which is found wild in Mexico from lat. 21° southwards in Guatemala, Honduras, San Salvador, Costa Rica, and Nicaragua; it also appears to occur in north-western South America. It grows to a large tree, having been measured of 180 feet in height and 15 feet in girth. The growth is rapid, When young the tree grows rapidly upwards, and forms a number of short lateral branches, which after a time drop off, being detached from the trunk by a peculiar joint, whose surface resembles a piece of coral. The bark is rather soft and thick. The leaves are large and oblong. The flowers are borne when the tree has reached some considerable size and has begun to form permanent branches. They are monœcious, male and female on the same branch, enclosed or embedded in a top-like common receptacle, which is covered externally with small leaves. This subsequently forms a somewhat fleshy fruit, containing numerous small seeds about ¼ inch in diameter, with white papery seed-coats. Besides this species there is a second, the Caucho of the Spaniards, found near Darien (Panama) and elsewhere. This is the tree which we have in Ceylon, and it appears probable that it is a different species, *C. Markhamiana*, Markham (not Collins), but the point requires further study. In its native country this forms an important source of rubber. It appears to be a smaller tree than the true *C. elastica*. The details of the description of these species may be found in the paper by Hooker mentioned in the list of literature below.

HISTORY IN CEYLON.—The *Castilloa* rubber was introduced into the Colony about the same time as the Para, and through the same agency. A Wardian case of plants arrived in 1876 from the Royal Gardens, Kew, and the plants were put out at Henaratgoda and Peradeniya. They grew well at both places, but especially at Henaratgoda, and were increased by cuttings. They began to flower in 1881, and in the following year a few seeds were ripened. About 1886 the growth became less rapid, and since then has been very slight, the soil in the gardens being shallow, and at Henaratgoda not well drained at a little depth. A large number of young plants were sent to India and many were planted in Ceylon, but, compared with Ceara and Para rubbers, *Castilloa* is very rare in the Colony, and very few estates possess any appreciable number of trees. Samples of rubber prepared here have been sent home for valuation, and have received very favourable reports.

CLIMATE AND SOIL.—The tree ranges, as we have seen, over a large tract of country, but the conditions for its successful growth seem much the same everywhere. It inhabits a warm, steamy climate, like that of the low-country of south-west Ceylon, and is very rarely found above 1,500 feet. The most common situations are in alluvial soil at the sides of valleys or on low ridges. It needs deep soil, with plenty of water, but does not thrive where the soil is swampy, nor in places where there is not good drainage at the roots. It is probably partly for this reason that the growth at Henaratgoda so soon became slow, for the land there is flat and only 20 feet above the level of the sea. At Peradeniya it is on better drained land, but the soil is very shallow.

The tree prefers a steamy climate, but will do where this is interrupted by a dry season of two or three months, as in south-west Ceylon. It grows best where the temperature never falls below 60° at any time.

The most promising localities for the cultivation of this tree would probably be found in the neighbourhood of Rambukkana, Kitulgala, Balangoda, and other districts in the foot hills of the south-west, and perhaps also in similar districts of the Bintenna country to the east of the mountain range, and in lower Madulsima, Passara, Monaragala, &c. It should be planted in sheltered places near streams, but with good drainage at the root. To plant above 2,000 feet is not advisable, and it would be better to plant below 1,000. The rainfall should not be below 70 inches, and should be well distributed. The tree affects drier localities on the whole than Para rubber, and so the two cultivations need not interfere with one another, as the Para tree will grow in the wetter places.

The tree grows best in a deep, warm, loamy soil. In its native country it is said to send its roots very deeply into the soil, and not to be a surface feeder. In the gardens at Henaratgoda, however, it sends out great roots at the base like the Assam rubber (*Ficus elastica*), growing out to considerable distances along the surface and projecting above it. One root was measured running along the surface for 30 yards, and where it finally became invisible it was 3 inches in thickness. This phenomenon at Henaratgoda may be largely due to the quality or lack of drainage of the lower soil, but it seems common in other places where the tree is grown in the Colony, and will limit its use as a shade tree, for which purpose it has often been recommended in other countries. If used as shade, it would perhaps do better with tea than with most of our other cultivated crops. In better soil and position than what has hitherto been tried, however, it may very likely strike deep roots, in which case other crops could be more easily cultivated between the rubber trees, *e.g.* plantations or even cacao.

CULTIVATION.—The seed should be sown as soon as obtained in a well-prepared nursery. They should be sown an inch deep, and about 8 inches apart, and lightly covered with a little vegetable mould. They must be kept lightly shaded, and watered when the surface of the ground is dry. In ten or twelve months the young plants will be 2 feet high and ready for planting out.

Cuttings may also be taken; those from lateral branches do not grow well, and have a tendency to grow more or less horizontally, so that main shoots must be used. When cut back the main stem produces buds from the axils of the leaves, and these may in turn be used as cuttings, and so on. Cuttings should be at least 3 inches long, with a basal portion of old wood, and perhaps 12 inches is better, as described for the case of Para rubber.

The young plants should be planted out during rainy weather in prepared places. Holes should be dug and filled with well-prepared sandy, loamy soil. If the plantation is to consist of trees of *Castilloa* only, they may be put at about 12 feet apart, or perhaps better a little closer. If other products are to be cultivated between the rubber trees, the distance must be much greater. The young trees must be shaded for a time, and probably it would be best if they were lightly shaded for two or three years till they reached a height of 20 feet or so. This might be effected by planting them, for instance, on land already bearing such light shade trees as are used for cacao. On parts of estates where the canker has rendered it needful to cut out the cacao it might be well worth while to try the *Castilloa*. The ground should be kept clear of weeds and the trees watered in dry weather of long duration, until they reach sufficient size to take care of themselves.

Rate of Growth.—The tree grows fairly rapidly at first, and soon reaches a height of 10 or more feet. From the annual Administration Reports of this Department the following extracts have been made with reference to this subject. In 1878 the original trees were two years old, from of planting out as cuttings; some were 16 feet high, and 16 inches round the base of the trunk. In 1880 the largest tree at Henaratgoda was 17 inches in girth at a yard about the soil. In 1882 the largest tree there was 46 feet high, and 26 inches round at a yard above the soil. In 1884 its girth was 32½ inches; in 1886, 38 inches; and it began to show signs of less rapid growth, so that it only reached 40½ inches in 1888, 42½ in 1890, and 43¼ in 1892. Up to about the tenth year, therefore, at any rate, the tree may apparently be counted upon to grow well; and even though the subsequent growth is slow, the yield of rubber seems to increase considerably. After reaching a girth of about 2 feet or 2 feet 6 inches the trees may probably be tapped for milk. Comparing the above measurements with those given in the Circular on Para rubber, it will be seen that *Castilloa* is distinctly slower in growth of the two, and probably a plantation of Para rubber would reach the girth of 2 feet (average) in two years' less time than one of *Castilloa*.

Tapping.—The trees should not be tapped till it reaches a girth of at least 2 feet. This should be attained in a period of perhaps nine years on the average, and it would be better to wait for two years more if possible till a girth of perhaps 2 ft. 6 in. is reached. After the eighth year there would probably be a fair number of trees in the plantation ready for tapping, and of course the number would increase every year till all were sufficiently large for the purpose.

The milk of this tree flows much more freely than that of *Hevea*, so that one cut seems to drain a much larger area of the stem of its milk. The native methods of tapping are mostly very wasteful, and also often cause the death of the trees. Sometimes the method described under Para rubber, by cutting V-incisions at frequent intervals, is used, and so far this seems to have been the only one used in Ceylon. We have found that the milk here runs so freely that a simple sloping cut is sufficient, and that there is no need to make to V. If this method is used, the cuts need not be so close together as in *Hevea;* they may be 3 or 4 feet apart instead of 1. Sometimes the whole tree is cut down and incisions made in the bark as it lies on the ground. Other methods are to cut spiral groves round the tree for some distance up, or to make a main channel on one side of the stem with lateral cuts leading into it. These methods are almost sure to kill the tree, at any rate after a few years, and only the first-mentioned, the method of simple incisions, should be used with cultivated trees.

Further details of methods will be given in succeeding Circulars of this Series. The general principle recommended is to attach four or five tin cups at distances of a few feet apart up the tree. Single oblique incisions are made, one above each cup, and the milk is collected and washed into a vessel with a tap at the bottom. Probably the best machine would be a glass churn with tap at base, fixed so as to revolve about a horizontal axis. The milk is left to stand, when it separates into a cream containing all the rubber, and a beery fluid below, which is run off by the tap. The cream is mixed with water, churned, left to stand, and the process repeated. The rubber is thus obtained almost pure in three washings, and the cream is poured out to dry on a porous surface, when a thin sheet of perfectly dry and almost pure caoutchouc is obtained in a short time.

YIELD.—Till further experience has been gained we do not know how much tapping is advisable in *Castilloa*, nor how much it will stand. The trees in the Island, so far as tested, yield very well, but it would be premature to draw any general conclusions. A few trees of about 3 feet girth gave an average of 5 ounces of rubber each from a day's tapping. Probably three or four tappings might be done every year without serious injury, but this remains to be investigated. The amount of rubber is not much larger than in Para trees of similar age, but it was collected from a quarter of the number of incisions, thus very much reducing the cost of its collection. It must also be remembered that this rubber was perfectly dry, whereas the driest rubber prepared by the old methods contained 10 per cent. or more of water.

The cost of opening plantations of rubber will be found in the preceding Circular. The probable return in the case of *Castilloa* is larger than in the case of Para, and its cost of collection is less, so that the cultivation of this plant as a bye product in favourable localities may be recommended to planters. Neither kind of rubber can be safely recommended as a principal product. Those who wish to plant it on a large scale would probably do better in countries further east.

LITERATURE.—The following books and papers, among others, relating to *Castilloa*, may be consulted in the Library at Peradeniya. The initials and figures indicate their place in the Library :—

Hooker, Sir J. D., and Dyer, W. T. T. on the *Castilloa elastica* of Cervantes, and some allied rubber-yielding plants, Trans. Linn. Soc. Series II., Vol. II., p. 209, 1885 ... ... G 1
Morris, D., Cantor Lectures on the Plants yielding commercial Indiarubber, 1898 ... ... M 6
Morris, D., The Colony of British Honduras, p.p. 74, 80... P 6
Seeligmanny., Lamy, and Falconnet, Le Caoutchouc et la Guttapercha, Paris, 1896 ... ... M 6
Forein and Colonial Office Reports :
F. O. Misc., 1894, No. 322 (Colombia)
Do 1895, No. 385 (Mexico) } ... F 4
Kew Bulletin of Miscellaneous Information, December, 1887 ... . J 3
Trinidad Bulletin, August, 1898, p. 115 ... ... B 3
Tropical Agriculturist : Feb. 1883, p. 682; Nov. 1884, p. 301 ; March 1885, p. 697, &c. ... ... I 1

JOHN C. WILLIS,
Director, Royal Botanic Gardens.

Peradeniya, April 7, 1899.

PARA RUBBER GROWING:

THE COMING INDUSTRY FOR CEYLON.

(*From the "Tropical Agriculturist" for June 1898.*)

"Is it to be Para Rubber or Ramie Fibre," may well be a question asked by the puzzled planter anxious to have two strings to his bow ; and we suspect the information published now will send a good many more customers after Rubber seed. We were aware of the wonderful progress made on Culloden estate when we took exception to a statement about good seed being unavailable save from our Government Gardens. The following report published in the *Ceylon Government Gazette* will shew what the Director of the Garden has now to say on the subject:—

Royal Botanic Gardens, Peradeniya, April 14, 1898.

The Hon'ble the Colonial Secretary.

SIR,—I have the honour to report that during the week ended April 2nd last, I visited the plantations of Para indiarubber at Edangodo and Yattipowa made in 1890-93 by the Forest Department, and also some of the estates near Neboda, on which a considerable amount of rubber has been planted.

2. The plantations belonging to the Forest Department are in very good order and in a year or two many of the trees will be in condition to allow of experiments in tapping being made on them, as is much to be desired.

3. On Culloden estate near Neboda, which I have examined in most detail, thanks to the courtesy of the visiting agent Mr. Grigson, there are about 30,000 or more trees in very fine order. The older trees were grown from seeds or cuttings obtained from Henaratgoda garden. Of recent years the estate has had much seed of its own, and this year their crop is expected to greatly exceed that at the disposal of Government.

4. A finer lot of trees than those on this eastate and the neighbouring estate it would be difficult to find. The oldest trees are only fourteen years old, but rival the trees twenty-one years old at Henaratgoda. This is partly due to the fact that the Culloden trees are more widely separated than those at Henaratgoda, being planted among tea at distances of about 30 feet, partly to the more favourable soil and conditions of the Kalutara district.

5. A few experimental tappings have been made on the older trees on this estate and have shown very good results better than those obtained at Henaratgoda, on which the data of profit and loss given in the Circular recently issued by this Department were based. As at present the demand for seed makes it more profitable to keep the trees for seed, these experiments are not being continued just now.

6. From what I saw of the condition of the trees and the results of these tappings, I am strongly confirmed in my previous opinion that the cultivation of rubber bids fair to prove a profitable industry in Ceylon and a useful adjunct to the larger industry of tea and coconut cultivation.

I am, &c.,

JOHN C. WILLIS, Director.

INDIARUBBER FOR CEYLON PLANTERS.

(*From the "Tropical Agriculturist" of March* 1897.)

"J. M.'s" letter on next page appears at the right time. We feel that it was a great omission in the Planters' Association Report that no reference was made to rubber, and we trust our suggestion as to collecting information on this and other minor products, from the District Associations, will be adopted another year. Meantime, it is of intesest to know that very shortly a series of experiments in harvesting rubber is to be undertaken at the Henaratgoda Gardens and that the results are to be carefully noted and published for the guidance and, we trust, encouragement of planters. Every year, too, should make the areas cultivated with rubber under the direction of the Forest Department, more interesting, and it should soon be time to institute tapping experiments, so as to judge year by year, what is the best and most profitable time and mode to harvest the crop. Then if planters, with an appreciable number of rubber trees or creepers and a certain amount of experience in cultivation and harvesting, will but tell us of the same, briefly and to the point, we shall indeed be able to put forward more reliable information as to the present position of Rubber-growing in Ceylon. The importance of the industry as one of the few products, for which there is an ever-growing demand, cannot be over-estimated.

THE CULTIVATION OF RUBBER IN CEYLON.

To the Editor "Tropical Agriculturist."

Kandy, Feb. 2.

Dear Sir,—It is much to be desired that we should hear more about rubber and its cultivation from all who have information to impart, such as those experimenting in Ceylon and those who are directors of such establishments as the Peradeniya Botanical Gardens. It would indeed be a very appropriate time for Mr. Willis to strike his first note.

Some time ago attention was called in your columns to Mr. Rowland W. Cater's communication to *Chamber's Journal* on *castilloa* rubber and I see in the *Standard* of 29th January an interesting article upon "The Rubber Industry" commencing with the recent discovery of the Germans in their Cameroon possessions, of a prolific rubber yielding tree *Kickxia Africana.* It is said that the value of the export from Lagos was £324 6s 4d in 1894 and £*269,893* in 1895 all from this *Kickxia Africana.* In the *Standard* reference is made to efforts of Indian and Ceylon Governments and Ceylon planters to ascertain if the cultivation of rubber can be made profitable and speaks of the experiments of Ceylon planters not being remarkably successful, though finest varieties were introduced, and it states that "it is not uncommon still to hear of coffee planters in Ceylon and others in India laying out their estates in rubber !"

I do not think the introduction of the best varieties was on a large enough scale or has had sufficient time for very complete proof of success over an area of large extent.

The advantange of cultivation in respect to best varieties, accessibility of cheap labour, purity, and careful preparation as opposed to collecting in primeval forests—under disadvantages, that involve destruction of the trees, and after mixing with foreign matter and at much cost—may be so great as to justify more attention to the matter than has hitherto been given here.

Mr. Cater's article " Out with the Indian Rubber Gatherers" is valuable for information of various sorts; but when he gives the figure of estimate of a plantation of *castilloa elastica* at Nicaragua with its results in 8 years it makes one wonder whether we have not neglected our opportunities in Ceylon. Having taken his selling basis on 2s a lb. only, calculating his trees planted 15 feet apart, included the premium of 3d per tree paid by the Government, wages of tapping at over 1s 3d per diem, he brings the following result of a 500 acre clearing at Nicaragua :—

	£
Cost of 500 acres of land at 5s per acre... ...	125
Survey and procuring titles thereto	100
Clearing land for planting	1,000
Collecting seed and planting	500
Eight yearly weeding at £200 each	1,600
Extras, implements, &c., &c.	300
	£3,625
Interest on £3,625 eight years at 5 per cent per acre ...	1,450
Planters expenses, cost of living, etc. per eight years at £200 per annum	1,600
Cost of gathering the 8th year crop	1,500
	£8,175

But his estimate of profit per acre at the 8th year is as follows :—

Dr.	£	s	d
Cost of cultivation eight years 193 trees per acre ...	7	4	9
Cost of tapping or harvesting	3	0	0
Balance of profit	88	13	6
	£98	18	3

Cr.	£	s	d
Government premium	2	8	3
Yield 965 lb. per tree at 2s	96	10	0
	£98	18	3

So that on 500 acres the profit would be 44,337·10.
If this is not satisfactory—go on to the next—the 9th year.

£			£
200	for weeding	Value of crop in 9th year	50,000
1,500	for harvesting		
500	for planting		
180	for interest		
47,600	for profit		
50,000		Profit would be £47,620.	

His report of yield of the *castilloa elastica* in Nacaragua is interesting in view of the late Dr. Trimen's somewhat adverse report on the yield in Ceylon.

The trees at Wiharegama, Matale, seeded very freely and it is much to be regretted that on no proper scale has experiment been made with this variety. J. M.

RUBBER CULTIVATION IN CEYLON UNDER THE FOREST DEPARTMENT.

(*From the "Tropical Agriculturist" of November 1897*).

We give below the papers embodied in the Sessional Paper compiled in answer to Mr. Chamberlain's brief despatch giving cover to a letter from Kew. The experiments in "tapping" promised by Mr. Willis will be looked for with much interest:—

The Right Hon. J. Chamberlain, M.P., to Governor the Right Hon. Sir J. West Ridgeway, K.C.B., K.C.S.I.

Downing Street, April 23rd, 1897.

Sir,—I have the honor to enclose, for such action as you may think fit to take, a copy of a letter from the Director of the Royal Botanic Gardens, Kew, calling attention to a report on the cultivation of rubber-producing trees in Mexico, and suggesting that the subject should be entertained by your Government I have, &c., J. Chamberlain.

The Director, Royal Gardens, Kew, to the Under Secretary of State, Colonial Office.

Royal Gardens, Kew, April 20th, 1897.

Sir,—You have no doubt observed that the employment of india-rubber in the industrial arts has of late enormously increased. This substance is obtained in the tropical and warmer parts of the world from trees occurring spontaneously, and which have to no appreciable extent at present been subjected to cultivation. Apprehensions have therefore been expressed that the supply at no distant date may be very much restricted.

2. On this point without accurate information it is difficult to give a positive opinion, but it must be admitted to be extremely probable. It is therefore not surprising that projects have been formed to grow plantations of rubber-producing trees artificially. I am anxious to draw the attention of the Secretary of State to the account of an enterprise of this kind given in the accompanying report by Her Majesty's Minister in Mexico.

3. Twenty years ago the Secretary of State for India in Council invoked the aid of this establishment to introduce the species yielding india-rubber in South America into India. The operation was succesfully accomplished at considerable cost. Three species were established in Ceylon, where they have since produced seed, which is available for distribution. As far as I am aware, no practical result has followed. Yet it cannot be doubted that there must be many spots in our Eastern Colonial Possessions

where rubber cultivation might be prosecuted successfully. I venture to think that the matter is one to which the attention of the Governments of Ceylon and of the Straits Settlements might be properly drawn. Probably if a memorandum were issued by the botanical officers of these colonies pointing out the culture, conditions suitable to each species and the source from which seed could be obtained, planters would engage in the enterprise.

4. In recent years a tree (*Kickxia africana*) has been discovered in West Africa which yields a rubber of excellent quality, and this has become the basis of a trade of great magnitude. Seeds of this tree have been sent from Kew to the Botanical Departments of Ceylon and of the Straits Settlements. I am, &c.,

W. T. THISELTON-DYER.

The Conservator of Forests to the Hon. the Colonial Secretary.

Office of the Conservator of Forests, Colombo, May 20th, 1897.

Sir,—With reference to your letter No. 195 of 18th instant I have the honour to state that the pamphlet enclosed therein deals with the Castilloa rubber.

2. The late Dr. Trimen recommended the plantation, not of Castilloa, but of Para rubber plantations, and in consequence the Forest Department plantations have been made with the latter species.

3. I have already requested the Assistant Conservator to make an estimate of plantations on a larger scale than has hitherto been done, and as soon as it is submitted I shall forward it with my remarks.

4. I can however state here that if a large plantation is taken in hand it will be necessary to have a special superintendent in charge of the plantation for the Assistant Conservator, with his numerous duties requiring his presence in different parts of two Provinces, will be unable to devote sufficient time to a plantation which requires constant supervision.

I am, &c.,

A. F. BROUN, Conservator of Forests.

The Conservator of Forests to the Hon. the Colonial Secretary.

Office of the Conservator of Forests, Colombo, May 25, 1897.

Sir,—In continuation of my letter No. 202 of 20th instant I have the honour to annex copy of a report on the subject by the Assistant Conservator of Forests, Western Province.

2. Mr. Lewis proposes to plant 300 acres per annum, and submits an estimate for the first year amounting to R10,202 or R34 per acre. Against this expenditure he shows an estimate of revenue from the sale of timber, firewood, &c., amounting to R4,200. The net expenditure would therefore be R6,002, or R20 per acre for the first year. To this amount would have to be added the expenditure in the second, third, and fourth years on weeding and supplying, which I expect would amount to R12, R8, and R5 per acre, respectively.

3. To my mind, if such a place can be selected I would much rather keep the plantations in one block than open a number of different plantations at various points. Such a multitude of plantations would not only increase the cost of fencing and watching, and the cost on a larger number of cooly lines, but it would do away with the advantage of having a special superintendent always on the spot.

4. If Government wishes the work to be taken in hand, I shall early next month inspect the place near Pelenda where the Assistant Conservator proposes to start work. It will also be necessary to issue instructions to the Director of the Botanic Gardens to reserve all the seed from the trees at Henaratgoda for our plantations.

5. Finally, I beg to point out to Government that the expenditure on these plantations lessens the chance of a surplus for the Department, and that

if it intended that the Forest Department, should show an increasing net revenue, the starting of these plantations should be put off.—I am, &c., A. F. BROUN, Conservator of Forests.

The Assistant Conservator of Forests, Western and Sabaragamuwa Provinces, to the Conservator of Forests.

Colombo Kachcheri, 20th May, 1897.

RUBBER CULTIVATION, PASDUN KORALE AND KUKULU KORALE.

SIR,— With reference to our conversation at Avissawella on the 12th instant, regarding the further addition to the area of land under rubber cultivation, I have the honour to state that I think it is possible that at Pelenda in the Pasdun Korale, and in the delta formed by the Pelan-ganga, Kukulu-ganga, and Maguru-ganga streams, that the total extent might be brought up to say 3,000 acres.

2. I may remark here, however, that the question of area is not so difficult as the selection of land of a suitable degree of flatness, situation, soil, and elevation: for, while it is perfectly possible to find an even larger extent, experience shows that it is undesirable to plant steep hill sides or swamp lands, or lands in which the soil has a high percentage of sand in its composition, with this product.

3. Under these circumstances it is extremely difficult to find a continuous piece of land with all suitable conditions, and therefore I would respectfully suggest that selected areas be first fixed upon, and if their success will justify it, they could in many cases be connected by opening the intermediate areas.

4. I am of opinion that in this way a most profitable block of 150 acres could be obtained in the ówita lands in the Kukulu korale; where there are 850 acres of this sort of land, but I think it would be unwise to select any below flood level, and so I restrict the proposed extent there to 150 acres. I have a further reason for suggesting this land in particular, as it is both flat and fertile and might be specially worked as a centre for raising seed, for which it is reasonable to anticipate a very large demand as rubber becomes known as a permanent industry; and judging by results of areas set apart in tea for seed bearing, it is not unreasonable to anticipate a very large revenue from this source alone.

5. I may moreover point out that local labour in the Kukulu korale is not in such demand as in other places, where tea estates absorb all available hands for plucking, &c., and therefore be easily obtained by us.

6. I would venture to suggest that 300 acres of rubber per year might be opened, and that operations might begin at once this year, by selection and survey of suitable blocks, and preparatory extraction of all timber that could be first disposed of; and if this is done under European supervision I anticipate that the return by sale of timber and firewood would more than pay the salary of the officer in charge, thus securing the services of one who would be able to devote his entire attention to the proper management of the plantations at practically no cost to the estate. I submit that constant supervision is essential to the proper management of such a plantation that I propose, to increase by 300 acres yearly, and for that purpose I have estimated for a European Assistant to be under my orders.

7. Annexed will be found an estimate for opening 300 acres at once, to be planted early in 1898 with plants to be first grown in a nursery, for which purpose all the seed at Henaratgoda should at once be secured; and I may add that I have, in anticipation, communicated with the Director of the Botanic Gardens to know what quantity can be obtained.

8. Finally, I would beg to be informed with as little delay as possible if I may make arrangements for the selection of 300 acres of land, and if the estimate may receive sanction.

I am, &c.,

FREDERICK LEWIS,

Assistant Conservator of Forests.

ESTIMATE OF COST OF OPENING AND PLANTING 300 ACRES OF FOREST LAND WITH RUBBER: PASDUN KORALE.

	R
Felling and clearing 300 acres of forest at R12 per acre ...	3,600
Lining 300 acres 10 ft, by 10 ft. at R2 per acre	600
Holing 300 acres at 75 holes per cooly, at 40 cts. 130,680÷75 by 40 ...	697
Filling and Planting and carrying plants from nursery to holes, 300 per cooly at 40 cts. 130,680÷300 by 40 ...	175
Draining: 300 ft. of drains per acre at 1 ct. per ft. run ...	900
Lines for coolies: one shed of 10 rooms of 12 ft, by 10 ft. mud walls and battacola roof, at R30 per room	300
Roads for inspection: 2 miles at R80 per mile	160
Bungalow for Assistant: improvements to present building at Midellana plantation	75
Plant nursery, including watering of seed beds	150
Weeding (assuming the opening of the land to be in July 1897.) at R1 per acre, for six months=300 by 6	1,800
Cost of surveying lines round plantation, say	75
Contingencies such as special work, bridges over streams, or supplying vacancies, &c.	250
Total actual outlay ...	8,782

SPECIAL EXPENDITURE.

	R.	R.
Salary of Assistant, for one year ...	1,000	
Cooly to carry letters and orders ...	120	
Tools (cost of supply)	300	
		1,420
		10,202

ESTIMATED RETURN OFF 300 ACRES OF FOREST TO BE PLANTED WITH RUBBER.

	R.
600 trees sold standing at R2 per tree	1,200
Value of firewood and "ritti" after deducting cost of working: R10 per acre	3,000
Total to credit of first year's work	4,200

The Assistant Conservator of Forests, Western and Sabaragamuwa Provinces, to the Conservator of Forests.

Colombo Kachcheri, 9th June, 1897.

SIR,—In acknowledging receipt of the Hon. the Colonial Secretary's letter to you No. 211, and herewith returned, I have the honour to report that in 1890 a small plot of 15 acres was selected at a place called Edangoda, in the Kuruwiti korale in Sabaragamuwa, and planted with Para rubber. The land was selected close to the Kalu-ganga, and at certain periods of the year it was subject to floods. As the late Dr. Trimen was of opinion that as similar land in its native habitat was best suited for this species of rubber, I laid out my plantation in such a situation as would best correspond with these conditions.

2. It was found, however, that these periodical inundations were harmful, and that plants below flood level were destroyed, notwithstanding much attention having been paid to the supplying of vacancies. By this loss

about one-fourth of the Edangoda plantation was destroyed, but of the remainder above high-water-mark I cannot speak too highly. The trees are in robust health, and form an unbroken cover of trees of some 20 feet in height and from 15 to 20 inches in girth at four feet from the ground. Some 275 trees are this year in fruit at the Edangoda plantation, and I anticipate getting a crop of 30,000 seeds that will be avilable for use during the present year.

3. In 1891 the Edangoda plantation was extended by one acre, and at a place called Yattipowa, six miles from Edangoda, a second plantation of 16 acres was planted, and in 1892 a further addition of 21 acres more, while as an experiment in chena soil 5 acres of chena land at Edangoda were planted, thus bringing the total area in rubber to, say, 58 acres.

4 The Yattipowa plantation is, on the whole, very successful, the only exception to its general regularity of growth being found upon a ridge where the soil is inferior and the wind appears to check the growth. This is only a very small piece and is quite compensated for by the satisfactory growth of all the rest of the plantation.

5 I am not so well pleased with the experiment of planting chena land, as it has shewn a thin and weedy result in trees, but the general conclusion I have drawn from the experience gained is that flooded lands, wind-swept lands, sandy soils, and wide apart planting are equally unfavourable to the successful cultivation of Para rubber.

6. I am not in a position to give any information as to yield of the trees, as it has been deemed inexpedient to attempt to tap any of them, but for my own information I selected a solitary tree and obtained from it, from a single wound, a "tear" of pure rubber about 4 feet long and one-third of an inch wide, that when dried appeared to be of excellent quality. The oldest trees being only seven years old, I have not attempted to experiment further, but I hope to be allowed to conduct a few tapping operations in order to test the yield per tree.

I am &c,

FREDERICK LEWIS,
Assistant Conservator of Forests.

NOTE.—I wish to add that the foregoing distinctly applies to the Sabaragamuwa Province and that 27 acres have been planted in 1896 in the Western Province and not as yet added to the area in rubber.

The Conservator of Forests to the Hon. the Colonial Secretary.

Office of the Conservator of Forests, Colombo, July 5, 1897.

SIR,—With reference to your letter No. 243 of 26th ultimo, I have the honour to inform you that on the 3rd instant the Director of the Royal Botanic Gardens and I had a conference on the subject.

2. The demand for Para rubber seed is now so enormous that Mr. Willis says if all could be supplied 100 square miles could be fully planted up. The supply from the Royal Botanic Gardens can only satisfy a very small portion of the demand, and even some private sellers have booked all their crops, charging R20 per 1,000 seeds. The Director therefore thinks, and I agree with him, that the publication of a notice offering seed to the public on payment would lead to a great deal of disappointment.

3. He proposes, as soon as he has completed a series of experiments regarding yield of trees of different sizes and ages, &c., to publish a bulletin in which will be included the results of our experience as regards soil and locality.

4. I have lately visited the most recent rubber plantation in the Pasdun korale and was disappointed to find that some of the young plants had suffered from some extraordinary floods, and that as compared with the plantations at

Edangoda and Yattipowa. The initial growth of the young plants is very slow, the sand, which enters largely into the composition of the soil, does not seem to favour vigorous growth.

5. A further area of 75 acres has been cleared this year and will be planted up. They will yield further data as to the suitability of the Pasdun korale forests for rubber.

6. There is little doubt that the rubber plantations now made, will, if successful, pay handsomely. At present from the sale of seed alone R200 per acre could be obtained. I beg therefore for orders as to whether the Forest Department is to satisfy itself for the present with the plantations now existing and being planted up in the Western Province and Sabaragamuwa, or whether we are to make further extensions in Para Rubber plantations.

I am, &c.,

A. F. BROUN,

Conservator of Forests.

REPORT OF THE DIRECTOR, ROYAL BOTANIC GARDENS, ON RUBBER CULTIVATION IN CEYLON.

Royal Botanic Gardens, Peradeniya, July, 28, 1897.

The subject is one of great importance at present owing to the enormous increase of late years in the demand for rubber caused by the growth of the cycling trade and other industries in which rubber is consumed. That the price of raw rubber has not increased very greatly is chiefly due to the discovery in West Africa of a new rubber-yielding trees, *Kickxia Africana.* It seems likely that in a few years' time the reckless destruction of wild trees will cause the price to rise and that rubber-planting will thus become a profitable industry.

2. The trees yielding rubber are many, but most of them being large jungle climbers are unsuited for cultivation. The chief kinds likely to be useful in cultivation are Ceara rubber (*Manihot Glaziovii*), Panama rubber *Castilloa elastica*), Para rubber (*Hevea brasiliensis*), and African or Lagos rubber (*Kickxia Africana*).

3. The cultivation of Ceara rubber was taken up in Ceylon about 12 or 14 years ago with some energy, but the returns were found unsatisfactory, though the plant grew very well indeed, and now there are but few trees remaining. Of Panama rubber there is but little in Ceylon, and seed is only obtainable in extremely small quantities. The new Lagos rubber has only been introduced in the last two years, and the proper mode of cultivation and most suitable soil have yet to be discovered. The only rubber of importance at the moment is the Para kind, and the rest of this report refers only to it.

4. Para rubber was introduced into Ceylon in 1876, when the young plants obtained from Brazil at the expense of the Indian Government were planted in the Heneratgoda Garden. These are now very fine trees with an average height of 60 ft. and average girth (at 6 ft. above ground) of 4 ft., and from their seed other plantations have been made in the Botanic Garden and also by the Forest Department. A large number of seeds have been sold to private planters since 1886. The tree produces only a few seeds, the seed are large and only retain their vitality, for a very short time, and thus it is difficult to obtain seed from or send seed to distant countries. The crop produced by the trees (about 450) in the Botanic Garden is now about 75,000 seeds a year.

5. It is very difficult to obtain exact information, but I estimate the number of trees on private estates in Ceylon to be between 200,000 and 250,000, of various ages from one to ten years. This number represents an area of about 750 acres.

6. The present year has seen a sudden increase in the demand for seed. Hitherto the crop produced in the Botanic Garden has suffered for almost all demands, but the applications for seed in 1897 have been numerous, and I could easily sell 30 or 40 times as much seed as is obtained from the trees in

the gardens. The trees belonging to the Forest Department are only expected to yield 30,000 seeds this year, an insignificant quantity when compared with the demand.

7. The practice of this Department at present is to book seeds for delivery when ripe, in quantities of not more than 3,000 for one person, in the order in which applications are received. The price asked is R5 per 1,000. A much larger price could now be obtained: private planters are obtaining R20 per 1,000 seeds this year.

8. The present system of supplying seed is open to the serious objection that as 3,000 seeds are only enough to plant four or five acres, a planter really wishing to take up the cultivation on a large scale cannot do so within a reasonable number of years. It is desirable that greater encouragement should be given to planters to engage in this cultivation on a considerable scale, and that one man should be able to get as many as 40,000 or more seeds in one year. This would take nearly all the crop and would expose the Government to accusations of favouritism, which might be avoided if the seed were sold in large quantities by auction, or by invitation of competing tenders. This method would also probably increase the revenue derived from the sale of these seeds. An undertaking should be required from purchasers to the effect that the plants shall receive proper attention and cultivation on areas of land devoted to the one crop only.

9. The area of land suitable for this cultivation is not very large. The plant for complete success requires fairly flat land at about sea level, with good soil, not subject to frequent floods and heavy winds, and with a uniform wet climate. Only in parts of the low-lying south-western region of Ceylon are these conditions found. On the other hand, the cultivation of rubber need not interfere with that of coconuts, as it does not do well in sandy soil or near the sea, and it should thus form an additional cultivation in the Colony, rather than replace any of those already existing by using up the land occupied by them.

10. Opinions are at present much divided upon the question whether this cultivation will pay. The wild sources of rubber are at present far from exhausted, but they are becoming every year more and more difficult of access, and the cost of transport increases the price of the rubber.

11. The answer to this question really rests upon the amount of rubber that may be expected to be yielded by the trees when at a suitable age for tapping (say about ten years old). The accounts given by those who have observed the harvesting in Brazil vary greatly: many mention extraordinary amounts, but neglected the fact that such excessive tapping usually cause the death of the trees. Almost the only reliable observations are those made in the Henaratgoda Gardens. The late Dr. Trimen tapped one one of the original (1876) trees every other year from 1888 to 1896. The result showed that from tenth year onwards a yield of about 1½ lb. per tree, per year might be obtained. These trees being planted 30 feet apart the yield per acre would therefore be about 75 lb. of dry rubber a year. This is not sufficient to pay well. It would, however, be absurd to draw definite conclusions from experiments on one tree only. I have therefore commenced an extensive series of experiments in tapping &c., upon a plantation of 11 year-old trees at Henaratgoda. These experiments are now in progress, and their results will be published from time to time. At present I can only mention this one fact, that the average yield so far of an 11 year-old tree is about 6 ounces a year; the trees being 12 feet apart. This represents an annual yield of 112 lb. per acre, which should pay fairly well. It is probable that the trees will be found to yield more than this without injury, but as yet I do not feel justified in making any definite statement upon this point. The price of good Para rubber in London is now from 2s. 6d. to 3s 6d. a pound, so that a yield of 112 lb, represents a value in London of about £15 or £16. Considering the small labour cost of rubber, this should be enough to yield a good return upon the outlay.

My recommendations upon the question of rubber cultivation in Ceylon at the present time are as follows :—

(*a*) There being such a demand for seed by private individuals, I should recommend that the seed produced in the Botanic Gardens be sold, as heretofore, to such individuals, but in larger quantities, either by auction or by competing tenders.

(*b*) That the seed produced in the current year by the trees in the Government plantations under charge of the Forest Department, should be used in planting the land, which I understand to be already available for purposes of extension of those plantations, and that it be subsequently decided whether the seed of 1898 and following years be sold to the public or used in further extension of the Government plantations.

(*c*) That no further public attention be drawn to the question until after the seeding time for this year is past, when a bulletin should be issued from this Department dealing with the whole question of cultivation, yield, cost, &c.

(*d*) That in the course of the next year or two experiments in tapping on a large scale should be made upon the trees in the Government plantations, so as to ascertain, more accurately than can be done with the few trees in the Botanic Gardens, the yield of a plantation, the cost of collection and transport, and the price obtainable for the product.

JOHN C. WILLIS,
Director.

INDIARUBBER CULTIVATION UNDER THE FOREST DEPARTMENT IN CEYLON.

From the Report of the Conservator of Forests, for 1898, we quote the following passages referring to rubber:—

WESTERN PROVINCE.

The rubber plantation in the Pasdum Korale was not extended further as it did not prove to be a success. The plants which had been put in at what was called above flood-level by villagers were covered with water more than once, and those on higher ground are in poor sandy soil not suited to rubber and exposed to wash.

There are only about 86 trees per acre still standing. The expenditure on these plantations amounted to R841·78 or R24·57 per acre.

Samples of soil of plantations in other parts of Ceylon where Para rubber is grown successfully was sent home by the Director of the Royal Botanic Gardens, to be analyzed and this analysis will no doubt be useful as a guide for further selections.

PROVINCE OF SABARAGAMUWA.

The Para rubber plantations at Edangoda and Yattipowa are reported as doing well. Although a large proportion of the seed produced was sterile, these plantations gave a crop of 30,600 sound seed. Of these 11,600 seeds were sold, of which 5,000 went to South India and 600 were purchased by the Governor-General of Goa, while 6,000 were disposed of locally. The balance of 19,000 seeds were sent to our new plantations at Korossa, but they did not all germinate. Mr. J. C. Willis, Director, Royal Botanic Gardens, accompanied by Mr. Parkin paid a visit to the two plantations mentioned above, in March with a view to tapping, but they decided to put this off for another year. Samples of the soils were taken by them and sent home to be analyzed.

A new rubber plantation was started at Korossa, three miles from Rambukkana Railway Station. The land was selected as being flat, rich, and conveniently situated for the disposal of the seed. 27 acres were cleared with great difficulty owing to wet weather, and consequent trouble in burning off the jungle. The seed was germinated in baskets and then planted out basket and all with, so far, satisfactory results.

We now give summaries specially supplied to us of the Cantor Lectures on the Plants yielding Commercial India-Rubber, delivered by Dr. Morris, C.M.G., &c., before the Society of Arts :—

"SOURCES OF COMMERCIAL RUBBER."

CANTOR LECTURES: SOCIETY OF ARTS.

By Dr. Morris, C.M.G. ;

Lecture I.—Delivered April 18th :

(*Summary Specially Contributed by the lecturer*)

Since the days when Le Condamine first described the rubber tree of Brazil and Don José, King of Portugal, in 1755 sent several pairs of his royal boots to Para in order that they might be covered with the water-proof "gum-elastic" the use of India-rubber has enormously increased. Besides the demand in almost every department of arts and manufacture, the rapid development of cycling and of the use of rubber tyres for carriage wheels has added to the increased consumption of this interesting article. The quantity of raw Caoutchouc imported into the United Kingdom in 1830 was only 23 tons. Even in the year of the accession of our Queen it was only about 200 tons. Last year it had increased to 20,000 tons—exactly a hundred fold.

The present value of the imports are about five millions sterling. The total trade is probably not less than ten millions sterling. More than one-third of the imports is now received from British possessions. In 1888 only about one-fifth was so received. It is estimated that the world's consumption of rubber is 60,000 tons, of the value of 14 millions sterling. This stupendous quantity of raw material is laboriously extracted from the milky juice of trees and shrubs belonging to three natural orders, viz, the Spurges (*Euphorbiaceæ*), the Nettles (*Urticaceæ*) and ths Dogbanes (*Apocynaceæ*). These plants are distributed over nearly every part of the tropical zone—none are found in the temperate zones—the most important being found in the vast basin of the Amazon, an area almost as large as that of the Continent of Europe; others are found on the East and West Coasts of Africa, in Assam and the Malay Archipelago.

Hitherto the preparation of India-rubber has depended upon the crude hereditary art of a semi-savage people, the rubber-hunters, who explore the depths of tropical forests and obtain the rubber milk at the sacrifice of millions of trees, which owing to the recklessness with which they have been treated are yearly decreasing.

The result is that many localities where rubber was once abundantly obtained have almost ceased to produce it. New sources or supply have, it is true, been found in West Africa, especially in Lagos, the Congo State and Portuguese South-West Africa. But here also the work of destruction is rapidly going on. The collectors have to go farther and father into the interior and the cost of transit is thereby greatly increased. An account was given by the lecturer of an important discovery whereby the rubber could be extracted from the milk in a perfectly pure state. This is a mechanical contrivance on the principal of a cream separator. This was likely to prove of great value in the preparation of Central American and some West African rubbers where the milk flows in an appreciable quantity and is capable of being brought in by the collectors. It would be indispensable on regular plantations of rubber-trees. By such means the process of preparing the rubber could be kept under scientific control and all injurious substances such as proteids and all dirt and chips excluded. The value of the rubber so prepared has been shown to be increased fully 25 per cent.

The rubber-trees of Brazil were then exhaustively described together with the distribution of the various species yielding the Para rubber of commerce. The exports from Para in 1897 including rubber received from Bolivia, Peru and Venezuela amounted to 22,650 tons. Of this amount 51 per cent was shipped to the United States, and 38 per cent to the United Kingdom, leaving only about 11 per cent or 2,500 tons for all other countries.

The price of Para rubber which regulated the prices of all other sorts has been steadily increasing since 1894, when it was 2s 11d per pound; in 1895 it rose to 3s 2d; in 1896 to 3s 4d; in 1897 to 3s 6½d: while the average price for the first three months of 1898 was 3s 9½d. At the last sales on the 15th inst, it was 3s 11d per pound. It was, however, pointed out that these prices were below what they were in 1882 and 1883, when fine Para fetched 4s 4d per pound.

SECOND AND CONCLUDING LECTURE—DELIVERED APRIL 25TH.

There is a consensus of opinion that in nearly all localities in Central America, the trees of *Castilloa elastica* are being gradually exterminated. Hence the supply of rubber from Mexico, Guatemala, Nicaragua and U.S. of Colombia is steadily diminishing. The interesting tree yielding Ceara rubber (*Manihot Glaziovii*) readily propagates itself and its area has not apparently sensibly diminished of late years. The people, are, however, being more and more attracted into the rubber districts of the Amazon valley and the amount of Ceara rubber exported is comparatively small.

Mangeibeira rubber on the other hand seems to be increasing. The tree (*Hancornia speciosa*) is found in the States of Pernambuco, Bahia, Rio de Janeiro, and extends westward to Matto Grosso. The rubber is cured by means of alum. It is of a pinkish colour and the price is generally only one half of that of fine Para. Passing on to the rubber-producing areas of the Old World it was stated that the rapid development of African rubber was one of the most remarkable incidents of recent years. As regards the world's commerce, Africa now occupies a second place as a source of India-rubber. The value of the imports of African rubber into the United Kingdom during 1896 amounted to over a million sterling. Of this Foreign Possessions supplied rubber to the value of £206,972 and British Possessions £844,840. Up to within a recent period all the rubber produced in Africa was obtained from climbing plants belonging to the genus *Landolphia*, with sweet-scented flowers and edible pulpy fruits. In 1894 a new rubber tree (*Kickxia*) was found at Lagos from which in 1895 rubber to the value of nearly £300,000 was exported.

More recently still another new rubber-plant (*Carpodinus*) has been discovered in Africa. This is of a semi-herbaceous character with under-ground stems which are rasped in water and yield rubber of excellent quality. The rubbers of Assam, Burma, Penang, and Singapore were then dealt with. Borneo rubber although known since 1798 has only come into commerce within the last fifty years. It is yielded by climbing plants, closely related to the Landolphias of Tropical Africa and is generally of excellent quality.

New Guinea rubber is in part yielded by a species of *Ficus*. The natives are said to allow the sap to run over their arms and body, and when hardened they remove it and roll it up into balls, the size of cricket balls. The prospect of obtaining some of the future supplies of rubber from cultivated trees was favourably regarded. In selecting sites, preference should be given to localities in which the trees were already found. Para rubber-trees introduced to the East at the expense of the Government of India had done remarkably well in Ceylon, Tennasserim, and the Straits Settlements. In Ceylon such trees were estimated to yield 100 to 120 lb. of rubber per acre after tenth year. This would give a probable return of 20 per cent. on the capital invested. In the Straits Settlements the trees were apparently found to yield at an earlier age and the estimated returns per acre were placed as high as 30 per cent. It was added that where rubber trees were cultivated under suitable conditions, they would probably yield a larger quantity of milk than wild trees; also that the rubber from the greater care and attention it would receive, would be more uniform in quality and therefore obtain a higher price.

CAOUTCHOUC OR INDIARUBBER.*

ITS ORIGIN, COLLECTION, AND PREPARATION FOR THE MARKET, &C.

(CEYLON ROYAL BOTANIC GARDENS CIRCULAR, JUNE, 1899.)

In two previous Circulars of this Series the cultivation, &c., of Para and Castilloa rubbers have been dealt with, and the rough method of tapping and preparation of Para rubber hitherto employed in Ceylon has been described. In the present paper is contained a report by Mr. J. Parkin, M.A., of Trinity College, Cambridge, who has been engaged since March, 1898, in scientific investigations upon rubber, its origin, flow in different species of tree, composition, coagulation, &c. The complete results of Mr. Parkin's work will be published elsewhere; the present paper is intended to place before those interested in the subject the chief conclusions which have been arrived at, together with such data as will explain them, so that those who work with rubber may at least to some extent understand what they are doing in the various processes, and, having this understanding, be themselves able to suggest improvements, or to surmount difficulties which may and will crop up in the course of work.

Those who read this paper with the intention of employing the methods described should first of all test them in detail themseves on a small scale, till they thoroughly comprehend both of them and the principles upon which they depend.

The measurements of bulk of liquid and of weight of product are given, it will be noticed, in the metric system, which is universally employed by all scientific workers. It is vastly more convenient to use than the cumbrous and antiquated British system, which renders all calculations into which such items as specific gravities, percentages, &c., enter, extremely complex and troublesome. A translation of the metric to British measures is given below. The unit of length in the metric system is the centimetre (cm.); the cube of this (c. c.) is the unit of volume; and the weight of one cubic centimetre of pure water at its temperature of maximum density is the unit of weight, and is termed a gramme (gm.). Thus, to make a 10 per cent. solution of salt, one takes 10 gm. and dissolves it in 100 c. c of water.

One gm. equals 15·43 English grains; 28·35 gm. equal 1 oz. avoirdupois: 1 c. c. equals 0·06 cubic inch; 100 c.c. equal 3·52 fluid oz.; 1 cm. equals 0·39 inch: it is divided into tenths, millimetres (m.m.).

Mr. Parkin's paper follows; it is arranged under the following heads:—

A.—Botanical.
B.—The Extraction of Latex.
  I.—Incision.
    (1) Kind of Incision.
    (2) Instrument to Use.
  II.—Collection of Latex from Incisions.
  III.—Area of Trunk to be Tapped.
  IV.—Effect of Wounding on Flow of Latex.
C.—The Preparation of Commercial Rubber from the Latex.
  (1) Hevea.
  (2) Castilloa.
  (3) Manihot.
D.—Yield.
E.—Notes on other Caoutchouc-yielding Plants.

A.—BOTANICAL.

The milky juice, technically known as *latex*, which exudes from certain plants when wounded, is quite distinct from the so-called "sap" of plants. It is contained in special tubes running for the most part longitudinally in the other tissues of the plant and forming usually a connected and closed system.

This laticiferous system or tissue is an additional development in a comparatively few families of Flowering Plants, and although not altogether absent in the vegetation of temperate regions, it is markedly characteristic of tropical floras. The natural orders Euphorbiaceæ, Moraceæ, Apocynaceæ, and Asclepiadaceæ, chiefly tropical, are specially laticiferous, and it is the first

* See Review of this paper following after it.—J. F.

three that have so far furnished commercial rubber-yielding trees. The small order Sapotaceæ contains the trees which supply guttapercha, indigenous and almost peculiar to the Malay Peninsula and Archipelago.

Since from the latex of certain of these plants the rubber (caoutchouc) and gutta of commerce are prepared, the whole question of the formation, functions, and properties of latex is not merely one of special interest to the botanist, but also of great practical importance, especially now that the demand for these commodities is increasing while the supply is tending to diminish.

Owing to the high price which rubber fetches in the market at the present time, attention is being turned to the production of substitutes, and even to the manufacture of artifical caoutchouc itself. The latter has not as yet got beyond the stage of laboratory experiments, but the possibility of commercial success with it must be kept in view, as of course it is a point of vital interest to those engaged or intending to engage in rubber cultivation.

At the present time, then, rubber of good quality, free of dirt and moisture, can obtain a good price—as much as four shillings per pound. Consequently the planting of rubber trees is a tempting occupation, and one which has in a certain measure the promise of success, provided that the trees where planted will yield latex as freely, or nearly so, as in their natural habitats, and that every care is given to the extraction of the latex and the preparation of the rubber therefrom.

Hitherto the Para rubber collected by the natives in the Amazon valley from the indigenous tree *Hevea brasiliensis*, and prepared in a special manner known as the "smoking" method, has obtained the highest price and controlled the market. The loss of weight it undergoes in manufacture is from 10 to 15 per cent., due to impurity, while other rubbers lose more, even in some cases as much as 40 per cent. Ere long this is likely to be changed. The preparation of commercial rubber has recently received attention from a qualified botanist, Mr. Biffen, of Cambridge University, with signal success. His investigations carried out in Tropical America have resulted in the production of rubber from the milk with loss in manufacture of less than 1 per cent. We shall have occasion further on to discuss his method and its application, but shall merely lay stress here on the valuable aid which scientific investigation can render to the subject. In the light of this work the commercial rubber produced by cultivators will need careful preparation so as to reduce the amount of impurity to a minimum, else its value in the market will be greatly depreciated. Scrap rubber, such as is picked off the bark, will be apt to decrease in value, while the best rubber will, on the other hand, increase. Manufacturers will find the carelessly collected material not worth the trouble and expense of cleaning when a large supply of comparatively pure and dry caoutchouc is obtainable.

It thus behoves us to become acquainted with the important facts known relating to caoutchouc, and to endeavour to increase these by careful and systematic observation and experiment. We want to know the trees which promise best for cultivation, both as regards quality and yield of rubber. We have to consider the best times and means of tapping them, and then of preparing the rubber from the collected milk.

Before proceeding to these practical considerations and to the giving of details and conclusions of work recently carried out in the Island of Ceylon, it will be well perhaps to make a few remarks on the chemical and physical features of latex and on the structure and general arrangement of the tubes that hold it with special reference to the economic laticiferous trees, so as to approach the more strictly practical part in an intelligible manner.

Latex, as its name signifies, bears a strong resemblance physically to animal milk. The white capacity of this latter is, as is well known, due to innumerable globules of butter fat held in suspension in a clear aqueous fluid so as to form an emulsion; that of latex is likewise due to minute globules in suspension, which, however, are not of a fatty nature, but consist often of resinous matter, in which case the latex dries to a brittle solid, and occasionally of caoutchouc, when it dries to the tough elastic substance known commonly as indiarubber. The latex of species of Dichopsis and Payena, genera of the natural order Sapotaceæ, has its globules composed chiefly of guttapercha, a substance identical in its percentage composition with caoutchouc, but different in its properties.

Pure caoutchouc and gutta consist wholly of carbon and hydrogen united in definite proportions. Resins, on the other hand, contain oxygen as well, and often are present along with the above two substances. In the latex of gutta trees resin occurs in considerable amount varying in different plants. The gutta prepared from *Dichopsis gutta* contains about 17 per cent., whereas that from *Payena Leerii* reaches about 38 per cent.* Similarly, but in a less degree, caoutchouc-latices contain resin. Fortunately in such trees as *Hevea brasiliensis* (Para rubber), *Manihot Glaziovii* (Ceara rubber), and *Castilloa elastic* (Central American or Panama rubber) the resinous matter is in mere traces, so that the suspended globules of these latices may be considered as consisting almost wholly of caoutchouc.

Ficus elastica (Assam rubber), on the other hand, contains a larger amount, as much as 1 58 per cent., the caoutchouc being 9.57 per cent, in the pure latex.† Several trees, notably species of Ficus (figs) and Artocarpus (jak, bread-fruit, &c.), possess latex, which moulds between the finger and thumb to a very viscous substance, wholly unlike caoutchouc. This when treated with boiling alcohol yields a certain amount of resin, but it is by no means completely soluble in this medium. "Viscin" is an appropriate name given to a similar substance contained in the young shoots of *Ficus elastica.*

As far as I know such matter has not been submitted to careful chemical analysis to learn whether or not there is a substance present of the nature of a hydrocarbon (*i.e.*, containing only carbon and hydrogen), differing in properties from caoutchouc and gutta. Some latices, such as that of *Alstonia scholaris,* dry to a gutta-like mass and suggest that perhaps a member of the Apocynaceæ or Asclepiadeæ may be found to afford a useful gutta. Chemical analyses of the solid bodies of such latices are much to be desired. This is important to what will be pointed out later, viz., the difference in properties of the caoutchouc prepared from the twigs from that of the trunks of some rubber trees.

Latex, then, consists as a rule of globules or resin, caoutchouc gutta wax, &c., suspended in a watery medium.

The fluid part of the latex is not however plain water, but water containing various substances in solution. Of these perhaps albuminous matter (proteid)‡ is of most frequent occurrence, and of chief importance, as will be shown, from a practical point of view. Salts, usually of organic acids, are often present. The latex of *Manihot Glaziovii* contains phosphates largely. Tannin, too, is characteristic of some latices *e.g.*, Castilloa. Generally small quantities of sugar can be recognized in analysis.

In view of the extraction of latex, a few remarks on the distribution of the laticiferous tissue in the plant seem desirable.

The laticiferous system is usually distributed throughout the organs of a plant, present alike in the stems, leaves, roots, and fruits, and is formed at a very early stage in the developing organs, so that some time ere the part is mature copious milk is seen to exude from a wound. The tubes originate in two distinct ways according to the kind of plant.

In one case exhibited by Hevea and Manihot the laticiferous vessels arise from series of sacs (cells) arranged for the most part longitudinally. The separating walls (septa) between the contiguous cells break down, the original protoplasmic contents transform into or rather secrete the latex, and the result is a number of communicating tubes full of a milky fluid. The more complete the dissolution of the intervening partitions between the original separate elements, the more perfect is this form of laticiferous system, and the better the flow of latex from an incision. This, of course, is an important practical point. In gutta trees the laticiferous sacs, although they lengthen considerably, never communicate one with another; hence the difficulty of extracting the latex in quantity. The whole trunk has to be cut all over, thus sacrificing the tree, in order to obtain the guttapercha.

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* Obach, Cantor Lectures on Guttapercha, 1897, p. 23.

† Seeligmann, Le Caoutchouc et la Guttapercha, 1896. p. 90.

‡ A very complex class af nitrogenous compounds common to all living matter and essential to life.

The other type of laticiferous tissue is that shown by Castilloa, Ficus, Euphorbia, &c.; in fact, it is characteristic of the orders Moraceæ, Apocynaceæ, and part of the Euphorbiaceæ, the other part possessing the articulate system as it is called, which has just been briefly described. Instead of the laticiferous tubes arising *de novo* in the growing organs, the tubes present in the mature parts send branches into them. In fact, it has been established for several of these plants that the laticiferous system is laid down once for all in the seed in the form of a certain number of initial cells. Each of these commences branching in definite directions and keeps pace with the growth of the plant. Consequently this kind of system is throughly intercommunicative from the commencement and remains so. Hence as a connected system this is more perfect than the other, and the latex flows as a rule more freely from such plants. This may partly account for the much better yield of latex from an incision in the bark of Castilloa than in that of Hevea or Manihot.

The laticiferous system in the stem, the part of the plant of importance for rubber production, occupies definite positions.

In the stem bearing leaves the laticiferous ducts are situated as a rule in greatest abundance just without the vascular cylinder, the part between the pith and the external soft portion, the cortex. A lesser development may occur just within the outermost limiting layer of cells, communicating with the former at the nodes—*i.e.*, the points where leaves are attached to the stem. There may also be a third development in the pith very noticeable in such climbers as Landolphia. The first, however, is the important one to consider here.

After the primary growth has ceased, the stem begins to grow in a definite manner in thickness only; this is known as "secondary thickening" and continues during the whole life of a tree. The active part is situated between the bark and the wood and is known as cambium. The cells which compose it give rise on the internal side to new wood and on the external side to new bast, which goes to form a new addition to the bark. The older parts of the bark are continually being shed by means of a special cork layer. In laticiferous trees the laticiferous tubes continue to appear in each fresh addition to the bast by the cambium, Consequently the newest tubes are situated in the innermost part of the bast next the undifferentiated active layer of cells, the cambium. In Hevea and Manihot the tubes arise afresh from certain longitudinal rows of cambial cells, in the same way as they do during primary growth; whereas in Castilloa, *e.g.*, new branches are given off from the old and outer tubes, which penetrate and ramify through the new bast.

The laticiferous ducts as they are pushed outwards by the growth of the stem become crushed and dried up, so that the flow of latex from them is diminished or stopped. It is the last-formed ducts—*i.e.*, the innermost—that flow freest when wounded. An incision must then extend as far as the cambium, in order that the latex may exude plentifully, but it must not extend into the wood, else the wound will be liable not to heal completely. In the Heveas growing in the Peradeniya and Henaratgoda Gardens the bark can be penetrated for about $\frac{1}{8}$ inch (3 mm.) without latex exuding. Taking the thickness of the bark at $\frac{3}{8}$ inch (9·5 mm.),* which is about the average for the Peradeniya trees, the latex flows chiefly from the inner $\frac{1}{16}$ to $\frac{3}{32}$ inch (2 mm.). In Manihot and Castilloa milk exudes when the tissue just within the dead outer bark is penetrated. The difference between these two and Hevea in this respect is rather striking. It thus seems that the outermost laticiferous ducts in Hevea soon become dried up. It would be interesting to know whether the bark shows the same feature in trees growing in their natural habitat, the Amazon Valley, or in other places where they are cultivated.

Having now given a brief account of the chemistry of latex and of the anatomical features of the apparatus holding it in the plant a few words on the very debatable point—its function—may not be out of place here.

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* Mr. Ridley, Director of the Botanic Gardens, Singapore, has kindly informed me that the average thickness of the trunk bark of Heveas there, 11 years old, is $\frac{3}{8}$ inch.

From the comparison of laticiferous plants with their near relations, which do no possess true milk ducts, and from the origin of the system in the plant itself, the laticiferous tubes appear to be near akin to what are known as excretory sacs—special cells set apart to hold tannin, resin, &c., substances considered to be excretory and of no further use to the plant in the way of food. The globules of latex, then, consisting of resin, caoutchouc, &c., represent the excretory part. Accepting excretion as the primary function of the laticiferous tissue, this complex system of communicating tubes must, one would think, have been evolved to perform some additional function or functions. Since latex often contains such valuable food stuffs as proteids and carbohydrates (sugar and starch), the view of the tubes being channels for conducting these materials or for the storage of them is one which has much support at present. Personally I am not inclined to look upon latex as playing an important part in nutrition, and should imagine that if it were possible to extract all the latex from such a tree as *Hevea brasiliensis* without greatly injuring the other tissues, it would not be seriously harmed. I am inclined to regard the laticiferous system more as channels for holding water in reserve to be called upon during times of drought or during the dry season.

B.—THE EXTRACTION OF LATEX.

Having seen that in a rubber tree the laticiferous vessels occur throughout the plant, being present in the root, leaves, and young fruit, as well as in the stem, and appearing also in the new bast which arises through the secondary thickening of stems and roots, it is natural to inquire which is the best part of the plant from which to extract the latex for the preparation of rubber.

In a few laticiferous trees, not however well known caoutchouc-yielding ones, the main trunk and branches exude no latex when wounded. An example of such growing at Peradeniya is *Alstonia macrophylla*; only its leaves and twigs are laticiferous. Another species, *A. scholaris*, a native of Ceylon, on the other hand, possesses copious latex in its trunk. In such an exception as the above it looks as if the laticiferous ducts are only formed in the primary tissues and not in the bast arising from secondary thickening. *Alstonia plumosa* of Fiji is said to produce rubber, but only from the young branches, and so seems to resemble the above mentioned *A. marcrophylla* (*Kew Bull.*, July, 1898). Other examples of plants devoid of latex in the thickened stems are *Codiæum varie gatum*, *Ficus dealbata*, *Croton tiglium*.

The main trunk or branches are the parts which have furnished commercial rubber in the past, and are naturally the most suitable to the native collecting it from already grown forest trees or climbers, but with cultivators the need of waiting several years—at least six in the case of Castilloa and ten in that of Hevea—before the trunks of the trees are fit for tapping, is a serious item, and well may we consider whether any other part of the plant could be made to yield rubber of good quality and in sufficient quantity to pay the cost of extraction.

The root need hardly be considered, as its situation does not lend itself to tapping, although quite recently some new rubber plants have been discovered in Africa, viz., *Carpodinus lanceolatus* and *Clitandra henriquesiana*, belonging to the natural order Apocynaceæ. These are herbacious with thick underground stems, full of latex, from which the natives extract the caoutchouc by rasping them and then boiling. Dr. Morris mentions them in his Cantor Lectures on the commercial sources of Indiarubber, delivered in 1898, and suggests that they might be useful for cultivation, since they would give returns earlier than other rubber plants.

The only other parts of the plant besides the trunk and main branches of such trees as Castilloa or Hevea, which might be used for the extraction of rubber, are the young shoots. If these could be used profitably, then a return on the capital could be obtained in a year, either by growing crops of seedlings or by coppicing permanent plants. Our attention has been applied to this with, however, no encouraging results.

Hevea brasiliensis will not answer at all, as far as our experience goes, for three chief reasons :—

(1) The exudation of latex is small.

(2) When the shoots are crushed the latex does not freely ooze out and mix with water, but clots where it exudes in little lumps, which cling to the broken pieces of stem, &c. ; consequently the latex cannot be collected in any quantity for the preparation of rubber from it. This clotting as it exudes in young stems is perhaps due to the presence of organic acid occurring in the surrounding tissue and freed in the crushing, so as to mingle with the latex. A trace of acid readily coagulates the latex of Hevea.

(3) The rubber collected from the young stems and leaves has not the same quality as that procured from the trunk. It is somewhat adhesive with less elasticity and strength. In fact, the essential properties of caoutchouc are not well exhibited by this rubber obtained from the younger parts of the plant. The same is true for the rubber obtained from the unripe capsules, the outer part of these being especially rich in latex. Whether the defect is in the caoutchouc itself or due to some other matter present, has not been definitely ascertained. Most likely it is due to a difference in the chemical nature of the globules of latex themselves. When some of this latex is boiled well with alcohol and then filtered, and the clear filtrate mixed with water, only a slight milkiness is observed, pointing to a trace of resin , the latex of the trunk behaves similarly, just containing a trace of resin. Hence the poor quality of this rubber from the young parts does not seem to be brought about by the presence of a larger amount of resin or other matter soluble in alcohol. Accepting the view of the globules being not true caoutchouc, the extraction by chemical means would not result in a substance of better quality. Consequently, in our opinion the extraction of rubber from the shoots of Hevea is not feasible.

In Castilloa the latex from the stems bearing leaves as well as from the leaves themselves moulds between the finger and thumb into a very sticky substance, wholly unlike the caoutchouc-containing latex of the trunk. Some of it was collected in tubes and mixed with water, whereby the solid particles sank to the bottom in small clots instead of floating to the top ; these were removed and dried on a porous surface, and formed a brittle substance without any elasticity or extensibility, and which becomes viscous when slightly heated, as when pressed between the fingers. Its solubility in boiling alcohol was tested and compared with that from the trunk ; more resin of the kind soluble only in hot alcohol was indicated in the sample from the young stems. In the shoots, then, the caoutchouc appears to be replaced by the substance, which we have called "viscin," so common in other laticiferous plants, and to a certain extent by resin also.

The quality of the rubber from stems of about 5 to 10 inches (12·5 to 25 cm.) in circumference has also been roughly tested. The collected latex was mixed with water, when the solid particles floated up to the top in the form of a cream. This was removed, mixed up again with water and re-creamed, and then dried on a porous surface. The sheet of rubber obtained was slightly sticky and deficient in elasticity and strength. When pulled it extends fairly readily, but when let loose does not spring back smartly like ordinary rubber, but contracts gradually. It resembles the rubber of Hevea shoots and is intermediate between the true caoutchouc of the Castilloa trunk and main branches, and that of the shoots. This is an important point practically, for at any rate as far as the Castilloas are concerned, no rubber of good quality can be extracted from the plant till the trunk has attained a considerable thickness ; rubber is not procurable from the shoots, its place is taken by a viscous body, wholly lacking in the essential properties of caoutchouc. This only applies to the Castilloas of Ceylon. We have not had an opportunity of examining them in other countries, although one would expect similar differences to occur elsewhere. Our Castilloa seems not to be the species *elastica*, but a very closely allied one, *Markhamiana ;* the true *C. elastica* may not show this marked difference between the latex of the shoot and trunk. From an article in the *India-rubber World* reproduced in the *Tropical Agriculturist* for December, 1898,

p. 381, on some recent developments in rubber cultivation, one would conclude that the Castilloas growing in Trinidad possessed proper caoutchouc in their young stems. The second paragraph is here quoted in full :—

The most interesting point under discussion in relation to rubber-planting in the British West Indies is a series of experiments now being carried on in London and Trinidad, by which it is proposed to secure rubber from year-old trees of *Castilloa elastica*. It has been found that seeds sown broadcast over a prepared field will yield an abundant crop of young trees, which at about a year old can be cut and sent to a factory, where, with ordinary machinery operating a simple process, 8 per cent of fine rubber can be extracted from the young shoots. This can be done in the laboratory. It is claimed that the process is a simple one, that but little machinery is necessary, and that in future the world's rubber supply will be secured from an annual crop of young trees sown on cultivated estates and not from remote forests as at present. A series of experiments has shown that the young tree contains about 8 per cent. of rubber, which would, at present prices, return an estimated profit of $200 to $400 per acre. The extraction of rubber from young shoots has been accomplished chemically in the laboratory, but whether it can be applied to the economic production of rubber on a large scale remains to be seen.

In *Manihot Glaziovii* (Ceara rubber) the latex of the shoots appears to form as good a rubber as that from the trunk of the tree, so the objection to the extraction of rubber from the young parts, owing to its inferior quality, does not apply here. However, we hardly consider that it would be profitable to extract the rubber from the young stems and leaves either by mechanical or chemical means.

Even if the caoutchouc could be procured from the twigs by a chemical process in paying quantities, it might possess the same defect as gutta-percha obtained in this way, viz., lack of durability. The late Dr. Obach lays stress on this in his Cantor Lectures on Guttapercha delivered in December, 1897, (p. 49). The gutta is dissolved out of the pounded leaves by such solvents as carbon bisulphide and petroleum spirit, and then recovered by precipitation or evaporation from its solutions. Commenting on these processes he says :—" Hitherto no satisfactory mechanical process has been proposed for that purpose ; chemical methods have to be resorted to, as we have seen. This I consider to be a disadvantage, inasmuch as the durability of the guttapercha, particularly on exposure to air and light, is thereby imperilled."

In the case of gutta, there is good reason for attempting its extraction from the young parts, because the trees, owing to the laticiferous elements being closed sacs and not communicating tubes, have to be cut all over—in fact killed—to obtain a sufficiency of gutta ; they cannot be tapped in the same way as rubber trees ; they are of slow growth, and consequently are rapidly diminishing in numbers ; in fact, the best tree, *Dichopsis gutta*, is practically extinct now, except in botanical gardens and such places. On the other hand, with respect to rubber trees, there are not these drawbacks : some are of quick growth, yield copious latex when tapped, and such as Hevea exist in great numbers in their natural habitats.

In our opinion it seems hardly likely, at any rate as far as Ceylon is concerned, that rubber can be extracted profitably from the leaves, twigs, &c., so we must return to the consideration of the main stem and consider the best means of extracting the latex from this.

I.—INCISION.

Two chief points come up for consideration here, viz., the kind of incision, and the instrument with which to make it.

(2) Kind of Incision.—In order to obtain the latex from the trunk of a rubber tree the laticiferous ducts have to be cut in some way or other. The question naturally arises as to what is the best kind of wound to make in ordered to extract the maximum amount of latex with the minimum of injury to the tree. Since the milk tubes situated in the inner bark (bast) run for the most part longitudinally, it stands to reason that an incision made horizontally will yield more latex than a similar one made vertically, because a greater number of tubes will be severed in the first case than in the second. An

oblique incision is, however, on the whole preferable to a truly horizontal one, for the milk stream is directed to one point, the lower end of the incision, whereas in the transverse cut the milk is apt to trickle from more than one point, usually from the two ends. Whether the latex be collected from each incision separately—the best plan if it flows at all freely—or whether it be collected at the base of the tree from the streams coming from a number of vertical rows of incisions, the inclined incisions leave less latex to dry on the tree than the horizontal ones, for, as a rule, in the one case the latex oozes out in a single stream, whereas in the second case it makes two streams —that is, on the assumption that the amount of latex flowing out of each kind of incision is the same.

The two following experiments on *Hevea brasiliensis* illustrate the differences between the amount of latex collected from vertical, horizontal, and oblique (| – , \ ) incisions :—

(1)	Twenty-one vertical incisions gave	8·5 c. c. latex	
	Twenty-one oblique	,,	16.5 c. c. ,,
(2)	Fourteen horizontal	,,	6 0 c. c. ,,
	Fourteen oblique	,,	12·0 c. c. ,,

A very noticeable point in these figures is the very small yield of latex per incision. These experiments were performed perhaps at a time (March 6, 1899) when the latex was runing less freely than at other times, but the average amount is not greatly above this at any period of the year, as far as our observations go at Peradeniya and Henaratgoda. Further remarks on yield of latex in *Hevea brasiliensis* are reserved for another section of this paper; its scantiness make experiments much more difficult to carry out. In the above experiments as in subquent ones to be mentioned, the latex was collected separately from each incision into a known volume of water contained in a suitable vessel. After the flow had ceased the contents of the vessels receiving the latex from one kind of incision were poured into a measuring cylinder and the volume read off; the amount of latex is then arrived at by subtracting the quantity of water previously added from the total fluid.

Care was taken to have corresponding incisions of the different types at the same level of the stem on the same trees.

In both cases the oblique incision yields about double that of the other. There seems little difference between the amount collectable from a vertical and horizontal incision. Although there is a greater output of latex from the horizontal cut, yet much more dries on the wound than in the case of the vertical, consequently the amount which drops into the receiver comes to about the same in the two cases.

Having assumed, then, that the oblique incision is the best, the next point to be considered is whether or not it should be single or double. A double incision made in the form of an upright V has been largely employed, and is the one which has hitherto been used for tapping Heveas in the Botanical Gardens of Ceylon. Experiments on the relative quantity of latex collectable from single oblique incisions and from double ones in the form of a V have shown that for Heveas growing at Peradeniya and Henaratgoda the latter yield usually about double the amount that the former do, *but not always.*

Experiment at Henaratgoda, February 3, 1899.

Twenty-one single oblique incisions (/) gave 15·5 c.c. latex
Twenty-one double ,, ,, (V) ,, 32 c.c. ,,
The latter just about double the former.

Two Experiments at Peradeniya.

On October 18, 1898, six trees used :—
Twelve Vs gave 60·9 c.c. latex
Twelve /s gave 58·5 c.c. ,,
On October 20, 1898, seven trees used :—
Fourteen Vs gave 51·8 c.c. latex
Fourteen /s gave 32·3 c.c. ,,

The latex in these last two experiments was collected separately from each incision in test tubes fixed below. By measuring the height of the latex in each tube and then estimating afterwards the volume of water required to reach up to this height in the tube, the quantity of latex was ascertained, a method more accurate than the other one previously described; but since test tubes can hardly be used for collecting latex on a large scale the special tins employed for this are perhaps better used for experimental purposes. Besides, we have not always had a supply of test tubes at our command.

The trees in these two last experiments, as the numbers show, were flowing much better than those at Henaratgoda, and the difference between single and double cuts is much less marked. In the first case it is very slight; in the second case the Vs gave about half as much again as the single cuts; and it is to be noticed that the total amount of latex is considerably greater for the former than the latter.

This suggests that if the trees run well, say 5 c. c. per oblique incision, then very little more latex is obtained by doubling the incision in the form of a V; whereas if the flow is poor, then a V gives about double that of a single oblique cut. It looks as if in the one case a single incision drains about the same area as a V, while in the other case it drains about half only. If, then, the trees flow pretty freely, single oblique incisions are sufficient; the extra injury done, which is considerable, and the time taken in making the second half of the V, is not compensated for by the small additional amount of latex obtained. If, on the other hand, the flow is small, as in the experiment at Henaratgoda, then Vs should be employed in preference to single cuts.

The above remarks refer only to Hevea. Manihot has not been tested in this way, but, judging from their yield of milk per incision, we should imagine that Vs had better be employed than single oblique cuts. Castilloa, on the other hand, flows as a rule so much more freely from an incision than Hevea, that a V cut is wholly unnecessary.

One objection to the V shaped incision is the liability of loosening the piece of bark it encloses when the second half is made; this loosening is apt to retard the healing of the wound, or even to prevent in some cases a complete cicatrization. To obviate this, an X incision has been suggested. We have tried this, comparing the amount of collectable latex it gives with that of a V.

Experiment at Henaratgoda, March 4, 1899.

Twenty-four V-shaped incisions yielded 42 c. c. latex
Twenty four X-shaped ,, 23 c. c. latex

The Vs give nearly double that of the Xs. An X incision naturally flows from the two lower ends in two streams, thus more latex dries on the tree than in the case of the V; also the upper half of the X would seem to drain pretty nearly the same area of bark as the lower half. Thus these two points may explain why the V cut should give so much more latex than the X. There seems little doubt, then, that if a double cut is to be made, the V form is the best.

(2) INSTRUMENT WITH WHICH TO MAKE THE INCISION.—For most of our experiments we have used an ordinary carpenter's chisel and a mallet. The natives employ for tapping the Para rubber trees in the Amazon Valley a sort of hatchet with a blade not more than 1½ inch (3 cm.) in width, which rapidly thickens from the cutting edge so as to form a kind of wedge. The incisions are made in the bark by striking in an obliquely upward direction with this tool. After each blow a small vessel is quickly fixed by means of clay below the cut to collect the milk. The wedge-like shape of this small axe is a check against making the incision too deep, so as to penetrate the wood,—a point always to be guarded against.

Considering the smallness of yield of Hevea trees in Ceylon as compared with the ones in their native country, such a hatchet seems rather too rough a tool to use, as, without much practice, the blows could not be so regulated as to ensure the latex always flowing straight into the vessels fixed beforehand, and the impacts would be apt to loosen these. To fix the collecting cups after making the incisions requires some dexterity, in order not to lose any of the latex. It is an advantage to have these attached to the bark beforehand, and then to make the incisions just above them; to effect this a chisel and mallet have been found very suitable.

had twelve tins placed on its trunk in three vertical rows up to a height of 12 ft. The tins were about a yard apart in the vertical direction, and $1\frac{1}{2}$ to 2 ft. in the horizontal and oblique directions. The uppermost tins were filled, the rest about $\frac{1}{2}$ to $\frac{3}{4}$. Total latex equalled 900 c.c.

These experiments might have been arranged much better, in order to compare the distance apart of the incisions as to yield on the same tree, but lack of more trees prevented the continuation of them.

Assuming that the flow of latex per single incision from each tree was somewhat similar, these experiments show the advisability of having the incisions at a good distance apart. One incision draws latex from a large area of bark, although it does not completely drain it. The extra amount of labour and injury to the tree entailed by placing tins and making incisions closely together on the trunk of a Castilloa is not repaid by the small amount of additional latex obtained. Since the tins may be put on very sparsely, it is little trouble tapping the main trunk throughout its total length and even some of the main branches.

IV.—The Effect of Wounding on the Flow of Latex.

In Circular No. 4 of this Series, January, 1898, on Rubber Cultivation, it is shown in a series of experiments made by the Director on a number of Hevea trees that the second tapping gives a much larger yield of rubber than the first—the numbers indicate just about double the quantity.

This is a very remarkable and important fact and one which hitherto has not been scientifically observed. The natives of the Amazon Valley seem, however, to be aware of it, although no reference is made to it in such a comprehensive work as Seeligmann's "Le Caoutchouc et la Gutta-percha." The Director in conversation with Mr. Gwynne-Vaughan, a botanist who has visited the Amazon Valley, was told that the rubber tappers, when a freshly-tapped tree does not yield a large quantity of latex, say that it has not got used to milking yet.

The Director's experiments were conducted as described in the Circular. At the first tapping vertical rows of V-shaped incisions were made down the trunk of the tree, the rows being a foot apart and the V's a foot apart in the rows. At the second tapping new vertical rows of V's were made midway between the old ones: hence a new incision would be from six to nine inches off an old one. At the third tapping the incisions were made in between again, and would then be about three or four inches off the old ones; in this case the yield was much less than at the second tapping, but greater than at the first tapping. The fourth tapping was made wherever spaces occurred on the bark, and the yield was very little more than at the first tapping. The fifth and sixth tappings showed a decided falling off in yield of rubber compared with the first tapping. The tapping followed one another at weekly intervals.

An experiment was conducted in this wise at Henaratgoda, September 16, 1898. A number of trees were tapped only at the base by a circle of 8 V's around each and the latex from each cut collected separately and diluted with water. The rubber was extracted from the dilute latex by a method to be described later, and when perfectly dry it weighed $2\frac{3}{8}$ oz. After $2\frac{1}{2}$ days, new incisions were made a couple of inches or so above the old ones, and the rubber similarly extracted from the collected latex; it weighed when dry $3\frac{3}{8}$ oz. Thus nearly half as much again of rubber was obtained from the second tapping.

Such are the results by weight. There is little doubt that the volume of latex is proportionately increased. To prove this, experiments on a small scale were conducted at Peradeniya.

To make the wounds conspicuous, a piece of bark an inch square was removed from certain tree trunks. After the lapse of two days test tubes were placed around this wound about two or three inches off, and also on parts of the trunk away from the wound at the same level. Similar incisions were made and the quantity of latex carefully measured. The flow from the cuts by the wound was much greater and lasted longer than from those away from them.

The average amount of latex per wound tube	...	2·05 c. c.
Do. per other tube	...	0·90 c. c.

Hence the effect of the wound has been to rather more than double the output of latex from the area around it.

At what interval after the wounding is the response recognizable? The above experiment show that it occurred after the lapse of two days. Another experiment revealed it after the interval of a single day, but not in every case. After half a day no difference was observed between the wound incisions and the others. Trees growing in dry situations do not respond too quickly to the wounding. The state of the weather has no doubt something to do with it.

Seeing that the phenomenon is observable sometimes after the lapse of twenty-four hours, the increase in exudation of latex from an incision can hardly be due to the formation of new milk tubes, the time being too short for this.

To those that hold the view of the laticiferous tubes conveying food materials, it might be suggested that there is an increased flow of latex towards the injured part for purposes of reparation. I am inclined to consider that the wounding, in stimulating the flow of nutritive materials towards this area, causes a filtration of water into the laticiferous vessels which makes them more turgid, and when cut admits of the greater exudation of latex. In view of the theory of the water-holding function of laticiferous tissue, this may mean an extra supply of liquid to be called upon for healing the wound. Consequently the latex ought to be thinner, *i.e* , containing a less percentage of caoutchouc. This, from mere observation only, appears to be the case. The slight dilution of the latex, however, is much more than compensated for by the much greater flow also. When the latex is thick it oozes out with difficulty, and a great quantity of it dries on the incision and never reaches the collecting vessel. When the latex is thin it flows down from the wound freely, and very little dries on the wound.

This response to wounding seems a very important point with regard to the function of latex, and a very practical point with regard to the tapping o Para rubber trees, and needs much further investigation.

Further Experiments.

Experiment at Henaratgoda, March 2, 1899 :—

Seven Hevea trees were tapped at 6 ft., 3 ft., and base, two single oblique opposite incisions being made at each elevation.

The 42 incisions yielded 40 c.c. latex.

Two days afterwards similar incisions were made about two to three inches above the old ones.

The total quantity of latex from these 42 fresh incisions was 59·5 c.c.

There seems to have been a slight response to the wounding after two days. The weather was extremely dry at this period and the soil parched. After the lapse of six days since the first tapping a fresh series of incisions was made about two inches below the first made ones. The total quantity of latex yielded came to 113 c.c., a great increase, nearly three times that given at the first tapping. A week seems, then, a suitable interval between successive tappings.

Additional Experiment in course of performance at Peradeniya.

Four Hevea trees have been tapped in the following fashion and with the following results :—

First tapping, A.M. March 25, 1899. On each tree a horizontal row of 5 V-shaped incisions was made at the very base of the tree around half the circumference of the trunk, and a second row of 5 similar incisions at a height of six feet round the opposite half of the trunk, the V's in each case being about six inches apart.

The 20 incisions	6 feet up yielded	24·5 c.c	latex
The 20	,, at the base ,,	36·5 c.c.	,,
Total	...	61·0 c.c.	,,

Second Tapping, A.M. March 30, 1899, five day's interval. A similar number of V-shaped incisions was made. The ones at the base were put four to six inches *above* the old ones in such a fashion as to alternate with them, and the upper ones four to six inches *below* the old ones in a similar manner.

The 20 upper	incisions yielded	51·0 c.c.	latex
The 20 lower	,, ,,	54·5 c.c.	,,
Total	...	105·5 c.c.	,,

—a considerable increase, approaching double that of the first tapping.

Third tapping, A.M. April 6, 1899, an interval of a week. Incisions continued in the same way, the upper V's four to six inches below and the lower ones four to six inches above the ones at the second tapping.

The 20 upper incisions yielded	103 c. c.	latex
The 20 lower ,, ,,	117 c. c.	,,
Total	220 c. c.	

—a great increase, more than double that of the second tapping and nearly four times that of the first tapping.

Fourth tapping, A.M. April 12, 1899. Six days' interval, conducted similarly to third tapping, except that single oblique incisions were made instead of Vs.

The 20 upper incisions yielded	90·5 c. c,	latex
The 20 lower ,, ,,	118·0 c. c.	,,
Total	208·5 c. c.	,,

—almost equal to the quantity of latex obtained at the third tapping; thus it looks as if single oblique incisions would give about as much as V-incisions, at any rate when the milk runs freely and in fair quantity.

Fifth tapping, A.M. April 15, 1899. Three days' interval single oblique incisions.

20 upper incisions yielded	125·5 c. c.	latex
20 lower ,, ,,	130 0 c. c.	,,
Total	255·5 c, c.	,,

Sixth tapping, A.M. April 20, 1899. Five days, single incisions.

20 upper incisions yielded	137·5 c. c.
20 lower ,, ,,	152·5 c. c.
Total	290·0

Seventh tapping, A.M. April 25, 1899. Five days, single incisions.

20 upper incisions yielded	152·0 c. c.
20 lower ,, ,,	124·0 c. c.
Total	276·0 c. c.

Eighth tapping, A.M. May 1, 1899. Six days, single incisions.

20 upper incisions yielded	142·0 c. c.
20 lower ,, ,,	111·0 c. c.
Total	253·0 c. c.

The tappings started at the base crossed those stated from above this day, but are still termed "lower."

Ninth tapping, A.M. May 6, 1899. Five days, single incisions.

20 upper incisions yielded	130·5 c. c.
20 lower ,, ,,	134·0 c. c.
Total	264·5 c. c.

Tenth tapping, A.M. May 13, 1899. Seven days, single incisions.

20 upper incisions yielded	133·0 c. c.
20 lower ,, ,,	142·0 c. c.
Total	275·0 c. c.

Eleventh tapping. A.M. May 20, 1899. Seven days, single incisions.

20 upper incisions yielded	149·0 c. c.
20 lower ,, ,,	106·0 c. c.
Total	255·0 c. c.

Twelfth tapping, A.M. May 26, 1899. Six days, single incisions.

20 upper incisions yielded	153·0 c. c.
20 lower ,, ,,	109·9 c. c.
Total ...	262·0

Thirteenth tapping, A.M. June 1st, 1899. Six days, single incisions.

20 upper incisions yielded	222·0 c. c.
20 lower ,, ,,	106·0 c. c.
Total ...	328·0 c. c.

Fourteenth tapping, A.M. June 6th, 1899. Five days, single incisions.

20 upper incisions yielded	342·0 c. c.
20 lower ,, ,,	107·0 c. c.
Total ...	449·0 c. c.

Thus 280 incisions altogether were made, working from above downwards (uppers), and the same from below upwards (lowers); the respective total yields were:—

Uppers	1,955·5 c. c.
Lowers	1,547·5 c. c.
Total ...	3,503·0 c. c.

This experiment shows very clearly the effect of wounding on the flow of latex: the total rose from 61 c. c. at the first tapping to a maximum of 290 c. c. at the sixth, and then slowly fell off until the two series of wounds met and crossed at the eighth tapping; after this the yield slowly increased again to a second and higher maximum of 449 c. c., perhaps from the effect of the old wounds upon the new tappings made on the opposite side of the tree.

The amount obtained by tapping from the base upwards was altogether 1,547·5 c. c.; that obtained by tapping from the top downwards was altogether 1,955·5 c. c. Thus there seems little to choose between the two methods as the excess of the latter is mainly due to the wound effect, showing more largely at the extreme base; when tapping upwards the base was left before the full wound effect was produced. The great thing is to use the "wound effect" making new wounds near the old after an interval of say six or seven days. The old wound may be "renewed" with a knife several times, and a good yield is obtained thus, but the final result is liable to be a very ugly wound in the tree, which may lead to decay or other injury.

We do not yet know the conditions under which this "wound reaction" works, and it is probable that much will yet be found out about it: probably it will be found that under some conditions it is best to tap daily, while under others it is best to tap at intervals of two, three, four, seven, or even ten or twelve days.

A large number of experiments on different methods of tapping have been made and are still being made in the Botanic Gardens, and their results will be published later. Those planters who are beginning to tap their trees might well repeat some of the experiments described above on a larger scale. The success or failure of the cultivation depends chiefly on the yield of milk, and it has been clearly shown that this is extraordinarily different in different trees of the same size and age, and that it may be enormously affected by different methods of treatment. Each man must find out for himself the method absolutely best suited to his trees, in the light of the above observations and of his own and those of other workers.

C.—THE PREPARATION OF COMMERCIAL RUBBER FROM THE EXTRACTED LATEX.

Hevea Brasiliensis.—In experiments previously performed at the Gardens the latex was merely allowed to dry to form rubber. That which dried on the trunk was pulled off in strings and wound into balls; it naturally contained much impurity in the shape of particles of bark, and would probably not fetch in the market more than half the price of the best Para rubber. The part of the latex which collected in the coconut shells at the base of the tree was allowed to dry in these to small cakes of rubber of an almost black colour on the outside. Previous to drying the latex putrefied giving off a most offensive smell, and when solid became covered with mould. Even when the exterior of the cake appears to be dry, plenty of evil-smelling liquid occurs in the interior. In fact, a long time is necessary before these cakes become thoroughly dry. Putrefaction, mould, and moisture, are what manufacturers greatly object to in rubber, and consequently they lessen the value of the commercial article, and must, if possible, be avoided.

The putrefaction and moulding of Para latex is due to the presence of a considerable quantity of proteid in solution in the liquid part, which affords a suitable medium for the growth of bacteria and moulds. Moreover, the dark colour of the rubber prepared in this way is brought about by these growths. If the latex be allowed to dry quickly and be kept dry, it remains indefinitely of a pale yellowish colour. If allowed to get damp so as to encourage mould, then it becomes blackened in patches and eventually all over. As far as our observation go, it is mould rather than bacteria which produces the dark colour of Para rubber prepared as stated above. Some latex kept in a bottle for several weeks became very putrid, but did not mould, neither did it darken in colour. On the other hand, when moulds show their presence then the darkening commences; it is probably due to the penetration of dark-coloured fungous threads into the damp rubber. Para rubber then need not be of the usual dark colour; this is a defect and should be prevented.

The fine Para rubber prepared by the natives in the Amazon Valley owes its dark colour no doubt to the smoking process it goes through.

The two chief points with respect to the preparation of commercial rubber are to have it free from moisture and putrefaction. The first can be effected by drying the rubber particles in thin sheets; the second, by either removing the proteid matter or by the addition of some antiseptic substance which prevents the growth of bacteria and mould.

Para rubber when dry should be quite translucent and show no white opaque patches; these latter mean that some moisture is still included. For the rubber to dry quickly it should not be in pieces more than ⅛ inch (3 mm.) thick

Centrifugalization of Latex.—Considering that the caoutchouc in latex exists in the form of minute globules suspended in a fluid, and that they are lighter than water, it is rather urprising that no one till now has thought of the idea of separating the caoutchouc and so preparing rubber by centrifugal force, such as is used for separating the butter fat of milk. The credit of applying the idea is due to Mr. Biffen of Cambridge University, who, in connection with Mr. Esmé Howard, recently undertook an expedition through the rubber-producing districts of America. With a modified centrifugal milk-tester they tested the possibility of extracting caoutchouc from several latices with great success. Some of their results are given in a paper by Mr. Biffen on "Coagulation of latex" in the *Annals of Botany* for June, 1898, as well as in the *Journal of the Society of Arts*, Vol. XLVII., December 23, 1898, p. iii.

The latex of *Castilloa elastica* is the one which yields most readily to centrifugalization. The machine used is described by Mr. Biffen as "a modified form of the ordinary centrifugal milk-tester ...... capable of being rotated some 6,000 times per minute." Three or four minutes completes the separation in the case of *Castilloa*.

Regarding *Hevea brasiliensis* he says:—"On treating the latex in the same way for a slightly longer time a similar separation occurred." The latex of *Manihot Glaziovii* is also said to separate readily.

The advantages of this new process are obvious. The rubber can be obtained practically pure from the latex, without the admixture of proteid, &c., hence no liability to decay. Since the caoutchouc particles are obtained as a thick cream, which can be spread out on a porous surface, it allows of the rubber being prepared quite dry in a short space of time.

Through the kindness of Mr. Drieberg of the Agricultural School in Colombo we have submitted the latices of *Castilloa Markhamiana?* and *Hevea brasiliensis* to his cream separator. The caoutchouc of the diluted Castilloa latex was readily separated, but not so that of Hevea. In correspondence with Mr. Biffen, he says that the machine must revolve 7,000 times per minute to separate the caoutchouc from the latex of Hevea. Mr. Drieberg considered the cream-separator at the school to be going 6,000 times per minute, and it was unable to go faster; hence this must account for the want of success with the Para latex.

We have not been able to experiment before on the centrifugalization of latices. From our experience it is no doubt very practical and expedient for Castilloa latex. This is what might be expected, for, as we shall see later, it readily creams when diluted with water *i.e.*, the caoutchouc particles float to the top as a thick layer on standing.

In connection with Mr. Biffen's discovery a company has been formed and a large tract of land laid down in Mexico in Castilloa, with the purpose of producing commercial rubber by centrifugalization. A patent has been taken out on the machine, and consequently it remains to be seen at what price it will be put on the market. It may be somewhat prohibitive. In the meantime, let us consider what other means there are for preparing good rubber from the latex of Hevea and Castilloa.

COAGULATION BY ACETIC ACID.—The Para rubber of the Amazon Valley has always obtained the best price in the market, and this no doubt is largely due to the way it is manufactured. Descriptions of this are to be found in Seeligmann's "Le Caoutchouc et la Gutta-percha," p. 53, and in the "Cantor Lectures" for 1898 by Dr. Morris, p. 15, and need not be repeated here. However, the theory of it has been investigated by Mr. Biffen (*Annals of Botany*, June, 1898, p. 116), and the method shown to be an empirical one, based on sound principles. The smoke given off from the burning palm nuts contains acetic acid and creosote. The former coagulates the latex and the latter acts as a preservative, preventing the growth of moulds, &c. A practical method based on the above has been elaborated at Peradeniya, giving good results.

The latex of *Hevea brasiliensis* is usually of a white colour; sometimes it is cream-coloured, when it dries to a light amber-tinted rubber. The yellowish latex is constant for certain trees. Of the 32 trees at Peradeniya, 9 have a decidedly cream-coloured latex.

The latex has no very pronounced odour or taste. Sometimes it may be slightly sweet.

It is said to be slightly alkaline, although as far as my experience goes its alkalinity is not recognizable by ordinary red litmus paper.

It mixes in all proportions with water and shows no tendency to cream. This is in opposition to what Seeligmann asserts in his work before mentioned, p. 102. In order to prepare commercially pure caoutchouc of Hevea he says that the latex should be diluted four times with water and left for 24 hours in a very cold place, when the caoutchouc floats to the top in the form of a cream. I have never seen the least tendency of the Hevea latex to cream. Some latex diluted four times was kept in an ice chamber for six days without showing any signs of separation; in this case a little ammonia was added to prevent coagulation by putrefaction. In a previous experiment the diluted latex without any ammonia showed no change after 24 hours; after 48 hours coagulation had taken place to a considerable extent, but no creaming. This coagulation was without doubt due to the growth of bacteria, because a slight putrid smell was observable.

The effect of freezing the latex was tried to see whether in thawing the caoutchouc particles would segregate and form a cream or clot. The diluted latex was frozen solid by means of a mixture of ice and common salt. It melted to practically the same condition as it was in before and showed no signs of separation.

Now, Castilloa latex creams readily; its rubber globules are comparatively large, whereas those of Hevea are almost immeasurable. Seeligmann (*loc cit*, p. 91) puts the globules of caoutchouc of Hevea of a mean diameter of 3·51 u*; this is about that of Castilloa; possibly he has confused the two, and his remarks on creaming, although stated for Hevea, really refer to Castilloa.

Since the latex of Castilloa contains much larger globules than that of Hevea, it is not surprising that it readily creams, while the other does not.

Further, the diluted latex of Hevea is unaffected by boiling. In experiments with the latex it is nearly always necessary to dilute it, as it is so thick when pure; thus, if the pure latex be heated, water is driven off to some extent and it is liable to thicken so as to be charred. Hence the effect of boiling can hardly be determined without previously diluting the latex with water. The latex of *Manihot Glazovii* differs from Hevea in being coagulated by boiling, so that the rubber can be removed by this means.

The phenomena of the coagulation of latices by boiling or by the addition of chemical re-agents &c., are due to the presence of albuminous (proteid) matter. Biffen has investigated this, and produces several interesting facts, connected with it in his paper in the *Annals of Botany* referred to previously.

Coagulation is distinct from the mere separation of the caoutchouc particles in the form of a cream. In the former case a mass of rubber is obtained, which cannot be again mixed up with water; in the latter case the particles have not been fused together, but still preserve their individuality, and the cream they form can be again mixed up with water to produce as it were latex again.

Coagulation is brought about by the separating out of the proteid matter from solution, which entangles in its meshes the rubber particles so as to form a clot. Proteids differ from one another as regards their solubility in water, saline solutions, acids, alkalies, and may or may not be coagulated by boiling their solutions.

In the latex of the Ceara rubber tree the proteid is of such a kind as to be coagulated when heated; hence the rubber particles are brought together in the form of a clot.

With the latex of Hevea this is not the case; when heated no change takes place, hence the proteid is not coagulable by boiling.

The following analysis of the latex *Hevea brasiliensis* is given by Seeligmann (*loc. cit.* p. 94):—

Caoutchouc	32 per cent.	in solution.
Nitrogenous matter (proteid) ...	2.3 ,,	
Salts	9 7 ,,	
Resinous matter ...	traces	
Water, slightly alkaline ...	55 to 56 per cent.	

The following estimations were made on a sample of latex collected from one Hevea tree at Peradeniya on November 11,1898:—

Water	55·148 per cent.
Ash	0·405 ,,
Sugar (calculated as cane)	0·36 ,,
Proteid as calculated from the amount of nitrogen	2·8 ,,
	58·713 ,,
Caoutchouc, &c., by difference ...	41 287 ,,
	100·0 ,,

* The symbol u is used for the unit of length used in measurements under the microscope; it represents ·001 mm. or about $\frac{1}{25000}$ inch.

We desire to express our thanks to Mr. Kelway Bamber for kindly making this estimation of nitrogen as well as some others. From the above analysis we see we have to deal with a considerable quantity of proteid.

Faraday analysed many years ago a sample of latex imported from Brazil and presumably that of *Hevea brasiliensis*. He termed the proteid matter albumin, and Biffen quotes him as the authority for considering the proteid of this type. Typical albumin is that which largely composes the white of egg and is readily coagulated by heat. From experiments I am inclined to consider the proteid of Para latex, at any rate as far as Ceylon is concerned, not to be albumin, but rather an albuminate, resembling casein, the special proteid of milk. Its reactions and behaviour towards saline solutions and acids resemble that of an alkaline albumin.

Acids have been employed for the extraction of rubber from the milk. In Madagascar citric and sulphuric acids are used to coagulate the latex of *Landolphia madagascariensis* (*Vahea funifera*), Seeligmann p. 66. Dr. Morisse, when in the rubber producing regions of South America, tried the coagulating power of a number of chemical re-agents on the Para latex. His results are quoted in Seeligmann's book, p. 67. He finally employed a mixture of sulphuric acid and phenol (carbolic acid); the one the coagulating, and the other the preserving agent. From the numbers given I calculate that 0·2 grain sulphuric acid is required to coagulate 100 c. c. of latex.

Dr. Helfer has also employed acetic acid to coagulate the latex of *Artocarpus chaplusha* (Watt's Dictionary of Economical Products of India, Vol. IV., p. 343.)

The coagulating power of various acids has been tried here on the latex of *Hevea brasiliensis*, viz., hydrochloric, sulphuric, nitric, acetic, oxalic, tartaric, and citric acids, and we have come to the conclusion that on the whole acetic is the best acid to employ.

All the acids bring about the coagulation in the cold, but much quicker when warmed. The amount required is extremely small, and varies somewhat for the different acids. If excess be added, then coagulation ceases to be complete.

The quantity depends on the quantity of pure latex and is independent of its dilution; or in other words, doubling the dilution halves the acid for a given volume. A certain weight of acid is required for 100 c. c. of latex, no matter whether this be diluted with water to 500 c. c. or 1,000 c. c.

The figures to be given are approximate only. 100 c. c. of pure latex are completely coagulated, *i.e.*, the liquid part is left quite clear, by—

0·1 gram	...	...	...	Sulphuric acid
0·1 ,,	...	...	...	Hydrochloric acid
0·3 ,,	...	...	...	Nitric acid
0·95 ,,	...	...	...	Acetic acid
0·2 ,,	...	...	...	Oxalic acid
0·25 ,,	...	...	...	Tartaric acid
0·5 ,,	...	...	...	Citric acid

From the above it is seen that much more acetic acid is required than sulphuric acid, for example; hence, why not employ the latter as being cheaper? The reason is that with all the acids except acetic, the range for complete or nearly complete coagulation is extremely small. As regards sulphuric acid, coagulation was not complete with 0·05 per cent. of acid, about complete between 0·1 and 0·2 per cent., not complete with 0·3 per cent. or 0·25 per cent., far from complete with 0·6 per cent. Thus, unless the percentage for the pure latex can in practice be brought between 0·1 and 0·2, all the rubber particles are not extracted from the diluted latex.

With acetic acid, however, the range is much greater. Coagulation is complete between 0·09 and 0·39 per cent. and almost complete between 0·025 per cent. and 0·8 per cent.—a very considerable range, which can fairly readily be reached in practice. Thus, with acetic, the acid may be added either in quantities four times below the proper amount or nine times above it, with very little waste of rubber; whereas with the other acids such would mean a very incomplete coagulation. It is for this reason that acetic acid is advised in place of the others.

In my experiments the latex was usually diluted ten times; but, no matter what the dilution may be, the caoutchouc particles are capable of being collected together into a clot by the necessary amount of acid. This was even done for latex diluted 2,000 times. One c.c. of latex diluted to 2,000 c.c. requires, of course, just the same quantity of acid as if it was diluted only to 5 c.c. The common B.P acetic acid was used, in the proportion of 3 c.c. of acid to 100 c.c. of pure latex.

The following reason is given for this behaviour of Para latex towards acids. The latex is slightly alkaline. The proteid is of such a nature as to be insoluble in neutral solution, but soluble in alkaline or acid media. A small quantity of acid is necessary to neutralize the alkalinity, and this precipitates the proteid in a flocculent manner, collecting together the caoucthouc particles. If too much acid is added, then the proteid remains still in solution, being now in an acid medium. When the latex is diluted with water, the extra bulk of fluid requires just the same quantity of acid, because the alkalinity in amount remains the same. Acetic is a weaker acid than the others, and so does not bring about the changes so rapidly.

The following is the application of this method of preparing rubber from the latex by means of acid. If possible the volume of pure latex should be known, and then the required amount of acid can easily be calculated. Otherwise the times of dilution of the latex should be known approximately, and then the acid calculated for the whole bulk of fluid.

In our experiments a known quantity of water was added to each collecting tin, about 5 c.c. Since the latex of Hevea is so thick, a little fluid previously put into the tins is necessary to prevent the latex from drying. The whole of the collecting tins are emptied into a measuring cylinder and the amount of latex ascertained by deducing the quantity of water added. The washings of the tins, &c., are all added to the diluted latex, and the whole passed through a sieve made of coarse cloth, which removes particles of bark and other impurities. A second filtering is desirable. The latex now diluted, perhaps 20 times, is heated to nearly boiling point over a fire; any scum that may rise is removed, as it contains any remaining dirt which has passed through the cloth. If ammonia has been added to the water put in the tins to prevent spontaneous coagulation, the heating is continued for ten minutes or so to drive it off, else it will interfere with the coagulation. The milk should be continually stirred. The requisite amount of acetic acid is now added and the whole briskly stirred, when in a few seconds the caoutchouc separates out in clots. The boiling vessel is then removed from the fire and copious cold water added. The rubber clots are opaque and white in appearance; the liquid part should be quite clear or show only a slight turbidity. If quite clear, it shows that the whole of the rubber particles have been collected together into the clots; otherwise there is a little caoutchouc still in suspension: the greater the turbidity, the more caoutchouc globules remain in the liquid. The coagulum of rubber is quite soft and spongy and ought to be pressed out into thin sheets—the thinner the better—in order to allow the rubber to dry quickly. If pressed into pieces of the thickness of ⅛ in. (3 m.m.) or even less, the rubber soon dries provided the atmosphere is not very damp. The whitish opaque appearance gradually disappears and the rubber becomes translucent and of about the colour of gelatine.

Such rubber, if it does not dry quickly—and it is sometimes difficult to get it to do so on account of rubber districts being damp places—is apt to putrefy or at least mould. To prevent this it is advisable to add along with the acid a little creosote in alcoholic solution, about 0·5 per cent. of the total bulk of fluid. This will hinder growths of mould, &c., during the time the rubber is drying. Creosote has been found more effectual than phenol (carbolic acid), as it does not evaporate so quickly.

We have not tried any artificial means of hastening the drying of rubber. It should on no account be placed in the sun. The intensity of a tropical sun quickly gives to the surface a stickiness which is permanent and cannot be readily removed, and which renders the rubber less valuable in the market.

To dry rubber by heat does not seem advisable. If any artificial means are to be used, they should be more in the direction of hygroscopic re-agents, such as quick lime or calcium chloride placed in the drying chamber. But if the rubber be rolled into very thin sheets it soon dries of itself in good weather.

It was stated before that the acids coagulated the diluted latex in the cold. With acetic this takes place after a few hours. The whole of the caoutchouc globules are gradually gathered together into a very loose clot, which can readily be removed from the clear liquid and pressed into a sheet rubber.

This method may ultimately prove better for use on the large scale than the "hot" method, but it is difficult to use creosote in the cold as it will not then mix with the milk.

The rubber prepared by this acetic acid process, of course, contains abo all the proteid present in the latex. Mr. Bamber kindly estimated the amou of nitrogen in a sample of this rubber and found 0·592 per cent.; this corre ponds to 3·7 per cent. proteid, supposing the proteid in question to contain per cent. of nitrogen, which is the average amount.

3·7 per cent. proteid in the dry rubber corresponds to about 1·5 per cent in the latex. Hence it seems that not all the proteid of the latex finds itsel in the rubber. This is borne out by the fact that the clear liquid remaining after coagulation with acetic acid often gives re-actions with the tests fo proteid.

Experiments estimating the weight of rubber obtained from a give volume of latex by the acetic acid method have been tried. The rubber wa dried in a desiccator till constant in weight.

The numbers vary from about 45 to 50 grams per 100 c.c. of latex. A c. of latex weighs nearly 1 gram, so that 45 to 50 per cent. of crude rubber a obtained; deducting 4 per cent. of proteid, this leaves 41 to 46 per cent, whic must consist almost wholly of caoutchouc. Seeligmann mentions 31 as th percentage of caoutchouc in Hevea latex, Biffen only 28 per cent. to 30 p cent. The latex from the trees in Ceylon is evidently thicker with a larg percentage of caoutchouc. This, however, is not an advantage, on the whol for the flow is much less and is not nearly compensated for by the ext percentage of caoutchouc in the latex. We shall see that the percentage caoutchouc likewise varies for Castilloa latex.

EXTRACTION OF CAOUTCHOUC BY MEANS OF MERCURIC CHLORI (CORROSIVE SUBLIMATE).—The coagulating power on the latex of Hevea several salts has been tested, viz., sodium chloride (common salt), alu ammonium sulphate, magnesium sulphate, and mercuric chloride. Stating t results as for the acids, 100 c.c. of latex is completely or nearly coagulated the cold or boiling by—

7·5 to 12·5 per cent. sodium chloride (coagulation very partial, fluid l milky in all cases). 30 per cent. alum (40 per cent. and 25 per cent., i complete). 40 to 50 per cent. ammonium sulphate. 2·5 to 10 per ce magnesium sulphate. 8 3 per cent. mercuric chloride.

Mercuric chloride (corrosive sublimate) is the only one which has a str and complete coagulating power on the latex. From 0·3 per cent. upwards the caoutchouc is separated from the diluted latex, leaving the liquid p quite clear. It can thus be used for preparation of rubber from the milk

It acts better in the cold than when heated. Boiling the milk with i apt to make the coagulation incomplete, the liquid part being left turbid

The calculated amount of an aqueous solution* of mercuric chlorid added to the latex, diluted some ten times and then vigorously stirred. I few minutes a separation of the caoutchouc in small flocculent portion observed; these gradually rise to the top, being lighter than the water, after the lapse of an hour the caoutchouc is in the form of a lumpy crean the surface. If allowed to remain longer, say twelve hours, the cream bec a clot, and can be lifted out and pressed on to a sheet of rubber. It is perl better to remove the rubber in the cream form by running off the liquid bel either by a syphon or, better, by means of a tap at the bottom of the ves the cream can then be poured out in a thin layer into a porous surface so speedily dried.

* The salt is not very soluble in water. A 4 per cent. aqueous solution was u

The advantage of this method over the acetic acid one is two-fold. Firstly, the rubber is perfectly aseptic and cannot putrefy or mould. Secondly, the creaming allows the rubber to be dried quickly. The objections are the very poisonous character of the reagent and the presence of mercury in the rubber, although this is extremely small, about 0·75 per cent. of the salt in the dried rubber.

With this reagent any mineral matter in the water used for dilution will be apt to have an effect and prevent the separation of the caoutchouc. The mercuric chloride added will have to first satisfy such salts in the water as carbonates, before it will be free to act on the proteid ; consequently it is not advisable to dilute the latex too much. If, after adding the calculated amount the separation show itself not complete after a few minutes, more of the reagent can be added till the liquid part of the separated latex is quite or very nearly clear. This perhaps is a third advantage over the acetic acid method. If in the latter case too little acid has been added so as to effect only a partial coagulation, it is not easy to extract the remainder of the caoutchouc globules by further addition of acid.

CASTILLOA.—Mention has been made before-hand of the ease with which this latex creams. The comparatively large caoutchouc globules in the diluted latex float to the top to form a thick layer on the surface of the liquid below. This permits of a simple means of preparing good rubber from the latex.

Before proceeding to the discussion of this method a few points connected with the chemistry of this latex are worthy of mention.

The latex as it first trickles out of a wound is quite white like that of Hevea or Manihot, but it rapidly darkens in colour and at the same time a separation occurs; the caoutchouc globules collect together in white flakes or masses from the rapidly darkening fluid part of the latex.

The darkening is due to the production of a deep brown soluble colouring matter, and is dependent on the oxygen of the air and on a special ferment, an oxydase, occurring in the latex. The ferment acts as an oxygen carrier between the air and the colour-producing body of the latex. Boiling the freshly-drawn latex prevents the formation of the colouring matter, since it destroys the ferment. Tannin occurs in considerable quantity and renders the latex bitter to the taste. An alkaloid too is present. In fact, the liquid part of this latex is of a more complex nature than that of Hevea.

The proteid of the latex of *Castilloa elastica* has been investigated to some extent by Mr. Biffen (*loc. cit.*, p. 167). He finds the latex of acid re-action, which on the addition of a little alkali is coagulated. This he finds to be due to the nature of the proteid, which exists as acid albumin in the latex ; on neutralisation it comes out of solution and gathers together the caoutchouc particles in a clot.

Now, the latex of the Castilloa growing in Ceylon does not seem to behave like this. On the very gradual addition of alkali to the latex or to the filtrate of the latex no coagulation or precipitation occurs. Alcohol causes a coagulation of the latex and a copious precipitate in the filtrate, which is quite soluble in water again. We have reason to consider the Castilloas introduced into Ceylon to be not the species *Castilloa elastica*, but another one, *Castilloa Markhamiana* ; consequently the properties of its latex may very easily differ from those of *Castilloa elastica*.

The latex left to itself dries to a deep brown rubber of good quality, but with a large percentage of impurity. By creaming the rubber can be obtained translucent and colourless, and consists almost wholly of caoutchouc, whereas the former contains dried in it all the soluble constituents of the latex.

The proteid, as estimated from a nitrogen determination kindly made by Mr. Bamber, comes to 9·187 per cent. in the dried latex, *i.e.*, about 4 per cent. in the ordinary latex. A similar analysis made of the rubber prepared by creaming showed just a trace of nitrogen.

When the latex of Castilloa is mixed with water and allowed to stand, in the course of an hour or two the caoutchouc particles have all floated to the top to form a thick cream over the brown beer-like liquid below. This liquid can be syphoned off, or, better, removed from the vessel by a tap at the bottom. The cream can then be mixed up with water again and left to stand, and when the caoutchouc has again risen to the top the liquid can be run off a second time. After a third washing most of the soluble matter of the original latex will have been removed. The thick cream is now ready to be dried in thin layers either by mere exposure to the air or on a porous surface.

A few points of considerable practical importance connected with this creaming have been noticed. The first creaming is always the quickest, *i.e.*, the caoutchouc globules rise to the surface in the shortest time; succeeding creamings take gradually longer times. Why this should be is not quite clear. One reason to be put forward is, that the difference in density between the liquid and the caoutchouc is greatest at the first creaming owing to the soluble matter in the original latex, and as this latter is gradually removed the density of the water approaches nearer that of the lighter caoutchouc, and hence the globules have not the same tendency to rise. Perhaps another reason which partially accounts for it is that in the collected latex the caoutchouc globules are coherent in little masses, and naturally in this form rise quicker. Further washings are apt to separate the caoutchouc into the individual globules, and hence the rising of the rubber is retarded. From various experiments it is found that the latex diluted about five times with water creams fairly well three times; at the fourth time the creaming is not complete, the liquid to be run off remains somewhat milky. However, three times creaming at about the fifth dilution washes the caoutchouc well, giving almost colourless rubber. Washing at this dilution only once affords good rubber, which, provided the drying surface is very porous, is very slightly coloured owing to the brownish liquid in the cream being absorbed.

It seems, although the experiments as yet are incomplete, that churning facilitates the creaming. Perhaps a cylindrical churn rotating round its short axis with a tap in the bottom would be a suitable machine for the purpose.

Through the kindness of Mr. Drieberg we tried the diluted latex in a small glass churn and found that when brought to rest it creamed readily (see figure at end).

The caoutchouc cream, as it may be termed, consists of the globules which have not fused with one another, and of water. It is a thickened latex without the soluble matters in the aqueous part. To make rubber from it the water has to be removed.

The cream may be poured out on a clean surface in thin layers and the water allowed to evaporate, when the individual globules of caoutchouc fuse together to form a sheet of rubber. Mere atmospheric evaporation is slow. The drying is done much more speedily by pouring the cream on to a porous surface made of some fine earth. When dry, the rubber is so transparent as to be almost invisible. It is then stripped off and is ready for market. Two objections or drawbacks to a porous surface are to be mentioned. In peeling of the sheet of rubber particles of the surface are liable to be detached and rolled up with the rubber; this can be largely prevented by having the porous surface smooth and unfriable. The absorbing power of a porous material diminishes with use, especially if the watery part of the rubber-cream contains much soluble matter, because then the pores are apt to be clogged. What may be the best porous material is still a matter of consideration.

Rubber prepared carefully by the above method should contain very little impurity and command a good price. It should, in fact, be as good as that obtained by means of the centrifugal machine, although this latter allows of a much speedier preparation of rubber from the milk.

The rubber thus obtained is so dry that it is practically unnecessary to use any antiseptic or preservative such as creosote; but of course it should be packed carefully and exported as soon as possible, as rubber soon spoils in a tropical climate.

MANIHOT GLAZIOVII (Ceara Rubber Tree).—This latex has been shown by Biffen to be also capable of yielding its rubber by centrifugalization as well as by churning.

Experiments with this latex have not been very extensive.

Two chief points connected with its chemistry are that the proteid is of such a nature as to be coagulated by heat—hence boiling the latex clots it—and that a little alkali added in the cold brings about a separation, not in clots, due, I believe, to a precipitate of calcium hydrate (lime), which collects together the caoutchouc particles in a flocculent manner.

Ceara latex is very prone to putrefaction, which brings about spontaneous clotting. After a few hours standing it becomes malodorous.

Boiling the diluted latex and treating it the same way as Para milk might be suggested as a practical method of preparing the rubber. This would of course contain the proteid, and if not quickly dried would putrify, unless some preventative had been added.

From a nitrogen determination kindly made by Mr. Bamber, the rubber obtained by boiling the latex contains about 5 per cent. of proteid.

D.—YIELD.

The subject of yield is, of course, one of the most important practical points to be dealt with in this paper.

From our experiments it would seem that the amount of latex or rubber extractable from the trees introduced into Ceylon is much less than that from the same trees in their native homes, or even, so far as the few available results indicate, in other Eastern countries. This is distinctly discouraging for rubber cultivation in Ceylon. In this connection it is worthy of special remark that Ceylon contains no indigenous rubber-producing trees of any value, and that the milk of jak, breadfruit, and other introduced trees, which elsewhere is said to contain caoutchouc, here appears to contain none.

HEVEA BRASILIENSIS.—From Seeligmann's "Le Caoutchouc et la Gutta-percha," p. 45, are gathered the details of the flow of latex from the Heveas in the Amazon Valley. From each simple oblique incision about 30 c. c. of milk are obtained, flowing slowly for one to three hours. Nothing like this quantity has been obtained from the trees at Peradeniya or Henaratgoda. The average for a simple incision is not beyond 2 or 3 c. c.; it might possibly be raised to 10 or 12 c. c. by paying careful attention to the wound response and to the time of year.

The most that has been collected from one V-shaped incision was 20 c. c., flowing for two hours from a tree at Peradeniya, October 18, 1898. Usually the exudation stops in about a quarter of an hour, yielding 1 to 4 c. c. of latex.

There is a great individual difference in the trees in the yield per incision. Out of the 32 trees at Peradeniya, 2 flow much better than any of the rest, without any apparent reason. The same is observable at Henaratgoda. One tree there of large size barely exudes any latex when wounded; at most a few drops trickle into the collecting vessel. This inherent individual difference in yield may be due to a difference in the number of laticiferous tubes, or to a more or a less complete communication between the separate tubes. It suggests propagation, if possible, from the best flowing trees.

There is considerable variation in yield of latex per incision, according to the time of year, or perhaps rather to the state of the weather. From observations, necessarily very incomplete as extending over only a single year, I have largely come to the conclusion that moisture is the great requirement for flow of latex: that at the wet seasons of the year the latex flows more freely, at the same time being thinner, and that therefore tapping should be done just after a spell of wet weather. To my mind the laticiferous tubes act as water-storers; when there is plenty of moisture in the soil, more water is drawn up by the roots than is needed at once, and finds its way into the laticiferous ducts, to be drawn upon when required. The latex is thus slightly diluted and the vessels rendered more turgid, so that the extra pressure raised in them, as well as the thinner nature of the milk, causes a grater flow from a wound. Again, moisture may facilitate growth in thickness, and so the producing of new laticiferous elements. Nevertheless I am under the impression that in a given tube the latex may become more copious by the infiltration of water during wet weather, and that therefore the increased flow is not alone due to the formation of new laticiferous tubes.

Another point of importance is the nature of the soil as regards its retentiveness of moisture. From analysis of three soils taken from rubber plantations in Ceylon it is shown that the sample from Henaratgoda is very deficient in this water-holding property. This, no doubt, has something to do with the poor yield of milk from the Hevea trees there.

In the Circular on "Rubber Cultivation" the drier parts of the two monsoons—*i. e.*, from January to April and in August and September—are considered the most satisfactory times of the year for tapping. Rainy weather is, of course, inconvenient. All the same, the tapping should be done just after a spell of wet weather, when the laticiferous system is most turgid and full of latex.

Early morning, just after daybreak, is recommended as a convenient and also favourable time for tapping. Sunshine on the incisions is to be avoided, as the heat dries the latex on the wound, and is thus apt to check the flow by clogging the wound.

In the Government plantations of Heveas Mr. Lewis has noticed that the border trees, which receive most sunshine on their trunks, appear to exude latex more freely than the others, and has suggested the possibility of the sun's rays shining on the bark in the early morning exercising a stimulating effect on the flow of latex from a wound.

Sometimes we have thought to have observed the same, but when submitted to a test experiment no difference was observable between the illuminated side and the shaded side of the trunk. It is conceivable that the warmth of the early sun on the bark might stimulate the circulation of the latex if it exists, and so cause a greater flow of latex from a wound in such an area. As the morning advance this supposed increase would be marked by the the latex quickly drying over the wound and hindering further flow. The effect, if it occurs, would then be only very temporary.

The experiments at Henaratgoda on March 8, 1899, was conducted in this wise. Trees were chosen which in the early morning received the sun on one side of the trunk, eight in all. Two pairs of tins were fixed at corresponding levels on each tree, *i.e.*, on each tree two tins were placed on the sunny side and two on the shady side. After the sun had shone on the bark for about a quarter of an hour the incisions were made and the latex collected and measured :—

Sun-side	...	16 incisions yielded	24·5 c. c.
Shade side	...	do	29·0 c. c.

The shade-side has given more, which from the external effect of the sun on the latex is to be expected. The internal effect of the sun's rays on the latex is not supported.

CASTILLOA.—It has been mentioned that the flow of latex from an incisions is much greater than in Hevea. The largest amount obtained from a single incision has been 120 c. c. from a tree at Henaratgoda, *i.e.*, six times the largest amount obtained from a Hevea. It is quite possible, however, that the total quantity of rubber extractable from a Hevea tree at one time might equal that from a corresponding Castilloa, but the labour necessary would be much greater for the first.

The Castilloa latex as a rule contains only about half the percentage of caoutchouc that that of Hevea does. Experiments have shown for the trees at Henaratgoda the following percentage of rubber in the latex extractable by creaming : 17·6, 25·5, 21·1, 21. The greater the flow is, the less the percentage of caoutchouc, but not proportionally. The flow is increased much more than the percentage of caoutchouc is diminished, and *vice versâ*. Some results from tapping Castilloas growing in the Matale District exemplify this point. The quantity of latex collected per incision was very meagre and averaged 7 c.c. It was very thick and had 37 per cent. of extractable caoutchouc.

The following are the results obtained as regards yield of rubber from Castilloa trees growing at Henaratgoda, tapped at the beginning of March, 1899 :—

Tree 1 : girth 4 ft. from ground, 3 ft. 2 in.
Tapped the trunk up to 6 ft. with only 4 cuts.
Weight of dry clean rubber obtained 70 grams (2½ oz.).

Tree 2 : girth 3 ft. 2 in.
Tapped the trunk up to 12 ft. with 58 incisions.
Weight of rubber 282 grams (10 oz.).

Tree 3 : girth 3 ft. 5 in.
Tapped to height of 9½ ft. by 8 incisions.
Weight of rubber 84 grams (3 oz.).

Tree 4 : girth 3 ft. 8 in.
Tapped to height of 12 ft. by 12 incisions.
Weight of rubber obtained 191 grams (6¾ oz.).

What time should elapse before the trees flowed as well again, has not yet been ascertained. Perhaps the trees would not be worth tapping more than twice a year. In that case the yield of rubber per tree per year from a trunk 3 ft. in girth and 12 ft. in length would come to about 300 grams or 10¾ oz., a small amount compared to the results stated for its native country. In fact, the weight of rubber would not be much greater than from Heveas of corresponding size tapped ten to twelve times in the year, but the expense of extraction would be very much less.

[NOTE.—Experiments of yield of trees in Ceylon, started at various times during the past two years, are still in progress, and their results will be given in a later Circular; I should be grateful for any notes on this subject from planters and others who may have experimented in this direction.—J.C.W.]

E.—NOTES ON OTHER CAOUTCHOUC-YIELDING PLANTS GROWING AT PERADENIYA AND HENARATGODA.

URCEOLA (CHAVANNESIA) ESCULENTA, Benth. (N. O. Apocynaceæ), native of Burmah.—This is a climbing plant. The specimen growing at Henaratgoda has its main stem of about 9 inches (?)* in girth. On wounding it the white latex trickles out in fair abundance and moulds into good rubber free of stickiness. The latex from the thin stems such as bear the leaves or have recently shed them forms a sticky substance when moulded between the finger and thumb. The plant resembles Castilloa in this respect.

The latex both from the pith and the cortex of the young stem is sticky; hence it looks as if the true caoutchouc is only formed in the secondary bast.

It is mentioned in Dr. Morris's Cantor Lectures, p. 43, as a probable source of some of the Burmah rubber.

LANDOLPHIA KIRKII (N. O. Apocynaceæ).—The best rubber-climber of Africa. The latex from the thick stems of the plants growing at Peradeniya and Henaratgoda yields good rubber free of stickiness. The latex from the cortex of young stems and from the pith dries to a viscous substance.

LANDOLPHIA FLORIDA.—The single plant at Peradeniya has a main stem of 12½ inches in girth. The latex from it flows freely, but does not yield true caoutchouc, only the common viscous matter. The same is true for the latex of the young stems. This plant then cannot be considered a true rubber-producing one.

It is reckoned one of the chief rubber plants of Africa, especially the West Coast. In the Cantor Lectures by Dr. Morris, p. 31, it is mentioned as producing a very adhesive rubber.

LANDOLPHIA HENDELOTII.—The small plant at Peradeniya has a main stem of only two inches in circumference, which yields a viscous latex. It is native of Eastern Africa, and in the Cantor Lectures is not definitely stated as a rubber liane.

TABERNÆMONTANA CRASSA (N. O. Apocynaceæ).—Dr. Morris says that this tree of West Africa is supposed to yield some of the rubber exported from Sierra Leone and the Gold Coast.

The tree examined at Peradeniya has a circumference of 2 ft. 3 in. at the base of the trunk. The latex flows freely, but produces only a thicky substance and not true caoutchouc.

SAPIUM BIGLANDULOSUM (N. O. Euphorbiaceæ).—This tree is recognized as producing a valuable rubber at elevations of 6,000 to 8,000 ft. in Columbia (Morris's Cantor Lectures, p. 28).

* Was not measured.

The moderate-sized tree at Peradeniya (girth 3 ft. 2 in.) yields from an incision in the trunk a little latex, which dries to a sticky resinous substance, wholly destitute of the characteristic properties of caoutchouc. Another tree growing on the other side of the Island in the Botanical Garden at Badulla yields a similar viscous substance.

FICUS VOGELII (N. O. Moraceæ).—Considered to be a rubber tree in its natural habitat on the West Coast of Africa. A paragraph is devoted to it in the Cantor lectures, p. 33. The milk is said to have a large percentage of resin, but samples have been prepared which were favourably reported on by the manufacturers.

The good-sized tree growing at Peradeniya yields from its trunk abundant latex. When tapped on December 10, 1898, 32 c. c. per oblique incision was measured. The solid matter of the latex dried to a sticky substance with little elasticity. Of these six or seven supposed rubber trees, only two, viz., *Urceola esculenta* and *Landolphia Kirkii*, produce from their older stems rubber free from stickiness, tough, and elastic.

In all cases the latex of the younger parts does not yield true caoutchouc, or at least caoutchouc alone.

Possibly there is a tendency for such trees in Ceylon to deteriorate in their rubber-yielding capacities. The case of *Sapium biglandulosum* certainly points that way.

(Signed) J. PARKIN.

Peradeniya, April 13, 1898.

GENERAL REMARKS ON THE ABOVE REPORT.

As the report is rather long, and goes into some detail, it may be well briefly draw attention to some of the chief conclusions.

Caoutchouc or Indiarubber is found in certain families of plants, ecially the Euphorbiaceæ, Moraceæ, and Apocynaceæ, contained in laticius vessels or tubes, which are quite closed, but when wounded exude the milky latex. They lie as a rule in the inner bark of the tree, and contain, besides caoutchouc, various other substances, suspended or dissolved in water. These interfere with the purity of the caoutchouc and lower its market value.

The ideal rubber-yielding tree would be one in which there were many laticiferous vessels, all communicating freely with one another, and containing only caoutchouc in an emulsion with water. The trees cultivated in Ceylon do not reach this standard, but depart from it in different ways. Hevea contains very pure latex, but its laticiferous vessels do not seem to communicate freely, so that a large number of incisions are needed to get all milk; Castilloa has much freer communication, but a more impure latex, and less percentage of caoutchouc therein; Manihot has poor communication and very impure latex, containing a small percentage of rubber. The objects to be aimed at in practice are principally:—

(1) To get a good quickly growing tree, which will yield a large quantity of rubber after as few years as possible.

(2) To obtain the latex with as little labour as possible, and with the greatest possible cleanliness, as all impurity lessens its value.

(3) To obtain from this latex as pure caoutchouc as possible, with the least practicable labour and cost.

(4) To get the caoutchouc as dry and antiseptic as possible.

With regard to the first point, we have at present three trees which do well in Ceylon; Hevea, Castilloa, and Manihot. The second desideratum is best supplied by Castilloa, which yields latex very freely from a small number of incisions, and also gives a very fluid latex. Hevea is second best in this respect, and Manihot worst.

The preparation of the caoutchouc from the latex has hitherto been of the simplest description, the milk being merely allowed to dry. Under such conditions Hevea is distinctly the best tree, for its latex is naturally very free from other substances than caoutchouc (which from the point of view of rubber producers are regarded as impurities). When, however, the centrifugal machine is used, the distinction of this latex is lost, all latices yielding very similar rubber. If the machine be not used, some chemical or other mechanical method must be used. Hevea milk does well with the former, acetic acid or mercuric chloride being used; Castilloa milk does best with the latter, creaming being employed. The creaming must be done two or three times at least, and in this lies the superiority of the centrifugal machine over simple creaming, just as has been the case when it was applied to ordinary milk.

The question of what part of the plant to tap is gone into, and it is shown that only the main stem up to about ten feet from the ground is worth tapping. The possibility of obtaining good rubber from young stems and leaves has often been discussed, and Mr. Parkin shows good reasons for the belief that such parts contain no good caoutchouc, but rather an allied substance which may be called viscin. It is possible that some way of preparing caoutchouc from this, or of turning the viscin into caoutchouc, may be discovered, but at present there does not seem much prospect of success with the practice of growing annual crops of twigs.

The methods of tapping are then dealt with. For Hevea the well-known V method is still recommended, but for Castilloa simple oblique cuts are enough, as each cut taps a much larger area in this plant. In Hevea and Manihot the incisions must be much closer together than in Castilloa, for the same reason. An ordinary carpenter's chisel is recommended for the purpose, rather than the small hatchet used in Para, as the latter is easily driven into the wood, and cannot be used after the collecting tins have been put on. The milk is collected in small tins, about 2 inches deep and 1 inch wide in the case of Hevea, and larger in the case of Castilloa. These have one flat side and one convex; the flat side is placed against the tre[e] and held by a pin projecting at the top. The tin is luted on to the tr[ee] with wax or clay and the cut made just above it. Slightly ammoniat[ed] water is placed in the tins in the case of Hevea to prevent the latex f[rom] coagulating. One side of the tree should be tapped one year or sea[son], the other the next.

The very important subject of the effect of wounding on the flow of latex is then gone into. Many planters who have made trial tappings of their trees have been much disappointed at the extremely small flow of milk. The chapter mentioned will throw light on this, and bring out several important points which require attention in practice.

The question of the preparation of the rubber from the milk is then taken up. The faults of the rough method hitherto in use in Ceylon are pointed out; putrefaction, mould, and want of thorough drying are the chief. Two methods of preparing Hevea milk are described, that by means of acetic acid and that by means of mercuric chloride. Both of these yield very good rubber indeed; the objection to the latter is that some of the mercuric salt is left in the rubber, which may interfere with its market value. Castilloa milk is then dealt with. At present the number of trees in Ceylon is too small to make it worth while to use the centrifugal machine, and creaming is recommended, this gives most excellent rubber at small cost. A modification of the ordinary cylinder glass churn, provided with a tap at the bottom, will probably serve the purpose excellently.

Mould and putrefaction are guarded against by the use of antiseptics, such as creosote and mercuric chloride, and by the rapid drying of the rubber on porous surfaces.

Many points still remain for investigation, and the experiments initiated by Mr. Parkin are being continued at the Peradeniya and Henaratgoda gardens. Their further results, and the reports of experts upon the samples of rubber now in hand, will form a subsequent Circular.

The introduction of these scientific methods of dealing with rubber milk has very much altered the whole question of what tree to plant, whether to plant as a chief or a minor product, and so on. This has been considered in the preceding Circular (No. 11).

Literature.

The following books and papers, among others, may be consulted in the Library at Peradeniya; the initials and numbers indicate their position :—

General.

Files of letters, cuttings, small pamphlets, &c., in Director's Office (on special permission being obtained).

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Reports of other Gardens abroad, *e.g.*, Java, Singapore, West Indies, &c.	M 1
Reports of Madras Forest Department	A 2
Reports, Ceylon Planters' Association	A 6
Reports, Royal Gardens, Kew, 1876, &c.	J 3
Reports, Foreign and Colonial Office	F 4
Agric. Bulletin, Malay Peninsula	B 3
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Jamaica Bulletin	J 3
Kew Bulletin	J 3
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Trinidad Bulletin	B 3
Tropical Agriculturist	I 1

Special.

Castilloa—*see* Circular 11.

Assam Rubber :

Imperial Institute Series of Handbooks, 25	F 3
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African Rubbers:

Kew Bulletin, 1888, 253; 1889, 63; 1890, 89; 1895, 241; 1896, 76	J 3
Notizblatt, Berlin	J 3

Colombian Rubber:

Kew Bulletin, 1890, 149	J 3

Para Rubber:

Circular 4 of this Series.	
Kew Bulletin, 1893, p. 159; 1898, August	J 3

JOHN C. WILLIS,
Director, Royal Botanic Gardens.

Peradeniya, May 25, 1899.

INDIARUBBER OR CAOUTCHOUC.

ITS ORIGIN, COLLECTION AND PREPARATION FOR THE MARKET.

THE LATEST PERADENIYA "CIRCULAR" WITH MR. PARKIN'S REPORT.

(*Review of the foregoing paper.*)

Such is the subject of a Circular just issued from the Government Printing Press, and received by us from Peradeniya, giving the results of the investigations of Mr. J. Parkin, M.A., of Trinity College, Cambridge, as carried on at the Peradeniya Gardens, with General Remarks by Mr. Willis, Director of the Gardens. "Prodigious" was our first exclamation on seeing this "Circular," and yet it by no means contains the complete results of Mr. Parkin's work which will be published at home. Still it certainly includes more than enough to satisfy the most exigent of Ceylon rubber planters, and the report reaches us just in time to be included in our "INDIARUBBER PLANTERS' MANUAL" due from the press at an early date. There is, of course, in the 60 pages before us, a great deal that is of scientific, rather than practical, interest; and we cannot help suspecting that the recent discoveries in Central America and Trinidad by Mr. Biffen, Mr. Hart and others may have interfered to some extent with the practical value of Mr. Parkin's patient and truly scientific investigation. At the same time the fullest justice is done to Mr. Biffen in prominently referring to his valuable work; while the paper in the *Tropical Agriculturist* of December last (taken from the "India-rubber World") to which we made pointed reference some weeks back, is also specially referred to and quoted (on page 118) as showing that the Castilloas growing in Trinidad seem to possess proper caoutchouc in their young stems, and this would, apparently, mark them out as a different species from the Castilloas of Ceylon. But clearly, further investigation and experiment are required to settle this very important point, and we have also to continue to watch very closely the outcome of Mr. Biffen's discovery in Central America, and of Mr. Hart's continuous experiments in Trinidad.

Meantime to revert to the Circular before us: it opens after a few lines of introduction with an explanation of the measurements and contractions used; and then Mr. Parkin's paper comes under the following heads:—

A.—Botanical.

B.—The Extraction of Latex. I.—Incision (1) Kind of Incision; (2) Instrument to Use; II.—Collection of Latex from Incisions; III.—Area of Trunk to be Tapped; IV.—Effect of Wounding on Flow of Latex.

C.—The Preparation of Commercial Rubber from the Latex. (1) Hevea; (2) Castilloa; (3) Manihot.

D.—Yield.

E.—Notes on other Caoutchouc-yielding Plants.

The "botanical" chapter covers some eight pages and notices, among other things, the possible successful manufacture of "artificial caoutchouc" though no one has, as yet, got beyond the stage of laboratory experiments. The great inducement to plant rubber-yielding trees at a time when raw rubber of good quality is selling at 4s a lb., is noticed, as also Mr. Biffen's special investigations in tropical America resulting in preparations from the milk with a loss in manufacture of less than one per cent. The problems which Mr. Parkin put before himself are thus given:—

We want to know the trees which promise best for cultivation, both as regards quality and yield of rubber. We have to consider the best times and means of tapping them, and then of preparing the rubber from the collected milk.

We find special reference made more than once to *Alstonia scholaris* as "possessing copious latex (milky juice) in its trunk," This is not an uncommon tree in our low-country, and it ought at once, we think, to be exploited. One of the finest specimens in Colombo is near the Turret Road gate of Canella Villa, its trunk being covered with the "Colombo Agent" and other well-known creepers. In closing his botanical chapter, Mr. Parkin makes the following significant remark:

Personally I am not inclined to look upon latex as playing an important part in nutrition, and should imagine that if it were possible to extract all the latex from such a tree as *Hevea brasiliensis* without greatly injuring the other tissues, it would not be seriously harmed. I am inclined to regard the laticiferous system more as channels for holding water in reserve to be called upon during times of drought or during the dry season.

We come next to the "extraction of the latex," and here we have a large number of rubber-yielding trees specified, with the different modes of extracting the caoutchouc, and special mention of certain new African kinds with thick underground stems full of latex, which Dr. Morris suggests might, if cultivated, give early returns. These are *Carpodinus lanceolatus* and *Clitandra henriquesiana.* Then comes an important statement:—

The only other parts of the plant besides the trunk and main branches of such trees as Castilloa or Hevea, which might be used for the extraction of rubber, are the young shoots. If these could be used profitably, then a return on the capital could be obtained in a year, either by growing crops of seedlings or by coppicing permanent plants. Our attention has been applied to this with, however, no encouraging results.

Hevea brasiliensis will not answer at all, as far as our experience goes.

Now, here is where notice is taken of the different results obtained from young stems of Castilloa in Trinidad as fully related in our *T.A.* for December and March last and subsequent numbers. Finally, Mr. Parkin says:—

In our opinion it seems hardly likely, at any rate as far as Ceylon is concerned, that rubber can be extracted profitably from the leaves, twigs, &c., so we must return to the consideration of the main stem and consider the best means of extracting the latex from this.

But we suspect this is arriving at a premature conclusion, and we cannot see why eventually Ceylon should not do as well in this way as Trinidad. Mr. Parkin next proceeds to consider, in great detail, the best kind of incision, the best instrument, the collection of the latex from the incisions, the area of the trunk to be tapped and the results of experiments made at Henaratgoda in March last. All through here he is dealing with the Hevea or Para, and we may quote the concluding statement:—

The reason why the base of the trunk should yield so much more latex has, I think, something to do with the thicker and softer bark at this region. This peculiarity has not been only observed in Ceylon. In Colonel W. J. Seaton's report on the Para rubber trees of Tenasserim, Burmah, dated January 28, 1889, he remarks: "It was observed that the exudation of milk was greatest near the ground, where the bark was thickest, while at a height of six or seven feet it was almost *nil.*"

Mr. Parkin next, takes up the Castilloa tree as grown in Ceylon, and gives the results of his experiments as to the outflow of the latex. Further on, we have "the effect of wounding on the flow of the latex," with a further series of experiments in tapping, extending up to June 6th last. We do not give the details and results, because as we reproduce the Circular in full in our monthly periodical as well as Manual, planters specially interested can carefully study it there. Suffice to say that the result seems satisfactory, although in conclusion we are told:—

Probably it will be found that under some conditions it is best to tap daily, while under others it is best to tap at intervals of two, three, four seven, or even ten or twelve days. A large number of experiments on different methods of tapping have been made and are still being made in the Botanic Gardens, and their results will be published later. Those planters who are beginning to tap their trees might well repeat some of the experiments described above on a larger scale. The success or failure of the cultivation depends chiefly on the yield of milk, and it has been clearly shown that this is extraordinarily different in different trees of the same size and age, and that it may be enormously affected by different methods of treatment. Each man must find out for himself the method absolutely best suited to his trees, in the light of the above observations and of his own and those of other workers.

We now come to "the preparation of Commercial Rubber from the extracted latex," and we read:—

The two chief points with respect to the preparation of commercial rubber are to have it free from moisture and putrefaction. The first can be effected by drying the rubber particles in thin sheets; the second by either removing the proteid matter or by the addition of some antiseptic substance which prevents the growth of bacteria and mould.

And again:—

Considering that the caoutchouc in latex exists in the form of minute globules suspended in a fluid, and that they are lighter than water, it is rather surprising that no one till now has thought of the idea of separating the caoutchouc and so preparing rubber by centrifugal force, such as is used for separating the butter fat of milk. The credit of applying the idea is due to Mr. Biffen of Cambridge University, who, in connection with Mr. Erme Howard, recently undertook an expedition through the rubber-producing districts of America. With a modified centrifugal milk-tester, they tested the possibility of extracting the caoutchouc from several latices with great success.

Then experiments made by Mr. Drieberg at the Agricultural School with a cream-separator are referred to; but sufficient speed could not be got to operate successfully. Next:—

In connection with Mr. Biffen's discovery a company has been formed and a large tract of land laid down in Mexico in Castilloa, with the purpose of producing commercial rubber by centrifugalisation. A patent has been taken out on the machine, and consequently it remains to be seen at what price it will be put on the market. It may be somewhat prohibitive. In the meantime, let us consider what other means there are for preparing good rubber from the latex of Hevea and Castilloa.

Accordingly we are told of "Coagulation by acetic acid," "Extraction of Caoutchouc by means of Mercuric Chloride (corrosive sublimate)". Next we have the effect in dealing with "Castilloa," and again we are reminded that our Ceylon species "Markhamiana" probably differs from "C. elastica" in the properties of its latex; but on the whole greater success was attained than in the case of Para. Nor is the Ceara to be despised, since we read:—

Manihot Glaziovii (Ceara Rubber Tree).—This latex has been shown by Biffen to be also capable of yielding its rubber by centrifugalisation, as well as by churning.

Finally, we come to the "yield," and we are told "there is a great individual difference in the trees in the yield per incision. Out of the 32 trees of "Para" at Peradeniya, two flow much better than any of the rest without any apparent reason. Six times the largest quantity of latex got from a Hevea in a single incision, has been got from a Castilloa rubber tree. (It is extraordinary how a prejudice could have been formed some years ago against the cultivation of Castilloa trees in Ceylon!) On the other hand, however, the Castilloa latex, as a rule, contains only about half the percentage of caoutchouc than that of Hevea does. And the results of experiments are summed up as follows after giving details of tapping of Castilloa trees at Henaratgoda at the beginning of March:—

What time should elapse before the trees flowed as well again, has not yet been ascertained. Perhaps the trees would not be worth tapping more than twice a year. In that case the yield of rubber per tree per year from a trunk 3 ft. in girth and 12 ft. in length would come to about 300 grams or 10¾ oz., a small amount compared to the results stated for its native country. In fact, the weight of rubber, would not be much greater than from Heveas of corresponding size tapped ten to twelve times in the year, but the expense of extraction would be very much less.

Further experiments in tappings—both in Government Gardens and on private plantations—are clearly necessary. We are promised a note of results from the Kalutara district.

In his last chapter Mr. Parkin gives us some notes on other rubber-yielding trees growing at Peradeniya and Heneratgoda, none of which, except the African *Landolphias* seem to be worth much. At the end Mr. Willis gives us some "general remarks" on Mr. Parkin's Report, the cream of which we extract in the following, although Mr. Willis has a good deal more to say:—

The ideal rubber-yielding tree would be one in which there were many laticiferous vessels, all communicating freely with one another, and containing only caoutchouc in an emulsion with water. The trees cultivated in Ceylon do not reach this standard, but depart from it in different ways. Hevea contains very pure latex, but its laticiferous vessels do not seem to communicate freely, so that a large number of incisions are needed to get all the milk; Castilloa has much freer communication, but a more impure latex, and less percentage of caoutchouc therein; Manihot has poor communication and very impure latex, containing a small percentage of rubber. The objects to be aimed at in practice are principally:—

(1) To get a good quickly growing tree, which will yield a large quantity of rubber after as few years as possible.

(2) To obtain the latex with as little labour as possible, and with the greatest possible cleanliness, as all impurity lessens its value.

(3) To obtain from this latex as pure caoutchouc as possible, with the least practicable labour and cost.

(4) To get the caoutchouc as dry and antiseptic as possible. With regard to the first point, we have at present three trees which do well in Ceylon: Hevea, Castilloa, and Manihot. The second desideratum is best supplied by Castilloa, which yields latex very freely from a small number of incisions, and also gives a very fluid latex. Hevea is second best in this respect, and Manihot worst.

Here we must take leave of this very full, instructive and suggestive series of papers. The conclusions arrived at are by no means final; but there is a great deal of light thrown on problems of much practical importance to Rubber planters who all ought to feel, as we do, specially indebted to Mr. Parkin and Mr. Willis.

RUBBER IN MEXICO: CASTILLOA ELASTICA.

To the Editor "Tropical Agriculturist."

Henaratgoda, 21st July 1899.

DEAR SIR,—I beg to enclose particulars on Castilloa Elastica cultivation supplied by a leading Rubber planter in Mexico at my request, who has several plantations of his own. I trust that the particulars will be useful to the readers of the *Observer* and *Tropical Agriculturist*. He writes:—"A good many plantations of this tree are being started all over the Southern part of this country now, but owing to their being still young, seeds have still to be gathered principally in the forests."

Yours faithfully.

J. P. WILLIAM.

"CASTILLOA ELASTICA."

(*To Messrs. J. P. William & Co., Ceylon.*)

Mexico, June 1.

The fresh seeds are sown with or without the surrounding pulp in the nursery bed at one foot's distance, giving them some shade, and keeping the ground well drained. The best soil is considered to be alluvial sandy loam, but I have seen very large rubber trees growing on clayey soil, and in many localities the trees seem to grow with preference on the hilly ground and not down in the bottom of the canyons.

When one year old the young plants are transplanted in the rainy season to holes dug previously in the ground, and if the tap-root is very long, as is apt to be the case if the plants, as done in some places, are left in nursery till two years old, it is simply cut, leaving it only ten or twelve inches long and letting it bleed profusely before planting it, as it is said that the clogged milk impedes its taking root quickly. Transplanting without cutting the root is however preferable, as is also transplanting " en- pilon " that is with the lump of earth surrounding the roots ; but this is not always practicable when transplanting to a long distance. Cuttings are very seldom planted, and seem not to give good results.

As for planting in the sun or in the shade, there are different opinions as to the proper course. Some claim that they ought to be planted in the forest in the shade of other trees, and that the sun hurts its milk-production, makes its rind thicker and prevents its growing old and strong. The other side claims that the young trees planted in the sun grow much more vigorously than in the shade, and that not only the greater facility and convenience in looking after the plantation, but also the actual increased growth favors plating in the sun. It is rather difficult to decide which is true in the absence of large old plantations formed on both plans, but I for my part am of the opinion that it depends greatly on the climate of the locality where the plantation is made, for whereas on the Pacific Coast and part of the Atlantic coast there is a long dry season, sometimes fully six months during which the sun may inflict some damages on the trees and where consequently shade would be preferable, in other places as for instance on my own plantation there are rains in ten months or more in the year, and the moist atmosphere consequently prevents the sun from damaging the vitality of the trees, and especially if the altitude is from 200 to 500 meters over sea-level, as on my place, where a heavy shade would not be beneficial to the trees, since they would not get the necessary heat, and this is borne out by the fact observed by myself, that the young trees planted in the sun grow much quicker and stronger there than those left in the shade. Several planters in the State of Chiapas, however, claim just the opposite result, their plantations being situated almost at sea-level and farther south than mine. On the other hand I have seen a plantation of young trees grow nicely at a height of over 700 meters altitude, but these I am inclined to think that the absence of the necessary heat may have an adverse influence on the latex of the grown tree. I have found that lime and green manure seem to help the growth of the trees very much.

The distance between the trees varies much. Some give them as much as 20 feet, but the average seems to be 15 feet. Some few give only 12 feet but without planting anything else between the trees, and a few are trying the Trinidad system of planting at 8 to 10 feet only, intending to uproot and thoroughly bleed one half later. Of course, in selecting the distance, the quality and configuration of the soil and the climatic conditions have all to be taken into consideration. Where the ground is very wet and inclined to form pools, it seems advisable to follow the system of forming a hill around the foot of each tree, as, contrary to the " Hevea " excessive moisture and swampy land seem to hurt it.

I do not think the Castilloa Elastica ought to be tapped till in its eighth year to avoid injuring the tree, nor do I think that planters ought to effect such fabulous yields as five or more pounds a year, as some enthusiasts promise. Here we generally make the safe estimate of one to two pounds of rubber per year, and rather the former than the latter.

APPENDIX.

ALL ABOUT INDIA-RUBBER.

(From the latest Edition of the Encyclopædia Britannica.)

INDIA-RUBBER, or CAOUTCHOUC, consists of the dried coagulated milky juice of various trees and shrubs, belonging chiefly to the natural orders *Euphorbiaceæ*, *Moraceæ*, *Artocarpaceæ*, and *Apocynaceæ*. Although a milky juice is found in plants of many other families, it does not in all cases yield caoutchouc, nor do different species of the same genus yield an equal quantity or quality of that substance. On the other hand, there are many plants which afford a good rubber, but have not yet been sought out for the commercial purposes. The milky juice of plants furnishing caoutchouc is contained chiefly in the middle layer of the bark, in a network of minute tubes known to botanists as laticiferous vessels. In the *Apocynaceæ* these vessels are found also in the inner bark, or bast layer. The milky juice above mentioned possesses the properties of a vegetable emulsion, the caoutchouc being suspended in it in the form of minute transparent globules, averaging, according, to Adriani, $\frac{1}{12250}$ inches in diameter. Like other emulsions, it is easily coagulated by the addition of an acid or saline solution,—alum, or salt water being commonly used for this purpose ; but it is said by Mr. Bruce Warren not to be coagulated by alcohol. The caoutchouc appears to be kept in suspension in the juice by means of ammonia ; at least in some cases the fresh milk exhales an ammoniacal odour. Probably it is on this account that the addition of liquid ammonia prevents the juice from coagulating for a considerable length of time ; and the ammonia is in certain districts added when the milk has to be carried some distance from the place of collection. The addition of salt water to the juice is to be deprecated, as it renders the caoutchouc very hygroscopic. The best rubber known is obtained by careful evaporation of the recently strained juice at a moderate heat.

Trees are known to contain caoutchouc by the bark on incision yielding a milk that when rubbed between the fingers coagulates into an elastic fibre. The dried bark of such plants when broken shows between the two fractured surfaces of the bark a number of silky fibres which can be stretched for some distance without breaking.

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

The first notice of india-rubber on record was given nearly five hundred years ago by Herrera, who, in the second voyage of Columbus, observed that the inhabitants of Hayti played a game with balls made "of the gum of a tree, and that the balls, although large, were lighter and bounced better than the wind balls of Castile (Herrera, *Historia*, dec. i. lib. iii. cap. iv.). Torquemada, however, seems to have been the first to mention by name the tree yielding it. In his *De la Monarquia Indiana*, published at Madrid in 1615, tom ii., cap. xliii. p. 663, he says: "There is a tree which the [Mexican] Indians call Ulequahuitl; it is held in great estimation and grows in the hot country. It is not a very high tree; the leaves are round and of an ashy colour. This tree yields a white milky substance, thick and gummy, and in great abundance." He further states that the juice was collected and allowed to settle in calabashes, and was afterwards softened in hot water, or the juice smeared over the body and rubbed off when sufficiently dry. The tree mentioned by Torquemada has usually been identified as *Castiltoa elastica*, Cerv., but the above account cannot apply to it, as that tree is described by Cervantes as one of the loftiest forest trees of the north-east coast of Mexico, and its leaves are not round but oblong-lanceolate. Torquemada mentions also that an oil was extracted from the "ulli," or rubber, by heat, possessing soft and lubricous properties, and of especial effect in removing tightness of the chest. It was also drunk with cocoa to stop hæmorrhage. Even at that early date the Spaniards used the juice of the ule tree to waterproof their cloaks. This fact, however, apparently did not attract attention in the Old World, and no rubber seems to have reached Europe until long afterwards. The first accurate information concerning any of the caoutchouc trees was furnished by La Condamine, who was sent in 1735, by the French Government to measure an arc of the meridian near Quito.

In 1751 the researches of M. Fresnau, an engineer residing in Guiana, were published by the French Academy, and in 1755 M. Aublet described the species yielding caoutchouc in French Guiana. Nevertheless india-rubber remained for some time unknown in England except as a curiosity, for Dr. Priestly, in the preface to his work on perspective, called public attention to it, as a novelty for erasing pencil marks, and states that it was sold in cubical pieces of $\frac{1}{2}$ inch for 3s. each. Indiarubber was not known as a product of Asia until 1798, when a plant, afterwards named *Urceola elastica*, Roxb., was discovered to yield it by Mr. J. Howison, a surgeon of Prince of Wales Islands, and soon afterwards Assam Rubber was traced by Dr. Roxburgh to *Ficus elastica*, Roxb. It was not, however, until the beginning of the 18th century that the indiarubber industry really commenced. The rapid progress which this has made during the last twenty years may be perceived by a glance at the following table:—

Imported into England in the year	1830,	464	cwts.
,, ,, ,,	1840,	6,640	,,
,, ,, ,,	1850,	7,616	,,
,, ,, ,,	1870,	152,118	,,
,, ,, ,,	1879,	150,601	,,

It has been computed that in 1870 there were in Europe and America more than 150 manufactories each employing from 400 to 500 operatives, and consuming more than 10,000,000 lb. of caoutchouc. The imports into the United States have largely increased during the last few years.

Botanical Sources, Modes of Preparation, &c.

Notwithstanding the fact that caoutchouc yielding trees are found in a large belt of countries around the globe, including at least 500 miles on each side of the equator, yet the demand for the best qualities of india-rubber is in excess of the supply. The varieties which are almost exclusively used when great elasticity and durability are required are the Pará, Ceara, and Madagascar rubbers.

The Principal forms of caoutchouc which are imported into great Britain may be grouped under four heads, the order in which they are here placed indicating their respective values:—*South American* Pará, Ceara, Pernambuco, Maranhão, Cartagena, Guayaquil; *Central American*—West Indian, Guatemala; *African*—Madagascar, Mozambique, West African; *Asiatic*—Assam, Borneo, Rangoon, Singapore, Penang and Java. Of all these, the most important is the Pará, the imports of which, according to Messrs. Hecht, Levis, & Kahn, have increased, from 1,670 tons in 1857 to 8,000 tons in 1879. For this rubber and the Mosambique variety the demand increases every year,—an unerring indication of their value.

I. SOUTH AMERICAN.—*Pára rubber* is obtained chiefly from *Hevea brasiliensis*, Müll. Arg., a large euphorbiaceous tree upwards of 60 feet in height, branching from the base, and having trifoliate leaves, the leaflets being lanceolate and tapering at both ends (figs 1, 2). Other species of *Hevea*, as well as *Micrandra siphonoides* and *M. minor*, Benth., all of which grow abundantly in the most steamy valleys of Amazon and its tributaries, are also used indiscriminately by the natives to furnish Pará rubber. These trees are found in different districts, but all flourish best on rich alluvial clay slopes by the side of rivers, where there is a certain amount of drainage, and the temperature reaches from 89° to 94° at noon, and is never cooler than 73° at night, while rain is rarely absent for ten days together. The genus *Hevea* was formerly called *Siphonia*, and the tree named Pao de Xerringa by the Portuguese, from the use by the Omaqua Indians of squirts or syringes made from a piece of pipe inserted in a hollow flask-shaped ball of rubber.

The caoutchouc is collected in the so-called dry season between August and February. The trees are tapped in the evening, and the juice is collected on the following morning. To obtain the juice a deep horizontal incision is made near the base of the tree, and then from it a vertical one, extending up the trunk, with others at short distances in an oblique direction. Small shallow cups made from the clayey soil and dried in the sun are placed below the incisions to receive the milk, each cup being attached by sticking a piece of soft clay to the tree and pressing the cup against it. The juice, of which each tree yields only about 6 ounces in three days, has a strong ammoniacal odour, which rapidly goes off, and in consequence of the loss of ammonia it will not keep longer than a day unchanged, hence when it has to be carried to a distance from the place of collection 3 per cent of liquid ammonia is added. The juice is said by Bruce Warren to yield half its weight of caoutchouc, but 32 per cent appears to be the usual quantity. To obtain the rubber the juice is heated in the following manner:—A piece of wood about 3 feet long, with a flattened clay mould at one end of it, is dipped in the milk, or this is poured over it as evenly as possible. The milk is then carefully dried by turning the mould round and round in a white vapour obtained by heating certain oily palm nuts, those of *Attalea excelsa* being much preferred, and the vapour being confined within certain limits by narrowness of the neck of the pot in which the nuts are heated. Each layer of rubber is allowed to become firm before adding another; a practised hand can make 5 or 6 lb. in an hour. From whatever cause, the rubber thus prepared is the finest that can be obtained. The cakes when completed are, in order to remove them from the mould, slit open with a sharp knife, which is kept wet, and are hung up to dry. The flat rounded cakes of rubber made in this manner are known in the London market as "biscuits." They rarely contain more than 15 per cent of moisture. The scrapings from the tree, which contain fragments of wood, are mixed with the residues of the collecting pots and the refuse of the vessels employed and are made up into large rounded balls, which form the inferior commercial quality called "negrohead," and often contain 25 to 35 per cent of impurity. An intermediate quality is known as "entre-fine." Pará rubber is said to be sometimes adulterated with the juice of the Macandaruba tree (*Mimusops elata*), which might account for the great differences that have been occasionally observed in the behaviour of Pará rubber in certain stages of manufacture, the coagulated juice of the *Mimusops* genus resembling gutta percha rather than caoutchouc.

Previous to 1860 Pará rubber was exported only in small quantities, and then chiefly in the form of shoes; this variety ceased to be sent over in 1852. Occasionally "negrohead" has been imported in grotesque forms of animals, &c., and the better qualities in the shape of small bottles moulded in soft clay which has been afterwards washed out by water.

In British Guiana rubber is obtained from *Hevea paucifolia*, Müll. Arg.; in French Guiana from *H. Guayanensis* Aubl., where it is known as "heve," "siringa," or "cahoutchou,"—the last being the probable origin of the name caoutchouc; and in Venezuela, from *H. brasiliensis*, there called dápi or dápiche. None is exported to England from any of these localities. Small quantities of rubber intermediate in character between that of Pará and Pernambuco are occasionally imported from Maranhão. On account of its great value as a source of caoutchouc, the cultivation of the Pára rubber tree has been attempted in India; but it has been found to be too tropical a plant for cultivation in northern and central India, although suitable for Ceylon, Malabar, and South Burmah, according to recent reports. The seeds, which are about the size of a damson (fig 2. *d*), soon lose their vitality, and cuttings do not thrive unless taken from the young wood.

Ceara rubber is considered almost next to the Pará in value, as it is a "dry" rubber, very elastic and free from stickiness; but it often contains a quantity of wood and foreign matter arising from the mode of collecting it, the loss in washing previous to manufacture amounting sometimes to 25 per cent. It is the produce of *Manihot Glaziovii* Müll. Arg., a euphorbiaceous tree common in the province of Rio Janeiro, about 30 feet high, with a rounded head of foliage and greyish-green 3 to 7-lobed palmate leaves, somewhat resembling the leaves of the castor oil plant in shape and size (figs. 3, 4, 5). The trees are tapped, according to Mr. R. Cross, when the trunk attains a diameter of 4 to 5 inches, *i.e.*, when they are about two years old. The mode of collecting the rubber is as follows:—After brushing away the loose stones and dirt from the root of the tree by means of a handful of twigs. the collector lays down large leaves for the milk to drop upon. He then slices off the outer layer of the bark to the height of 4 or 5 feet. The milk, which exudes in many tortuous courses, some of it ultimately falling on the ground, is allowed to remain on the tree for several days, until it becomes dry and solid, when it is pulled off in strings, which are either rolled up into balls or put into bags in loose masses, in which form it enters commerce under the name of Ceara "scrap." The amount of Ceara rubber imported in 1879 amounted to 500 cwt. The attempts which have been recently made to cultivate this rubber plant in India have been attended with signal success. In Rio Janeiro it grows in a rocky or stony arid region, where a short underscrub is the only vegetation, and the atmosphere is hot and dry, the temperature ranging from 82° to 90° Fahr. It is, therefore, suited, for cultivation where the *Hevea* will not grow. In Ceylon it has been found to thrive at an altitude of from 200 feet to 3,000 feet above the sea-level. At Zanzibar and Calcutta also it succeeds well. The seeds (fig. 5, *c*), which have a hard thick coat, take a year in germinating, unless the edges near the end bearing the caruncular projection are rasped off. Cuttings, provided they have a single bud, strike readily.

Pernambuco or *Mangabeira rubber* is obtained from *Hancornia speciosa*, Gom., an apocynaceous tree common on the South American plateau in Brazil from Pernambuco to Rio Janeiro, at a height of 3,000 to 5,000 feet above the sea. It is about the size of an ordinary apple tree, with small leaves like the willow and a drooping habit like a weeping birch, and has an edible fruit called "mangaba," for which, rather than for the rubber, the tree is cultivated in some districts. Only a small quantity of this rubber comes to England, and it is not much valued, being a "wet" rubber. It occurs in "biscuits" or "sheets." The caoutchouc is collected in the following manner:—About eight oblique cuts are made all round the trunk, but only through the bark, and a tin cup is fastened at the bottom of each incision by means of a piece of soft clay. The cups when full are poured into a larger vessel, and solution of alum is added to coagulate the juice. In two or three minutes coagulation takes place, and the rubber is then exposed to the air on sticks, and allowed to drain for eight days. About thirty days afterwards it is sent to market. Pernambuco rubber, as is the case with most rubbers coagulated by saline solutions, contains a large quantity of water.

Cartagena rubber comes from New Granada in the form of black sheets $\frac{3}{4}$ inch thick having a somewhat rough or "chewed" appearance, and is more or less "tarry" or sticky. It also occurs in the form of strips or small pieces pressed together in bags. Its botanical sorrce is not known, but is thought to be a pinnate-leaved tree, a portion at least being derived, it is supposed, from *Castilloa elastica.* It loses 35 per cent of moisture when dried. The importation of Cartagena rubber into Great Britain has declined from 3,518 cwt. in 1875 to 1,679 cwt. in 1879.

Guayaquil rubber is imported from Ecuador in large flakes or lumps, of a whitish colour in the best kinds, the inferior sorts being porous and filled with a fœtid black liquid, having an odour of cow-dung, and staining the knife and hands. It is believed to be obtained from *Castilloa elastica.* The amount imported into Britain has diminished from 3,815 cwt. in 1875 to 482 cwt. in 1879. In washing for manufacture it sometimes loses up to 40 per cent of its weight. The bulk of the two last mentioned rubbers is exported to the United States.

II. Central American.—The source of all the principal rubbers exported from central America is *Castilloa elastica*, Cerv., a lofty artocarpaceous tree, with a trunk 3 feet or more in diameter, and large hairy oblong lanceolate leaves often 18 inches long and 7 inches wide, those subtending the young branches being much smaller and more ovate (fig. 6). The tree grows most abundantly in a sporadic manner in the dense moist forests of the basin of the Rio San Juan, where the rain falls for nine months in the year. It prefers rich fertile soil on the banks of watercourses, but does not flourish in swamps. It is found also in Costa Rica. Guatemala, Honduras, Mexico, Cuba and Hayti, and in Panama in company with another species, *C. Markhamiana*, Collins, and on the west coast of South America down to the slopes of Chimborazo, the Cordilleras of the Andes separating the *Castilloæ* from the *Heveae* of Brazil, according to Mr. R. Spruce.

Nicaragua rubber.—In Nicaragua the juice is collected in April, when the old leaves begin to fall and the new ones are appearing, during which time the milk is richest. The tree is tapped either in the same manner as the *Hevea*, or by encircling the tree with a simple spiral cut at an inclination of 45°, or by two spirals in opposite directions if the tree be large. At the bottom of the spiral an iron spout about 4 inches long is driven into the tree, and the milk is received in iron pails. A tree 20 to 30 feet high to its first branches, and about 4 feet in diameter, is expected to yield 20 gallons of milk, each gallon giving about 2 lb. of rubber. In the evening the milk is strained through a wire sieve and transferred to barrels. The milk is coagulated by the addition of the juice of the "acheté" plant (*Ipomœa bona-nox*, L) or of another plant called "coasso." The strained juice of either of these plants, obtained by bruising the moistened herb and subsequent expression, is added to the milk in the proportion of about 1 pint to the gallon. If these plants are not procurable, two parts of water are added to one of the milk, and the mixture allowed to stand for twelve hours. The coagulum is next flattened out by a wooden or iron roller to get rid of the cavities containing watery liquid, and the sheets are then hung up for fourteen days to dry, when they weigh about 2 lb., the sheets being usually $\frac{1}{2}$ to $\frac{1}{8}$th inch thick and 20 inches in diameter. When coagulated by water, the mass is placed in vats in the ground and allowed to dry, this taking place in about a fortnight. It is then rolled into balls. That which dries on the incisions in the tree is called bola or burucha, and is said to be highly prized in New York. The loss of Nicaragua rubber in drying is estimated at 15 per cent. It is exported chiefly from San Juan del Norte, or Grey Town, and the larger proportion goes to the United States. The *Castilloa* appears to be suitable for cultivation only in districts where the Pará rubber would grow equally well. The deciduous lateral shoots if planted will never grow erect.

West Indian rubber is the variety usually imported into England, but in comparatively small quantity only. It occurs in the form of blocks, the finest quality consisting of thin separable sheets, and the second of "scraps," usually conglomerated and containing fragments of bark. It is the best description of Central American rubber known. It is not, as its name seems to imply, produced in the West Indies, but derives its appellation from being brought over in West Indian steamers.

Honduras rubber rarely comes over to England: it is of good quality, and free from "tarry" matter.

Mexican rubber is imported into Liverpool in small quantity only. The imports of Mexican caoutchouc decreased from 1,292 cwt. in 1875 to 158 cwt. in 1879.

Guatemala rubber is a very inferior kind and very unequal in quality; the best varieties are whitish, and the "lower" are black with a "tarry" appearance. It occurs in the form of sheets compacted together, from between which when pressed a thick resinous fluid exudes. This when evaporated leaves a hard resinous substance unaffected by hot water or steam. The rubber is collected from the trees as in Nicaragua, but it is poured on mats to dry, and the thin sheets are subsequently peeled off, folded into squares, and subjected to pressure to remove as much as possible of the contained moisture. The imports of india-rubber into England from the whole of Central America amounted only to 2,080 cwt. in 1879, having decreased from 5,809 cwt. in 1875. The greater proportion of Central American rubber is exported to New York, especially that from Nicaragua and Panama.

Siphocampylus Caoutchouc, Don., and *S. Jamesonianus*, D. C., Central American plants belonging to the natural order *Lobeliaceae*, are also stated to yield rubber of good quality; and at the Philadelphia exhibition a rubber called Durango caoutchouc, obtained from a composite plant, was exhibited.

III. AFRICAN.—India-rubber is produced throughout equatorial Africa, the chief districts of export being the Gaboon, Congo, and Benguela on the west coast, and Madagascar, Mozambique, and Mauritius on the east. The Madagascar, Mauritius, and Gaboon rubbers are, it is believed, chifly exported to France. Those which enter into British commerce are known as Mozambique, Madagascar, and African, although the imports are described as coming from the following districts in the blue books:—Senegambia and Sierra Leone 3,8C8 cwt., West Coast 11,307 cwt., East Africa 7,621 cwt., Cape of Good Hope 4,241 cwt., Mauritius 570 cwt., Gold Coast 12 cwt. The above imports, which are for 1879, shew an increase during the past five years, except in the case of Mauritius, Madagascar, and the Gold Coast. Africa in respect of the large amount exported, may now be considered as taking the second place as an india-rubber producing continent.

Mozambique rubber, which is one of the most important varieties, occurs in the form of balls about the size of an orange, and "sausages," or spindle shaped pieces made up of slender strings of rubber wound around a piece of wood, which is eventually removed; or sometimes it occurs in smooth pieces of irregular size known as "cake" or "liver." *Madagascar rubber* consists of two qualities, the best of a pink and the inferior or "lower" of a black colour, and occurs in shapeless pieces.

The other kinds included under the general name of African are amorphous lumps called "knuckles" from Congo; small "negroheads" or "balls" of scrap, and smooth cakes from Sierra Leone; small square pieces like dice called "thimbles" and others more irregular in shape called "nuts," and "small negroheads" from the Portuguese colonies; "tongues," consisting of flat pieces, usually wet and sticky, from the Gaboon; and "balls" from Liberia. African rubber, as a rule, possesses, more adhesiveness and less elasticity than Pára rubber, and is inferior in value. Comparatively little is known of the plants yielding caoutchouc in Africa or of the mode of collection. In Angola, according to Dr. Welwitsch, the natives either cut off a piece of bark, and allow the milky juice to run into a hole in the ground, or placing the hand against the trunk of the tree permit the milk to trickle down their arms, going from tree to tree, until the arm is covered, when the rubber is rolled back towards the hand in the form of a ring. The wood of some of the trees, according to Mr. Collins, contains a gum which, if the incision penetrates below the bark, mixes with the rubber and deteriorates it. In Madagascar, according to M. Coignet, rubber is obtained from the "Voà-héré" or "Voà-canja," *Vahea madagascariensis*, Boj., the Voà-hine, *V. comorensis*, Boj., and from *V. gummifera*, Lam. In Senegambia it is obtained from the "Anjouan" *Vahea senegalensis*, A.D.C. In Mauritius *Willughbeia edulis*, Roxb. (which is found also in Madagascar, and in Chittagong and Silhet in India), appears to be the chief source of rubber. All the above are climbing shrubs with opposite entire leaves and fleshy fruits.

In Central Africa, from Liberia on the one side to Zanzibar on the other, caoutchouc is collected from plants of genera nearly allied to *Vahea*, a few only of the species being known to botanists. In Angola, under the name of "Licongue," in Golungo Alto and Cazengo, it is collected from *Landolphi owariensis*, Pal. de Beauv.; from *L. florida*, Benth., in Angola and Liberia, and from *L. Hendelotii*, D.C., in Senegal. At Kew there also exists specimen of indiarubber from the west coast of Africa obtained from an undescribed species of *Carpodinus* with hairy leaves and stem. In the basin of the Gaboon and Congo it is obtained, according to Du Chaillu from a climbing plant called *N'dambo*, which gives its name to dambonite, a peculiar substance contained in this kind of rubber (see p. 11). That some African caoutchouc is yielded by species of *Ficus* there can be no doubt. In Sierra Leone it is collected from *Ficus Brasii*, R. Br. In Liberia, according to Mr. Thomas Christy, the finest rubber is obtained from *Urostigma Vogelii*, Miq., a tall tree with large handsome leaves, and lower qualities of rubber from other species, and from *Landolphia florida*, Benth. In Angola on the west, and at Inhambane on the east coast, rubber is also obtained from species of *Ficus*. In the Island of Rêunion caoutchouc is said to be obtained from *Periploca graeca* L.

IV. Asiatic.—The rubbers which enter English commerce from Asia include the Assam, Borneo, Rangoon, Singapore, Penang, and Java kinds.

Assam rubber is imported chiefly from Calcutta in baskets made of split rattans, weighing about 3 cwt each, and covered with a gunny bag. The rubber is glossy, of a bright pink colour and mottled appearance, and occurs in the form either of small balls pressed together or of irregular masses called "slabs" or "loaf" rubber. The former, being more liable to adulteration, are less in demand by manufacturers. The imports into Liverpool in 1879 were 7,000 cwt. Assam rubber is obtained from *Ficus elastica*, Roxb., a plant too well known as a window ornament to need description. A portion also is collected from *Urostigma laccifera*, Miq. *Ficus elastica* grows in the tropical rocky valleys of the Himalayas, between 70° and 80° E. long., where there is always a hot moist atmosphere, the temperature rising to 98° F. in the shade. The trees are tapped in the most careless manner. In the lower portion of the tree and in the large aerial roots, diagonal cuts penetrating to the wood are made, from 6 to 18 inches long, and in an elliptical form so as to be about 3 inches across the centre. The milk is received either in holes made in the ground or in leaves folded in the form of a funnel, that from the smaller cuts on the branches (for the collectors scarify every portion within reach) being allowed to dry on the tree. About 50 oz. of the milk collected in August gives 15 oz. of caoutchouc, but the percentage sometimes falls as low as 10 per cent. From February to April the milk is more scanty, but richer in caoutchouc, and is consequently best collected at that time. The milk is coagulated by pouring it into boiling water and stirring it until it is sufficiently firm to be carried about without being clammy; sometimes it is pressed, again boiled and dried in the sun. In this way the "loaf" rubber in irregular masses is formed. The small "balls" are formed of the strings of rubber which have been allowed to dry on the tree.

Assam rubber, although fairly elastic, is much depreciated in value by the careless mode of collection, and often loses, by washing at the manufactory, as much as 35 per cent of dirt, consisting of clay, sand, or bark. The exportation of caoutchouc from British India, exclusive of the Straits Settlements and Ceylon, in 1879 amounted to 9,973 cwt., of which 7,000 are estimated to have been produced in Assam. About three-fourths of the rubber exported from India goes to Great Britain, and the remainder to the United States.

In consequence of the reckless destruction of the trees, the cultivation of *Ficus elastica* has been commenced in Assam. It is calculated that the trees can be tapped at the age of twenty-five years, and that after fifty years they will yield 40 lb. of caoutchouc each (worth £3 4s.) every three years, it being injurious to their health to tap them more frequently.

Palay rubber is the product of *Cryptostegia grandiflora*, R. Br., an asclepiadaceous plant common on the coast of India; and from *Willughbeia edulis*, Roxb., and *W. martabanica*, D.C., a rubber is obtained in Chittagong; neither of these, however, is known in Britain as a commercial variety.

Borneo rubber comes to the Liverpool market in the form of balls or shapeless masses, internally of a white or pinkish colour, and very porous and spongy, the pores being usually filled with salt water, in consequence of which it often loses 20 to 50 per cent of its weight in drying. The imports into Great Britain amounted in 1879 to 5,000 cwt. Although Borneo rubber was first made known in 1798, it was not imported into England as an article of trade till 1864, when it appeared under the name of gutta susu, *i. e.*, in Malayan, milk-gum. The plant which yields Borneo rubber was indentified by Roxburgh as *Urceola elastica*, Roxb., an apocynaceous climbing plant with a trunk as thick as a man's body, and having a soft thick bark. Mr. F. W. Burbidge, who recently visited the island, states that there are three varieties of the rubber plant, known to the natives as "petabo," which yields the finest caoutchouc; "menoongan," which yields the largest quantity; and "serapit," from which the commonest rubber is obtained. The petabo variety, according to specimens at Kew, is referred to a species of *Leuconotis*. The rubber is obtained by cutting the plant into pieces varying from a few inches to 2 or 3 feet long, and allowing the juice to drain into buckets or jars, heat being sometimes applied to one end of the pieces when the juice flows slowly. The milk is coagulated by salt water. The Borneo rubber plant is probably one of the plants that would repay cultivation, as it grows rapidly, yields a supply of sap in three years, and after planting requires no attention.

In Sumatra, caoutchouc is obtained from *Willughbeia firma*, and is exported to Holland, but this variety is not known in England. Malacca rubber, which is not met with in English commerce, is said to be obtained from *Urceola elastica*, Roxb.

Rangoon rubber, and those of Penang and Java, are imported into England in small quantities only, and are irregular in appearance. From its physical characters, a portion at least of Rangoon rubber is believed to be the produce of a species of *Ficus*, probably *F. hispida*, L. Another caoutchouc-yielding plant, *Urceola (Chavannesia) esculenta*, Benth. belonging to the *Apocynaceae*, has, however, been recently discovered in Burmah, some specimens of which at the age of five years have stems 6 inches in diameter, while the crown covers an area of 200 square feet. It has been recommended for plantations as an available source of rubber, the cost of cultivation being very slight after the first year, and the profit commencing in seven years, at which age the yield is calculated to be 3½ lb.

Penang rubber in character resembles the Assam, and may be also supposed to be obtained from a species of *Ficus*. Dr. Wallich, however, has stated that its source is an asclepiadaceous plant, *Cynanchum ovalifolium*, Wright.

Java rubber is stated by Dr. De Vrij to be obtained from *Ficus elastica.* Like the Assam rubber it is dark and glossy, but it is of a deeper tint, and has occasional reddish streaks. It is said to be prepared by allowing the juice to dry on the incisions made in the tree. Singapore, Java, and Penang rubbers are much alike in character, and may be classed with the Assam rubber, having a firm texture, mottled appearance, and bright polished surface, but varying in colour in a single sample from light yellowish-white to dark brown. Java rubber is also exported to France.

Caoutchouc is obtained in the Malay Archipelago from *Alstonia costulata*, Miq.; and *Alstonia scholaris*, R. Br., is likewise reported to yield it. In Fiji it has been obtained from *Alstonia plumosa*, Labill. In North Australia caoutchouc has been prepared from *Ficus macrophylla*, Desf., and *F. rubiginosa*, Desf. ; the last-named plant has been recommended by Baron Müller as suitable for cultivation, being a hardy species. None of the above rubbers are asye t known in British commerce as regular articles of trade.

Bibliography.—Collins, in *Journal of Botany*, 1868 ; *Journ. Soc. Arts*, vol. xviii. p 86 ; Bevan, *British Manufacturing Industries*, 1877, p. 97-105, and *Report on Caoutchouc*, 1872 ; Markham, in *Journ. Soc., Arts*, p. 475, 1876 ; *L'Ingenieur Universal*, vol. ii. p. 187 ; Bernardin, *Classification de* 100 *Caoutchoucs et Guttaperchas*, Ghent, 1872 ; Christy, *New Commercial Plants ;* Kurz, *Forest Flora of British Burmah*, vol. ii. p. 184. (E. M. H.)

GUTTA PERCHA (GUTTA TABAN, &c.).

(From the *Encyclopædia Britannica*, vol. xi.)

This name* is applied to the concreted or inspissated juice of various plants belonging to the natural order *Sapotaceæ*, growing in the Malay Peninsula. To what particular tree the name "gutta percha" properly belongs, there is no evidence to show ; but it has been generally given to *Dichopsis Gutta* (Bentley and Trimen) or *Isonandra Gutta* (Hooker), the vernacular name of which is "taban."†

The *Dichopsis Gutta* attains a height of 60 to 80 feet, with a diameter of 2 to 4 feet. The leaves are obovate-oblong and entire, pale green on the upper side, and covered beneath with short reddish-brown shining down. The flowers are arranged in clusters of 3 or 4 in the axils of the leaves. The fruit, about an inch long, is of an ovoid shape, and is eaten by the Malays. In Siák (Sumatra) a vegetable butter is prepared from the seeds. The wood is soft, fibrous, spongy, of a pale colour, and marked with black lines, these being reservoirs of gutta percha.‡ The gutta, as it flows from the tree, is of a greyish hue, occasionally with a somewhat roseate tinge, probably arising from the colour vessels of the bark becoming ruptured through surcharge, and their contents mixing with the gutta. This species does not furnish all the gutta percha of commerce ; indeed there are other trees which yield larger quantities. In all there are about thirty varieties known ; but some of the vernacular names in different districts may prove mere synonyms.

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* Gutta, or as it is variously written gutah, gatta, gittah, gattah, is the Malayan term for gum, and Percha (pronounced as in perch, *not* hard as perka) accentuated variously as pârcha, pertja, perchá, is the name of the trees; hence the term may be translated "gum of the percha tree." The old name of Sumatra was Pulo or Pulau Percha, *i.e.*, "island (Pulau) of the percha tree."

† Taban, túban, taban, is the name of the tree, and, according to Logan a new word has been added to the Malay language, viz., Menaban (Men[t]aban), *i.e.*, to collect gutta taban. The greater number of Malay nouns admit of conversion into verbs by a prefix.

‡ For figures and botanical descriptions see *Lond. Journ. Bot.*, 1848; De Virese, *De Handel in Getah-Percha*; and Bentley and Trimen's *Medicinal Plants*, part 35, p. 16 (1873).

The geographical distribution of the trees producing gutta percha is very restricted. Gutzlaff defines the limits as 6° N. and S. lat. and 100° to 120° E. long.; whilst Captain Lingard (who has great personal experience on the subject) gives the limits as 4° N. and 3° S. lat., still further restricting the finer varieties to 3° 50′ N. and 1° S., with a temperature ranging between 66° and 90° Fahr., and a very moist atmosphere. These limits are well within the isotherm of 80° Fahr. Many of the best varieties are found only on the hill slopes at a distance from the sea-coast, each variety forming a separate grove of from 200 to 500 trees, with high forest trees above them. They grow best in a rich light loam, with a rocky subsoil.
The collection of gutta percha generally takes place directly after the rainy season, as in the dry season the gutta does not flow so readily, while during the rains ague and jungle fever are most prevalent; and the gutta is liable to be washed away from the felled trees. The yield of a well-grown tree of the best variety is from 2 to 3 lb. of gutta percha, such a tree being about thirty years old, 30 to 40 feet high, and 1½ to 3 feet in circumference. A full-grown tree sometimes measures 100 to 140 feet to its first branches, with a girth of 20 feet at a distance of 14 feet from the base, and may yield 50 to 60 lb. of gutta percha, which loses in six months about 35 per cent of its weight in drying.

The methods of extracting the gutta percha are much the same amongst the Malays, Chinese and Dyaks. The trees are cut down just above the buttresses, or *banees*, as they are called; and for this purpose a staging about 14 to 16 feet high is erected. The tools used in felling are either "billiongs" or "parangs." A billiong is a kind of axe used by the Malays in felling, building, &c. The blade is of a chisel-like form, and the tang is secured at right angles to a handle by means of a lashing of "rattan" or cane. The Chinese sometimes use an axe perfectly wedge-shaped. The parang looks more like a sword-bayonet, and in the hands of a Malay is a box of tools in itself, as with it he can cut up his food, fell a tree, build a house, or defend himself.

When the tree is felled the branches are speedily lopped off to prevent the ascent of the gutta to the leaves. Narrow strips of bark, about an inch broad and 6 inches apart, are then removed, but not all round the tree, as its underpart in its fall becomes buried in the soft earth, much sap being thus lost. Some natives beat the bark with mallets to accelerate the flow of milk or gutta. The milk flows slowly (changing colour the while) and rapidly concretes, and, according to its source, may vary from yellowish white to reddish or even brownish in hue. The gutta as it flows is received into hollow bamboos, doubled up leaves, spathes of palms, pieces of bark, coconut shells, or in holes scraped in the ground. If the quantity obtained is small, it is prepared on the spot by rubbing it together in the hands into a block, in one end of which a hole is made to carry it by. In this state it is known in the market as "raw gutta" or "gutta muntah." If water gets mixed with the juice, the gutta becomes stringy and is considered deteriorated, but after boiling appears quite as good. Sometimes the gutta is kept in a raw state for a month or two, and then undergoes the next step in the preparation, that is, boiling. The boiling is generally conducted in a "kwali" or pan of cast or hammered iron, of about 15 inches in diameter and 6 inches deep. The boiling is either simply with water, or with the addition of lime juice or coconut oil. If one pint of lime juice be added to three gallons of gutta juice, the latter coagulates immediately on ebullition.

On arriving at the port of shipment the gutta, before exportation, generally undergoes examination and classification into parcels, according to quality. As received in the "godowns" or warehouses it presents great diversities in condition, shape, size, and colour,—from crumbling, hardly coherent, whitish or greyish "raw" or "getah muntah" fragments, to reddish or brownish blocks as hard as wood. Sometimes it is made up into all manner of grotesque shapes of animals, and it is nearly always largely adulterated with sago-flour, sawdust, clay, stones, &c. The Chinese are great adepts in assorting and classifying gutta, and frequently prepare from different varieties a certain "standard sample" by cutting or chopping the material into thin slices and boiling with water in large shallow iron pans, keeping the contents constantly stirred with poles, and adding good gutta percha and even coconut oil to give a better appearance. When sufficiently boiled the gutta is pressed into large moulds, and is then ready for shipment. This process of reboiling is wholly unnecessary, and in some cases is done only to get rid of stuff which has no right to be called "gutta percha."

The amount and value of gutta percha imported into Great Britain in 1875-77 were as follows:—

	1875.	1876.	1877.
Cwt. ...	... 19,686	21,558	26,359
Value ...	...£149,684	£163,441	£238,327

The price of gutta percha ranges from 4d. to 3s. per lb., according to quality and demand.

History.—The early history of the use of gutta percha is somewhat obscure; the Malays and Chinese are said to have long known and used it. One of the earliest notices of it in England occurs in a catalogue of the collection of the famous Tradescants.* Dr. Montgomerie, a surgeon in the East India Company's service, was the first to direct attention to gutta percha as likely to prove of great utility in the arts and manufactures. Having observed the substance in Singapore in 1822 in the form of whips, he commenced experimenting with it. In 1842, being again stationed at Singapore, he followed up the subject, and his recommendation of it to the medical board of Calcutta as useful for making of splints and other surgical apparatus met with high approval. He also sent specimens, with relative information, to the Society of Arts of London, which society warmly took up the subject, and on Montgomerie's return to England in 1844 presented him with its gold medal: Some have claimed the honour of introducing gutta percha to the notice of the commercial world, for Dr. (afterwards Sir) Jose D'Almeida, who sent a specimen merely as a curiosity to the Royal Asiatic Society in 1843, but careful investigation clearly decides the question of priority in favour of Montgomerie. The Society of Arts having requested him to lay before them the result of his experiments, he delivered a lecture in the autumn of 1844, and many patents were at once taken out, the chief being those of Mr. C. Hancock, Mr. Nickels, Mr. Keene, Messrs. Barlow and Forster, Mr. E. W. Siemens, and others. After this the substance soon came into general use.†

Properties.—Gutta percha, like many other milky juices, occurs in the laticiferous tissue of the plant, which exists in greatest abundance in the middle layer of the bark. See BOTANY, vol. iv. p. 87.

Gutta percha is resolvable into two resins, *albin* and *fluavil.* Like caoutchouc or indiarubber, it is a hydrocarbon; Soubeiran gives its composition as—carbon 87·80 and hydrogen 12·20. In commercial gutta percha we have this hydrocarbon or pure gutta, *plus* a soft resin, a resultant of oxidation of the hydrocarbon. M. Payen gives the following analysis of commercial gutta percha:—

Pure gutta (milk-white in colour and fusible), 75 to 82 per cent.

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* In the *Museum Tradescantianum; or, a Collection of Rarities preserved at South Lambeth, near London, by John Tradescant,* . . . London, MDCLVI., the following entry occurs (p. 44):—"VIII. Variety of Rarities.—The pliable mazer wood, being warmed, will work to any form." This museum became the nucleus of the Ashmolean Museum at Oxford. The word "mazer," variously spelt, often occurs in early English poetry, and is specially mentioned in old catalogues and wills. It is by no means impossible that mazer cups may have been made of gutta percha, as its lightness, strength, and non-liability to fracture would recommend it; and curiously enough one of the vernacular names of the tree yielding gutta percha is "mazer wood tree."

† See Collins on "Gutta Percha" in *British Manufacturing Industries* (Stanford & Co.,) and the very interesting volume of *Specifications* of *Patents in Caoutchouc, Gutta Percha,* &c., issued by the Patent Office.

Resins soluble in boiling alcohol :—

1. Crystalbin or albin ($C_{20}H_{32}O_2$), white, and crystallizing out of the alcohol as it cools, 6 to 14 per cent.

2. Fluavil ($C_{20}H_{32}O$), yellow, falling as an amorphous powder on the cooling of the alcohol, 6 to 14 per cent.

It is thus apparent that the change of pure gutta into a resin-like mass takes place naturally if means be not taken to stop it. Many a good parcel has been thus lost to commerce, and the only remedy seems to be thorough boiling as soon after collecting as possible. It must be remembered too, that in cutting through the bark to arrive at the laticiferous vessels, many other vessels and cells become ruptured, containing tannic and gallic acids, &c., and the presence of these no doubt accelerates oxidation. In opening bottles of the milky juice a turbidity and effervescence are often noticed, owing to the formation of a brownish liquid, the colour being probably due to the presence of gallic acid. In improperly prepared blocks of gutta also, these foreign substances induce the presence of a brown fermented and putrid liquid which decomposes the internal mass. Many of these substances, being soluble in water, are removable by the process of boiling.

Gutta percha as met with in commerce is of a reddish or yellowish hue, but when quite pure is of a greyish-white colour. In this state it is nearly as hard as wood, only just receiving the impression of the nail, is of a porous structure, and when viewed under the microscope has the appearance of a series of variously hued prisms. When moulded, rolled into sheets, or drawn into ropes, it assumes a fibrous character in the direction of its greatest length, in which direction consequently it can be stretched without rupture. If, however, a strip of a sheet be cut off across the fibre, it will be found that a redistribution of the tenacity of the slip takes place; *i.e.*, the direction of the fibrous character is developed in an opposite direction. The electrical properties of gutta percha were first noticed by Faraday. If a piece be subjected to friction, an electric spark can be obtained. On its relative electric conductivity, see vol. viii p. 53.

At a temperature of 32° to 77° Fahr., gutta percha has as much tenacity as thick leather, though inelastic and less flexible. In water at 110° Fahr. it becomes less hard; towards 120° Fahr. it becomes doughy, though still tough; and at from 145° to 150° it grows soft and pliable, allowing readily of being rolled and moulded. In this state it has all the elasticity of caoutchouc, but this it loses as it cools, gradually becoming hard and rigid again, and retaining any form impressed on it whilst in its plastic condition. It is highly inflammable, and burns with a bright flame, dropping a black residue like sealing wax. The specific gravity of gutta percha has been variously stated at from 0·96285 to 0·99923. It is insoluble in water, alcohol, dilute acids, and alkalies, but dissolves in warm oil of turpentine, bisulphide of carbon, coal tar oil, caoutchin or oil of caoutchin, and its own oil—for it yields by destructive distillation an oil similar to that yielded by caoutchouc under the same treatment. Ether and some of the essential oils render it pasty, and it is softened by hot water, absorbing a small quantity of the water, which is slowly parted within cooling.

Manufacture and Application.—Gutta percha, as received in England, is in irregular clumps or blocks, and is frequently adulterated with massive stones, sawdust, bark, sago flour, and other foreign matters; and the first step in its manufacture is to cleanse it thoroughly. The blocks are first sliced by means of a powerful circular wheel driven by machinery, and having fixed in it two or three strong chisel-like knives, by which it is divided into thin slices. These are placed in wooden troughs filled with water and heated by steam. As soon as the gutta percha becomes soft it is taken out in baskets and placed in a toothed iron cylinder, called a "devilling" machine, which tears it into fragments; these fall into a trough of water, and the impurities sink to the bottom, leaving the purified gutta floating in the form of a spongy mass. This mass is then taken out by means of perforated shovels, thoroughly washed in cold water, and dried in baskets. It is then packed in jacketed iron chests heated by steam, and left till it becomes soft, when it is at once removed, and kneaded or masticated by means of a cast-iron cylinder, with a movable lid and an internal revolving toothed iron axis—the result being a homogenous dough-like reddish brown mass. Sometimes various substances are introduced into this machine, which is called a "masticator," to increase the hardness or density of the gutta, or to colour it—such as orange or red lead, chrome, vermilion, yellow ochre, sulphur, caoutchouc, gypsum, or resin, care being taken to use such substances only as are not affected by the heat necessary in the operation. The incorporation is conducted with great nicety, as at the will of the operator, a soft and elastic or a hard and horny substance can be produced. When sufficiently masticated, the gutta is placed whilst still hot between two steel cylinders, and thoroughly rolled. By means of an endless band of felt the gutta is returned again to the cylinders, the distance between which is gradually diminished so as to compress and completely drive out any contained air from the gutta percha. There are various machines for cutting, driving bands, &c., to a uniform width, and for rounding off the edges and finishing. Soles for boots are made by cutting a long strip of the requisite width, and then passing the strip under a hollow die.

In making piping a machine is used consisting of a cylinder, with a die-piece attached of the requisite size. By means of a piston the gutta percha, which is introduced into the cylinder in a plastic condition, is driven through the die-piece, and the piston gives the inner diameter of the piping. As the piping issues from the machine, it passes immediately into a trough of water, which "sets" it and prevents it from collapsing. The value of gutta percha piping is very great: it does not contaminate water as lead piping does; it withstands insects, damp, &c., and is easily manipulated, being shortened, lengthened, or repaired without trouble or expense; and its acoustic properties have led to its employment largely in the manufacture of aural, stethoscopical, and other instruments. Gutta percha speaking-tubes are now to be seen in nearly every office. The substance too, from the fact that few acids and alkalies affect it, especially if dilute, is largely employed for funnels, siphons, and other chemical apparatus.

In telegraphy gutta percha is of the very highest importance, being a cheap, lasting, and powerful insulator, easily applied to telegraphic wires. The general method of coating telegraphic wire is by charging a cylinder with plastic gutta percha, and forcing it through a die-piece, the wire forming a central core. As the wire is drawn through this "die" or "moulding" piece, it becomes coated to the requisite thickness, and, after passing through water, it is wound on drums ready to be coated with tarred rope, and with galvanized iron wire if required for submarine cables.

The readiness with which gutta percha, whilst in its plastic condition, receives an impression, which it retains when cold, early led to its employment in the decorative and fine arts, since it reproduces the finest lines, as in the taking of moulds from electrotypes. See ELECTROMETALLURGY.

In the production of imitations of oak and other ornamental woods, gutta percha has been largely used, since by the admixture of various substances "graining" or "marbling" can be very naturally represented, and a coating of a solution of gutta percha gives a varnish of great brilliancy.

Substitutes.—Many substances have been recommended as substitutes for, or as supplementary to, gutta percha. Among these Balata gum undoubtedly holds the first place. It is obtained from the *Mimusops Balata* (Gartner), a tree found in British and French Guiana, Jamaica, &c. Prof. Bleekrod seems to have been the first to direct attention to this substance, by bringing it before the notice of the Society of Arts in 1857. The Balata gum combines in some degree the elasticity of caoutchouc with the ductility of gutta percha, freely softening and becoming plastic, and being easily moulded like gutta percha. What small parcels have been sent to England have met with a ready sale, and were remarkably pure and free from adulteration, But unfortnnately, through the difficulty of collection, the occupation being dangerous and unhealthy, the supply of this excellent article has fallen off. It is procured by making incisions in the bark of the tree about 7 feet from the ground, a ring of clay being placed around to catch the milk as it exudes. A large tree is said to yield as much as 45 lb. of "dry gum." *Pauchontee*, the produce of *Dichopsis elliptica*, Collins (*Bassia elliptica*, Dalzell), is a most interesting substance, and may yet prove an article of commerce if properly treated; at present, although by heat it becomes plastic and ductile, it is brittle and resin-like when cold. The tree is found very generally distributed in Wynaad, Coorg, Travancore, &c.

Many of the euphorbias yield milky juices which have some at least of the properties of gutta percha. The chief among these are the cattimandoo (*Euphorbia Cattimandoo*. Elliot) and the Indian spurge tree (*E. Tirucallis*, Linn.) of India, and some euphorbias at the Cape of Good Hope. The alstonia or pala gum (*Alstonia scholaris*, R. Br.) and the mudar gum (*Calatrops-gigantea*, R. Br.), have also been recommended as substitutes for gutta percha. But the attempts made to utilize these substances have as yet been unsuccessful.

Future Supplies.—A very important matter for consideration is the question of the future supplies of gutta percha. It is after all only a spontaneous natural product. If a Malay or Chinese wishes to plant pepper, gambier, &c., he burns down a portion of the forest, and, when he has raised two or three crops, he clears a new portion, and thus finely-wooded spots become denuded of trees, and covered with rank grass rendering them unfit for further cultivation. Again, to obtain the gutta percha the trees are cut down and none are planted in their stead, so that in districts where they were in abundance one or two only are now preserved as curiosities. It is a wonder indeed that a single tree is left. A writer in the *Sarawak Gazette* says, that from 1854 to 1875 over 90,000 piculs (of 133⅓ lb. each) of gutta percha was exported from Sarawak alone, and this meant the death of at least 3,000,000 trees. In fact the only thing that preserves the tree at all is that it is of no use to cut one down till it is 25 to 30 years old. Sooner or later recourse must be had to cultivation and conservation. (J. Co.)

RESINOUS AND GUMMY SUBSTANCES.

(From Spon's Encyclopædia &c., Part V.)

GUTTAPERCHA.—This name, as naturalized in European commerce, embraces the inspissated juices of several species of sapotaceous trees growing wild in peninsular and insular Malaysia. Their range has been defined as lying between 6° N. and S. of the equator, and between 100° and 120° E. long.; this has been more recently curtailed to 4° N. and 3° S. lat., the finer varieties being confined between 3° 50′ N. and 1° S. lat., where the air is very humid, and the temperature ranges about 19°-32° (66°-90° F.).

The Malay word *gutta* (variously spelt) signifies "gum" simply, while *percha* is the name of the tree. The *guttas* distinguished by the Malays are as follows:—(1) *Gutta-susu*, obtained from a scientifically unknown tree, now extinct except in the interior of Perak; the product is the most esteemed of any, on account of the firmness of texture. Must not be confounded with the Bornean article of the same name, which is a kind of indiarubber. (2) *Gutta-taban*, the "guttapercha" of commerce, which will receive further attention presently. (3) *Gutta-rambong* and (4) *Gutta singgarip*, kinds of indiarubber, and described in that section. (5) *Gutta-puti* or *gutta-sundek*, the product of an undetermined species of *Dichopsis* [*Isonandra*], frequently met with on this Sayong and Meeru ranges (Perak). It is obtained and prepared in the same manner as *taban*, but is much whiter and more spongy, and valued at little more than ¼ the price of *taban*; of it, some 484½ *piculs* (of 133⅓ lb.) were exported from one port in 1877. (6) *Gutta-julatong*, of unknown origin, often used in Perak for mixing with *taban* and *puti*, thus rendering them very brittle. (7) *Gutta-kolian*, said to be derived from *Isonandra* [*Dichopsis*] *Motleyana*, of the Peninsula, Java, and Sumatra; the product is used only for adulterating. (8.) *Gutta-burong*, the milks of various species of *Ficus*, employed as bird-lime, and described under indiarubber.

[Since the preceding remarks have been in type, Beauvisage has published a monograph on guttapercha, see Bibliography (p. 1695), which deserves the attention of all interested in the subject; it is too late to do more here than give a brief epitome of his nomenclature:—*Dichopsis (Isonandra) Gutta* is called *Gutta-balam* at Pajakomlao (W. Sumatra) and the Lampongs (S. Sumatra), *gutta tambaga* at Lobo Along (W. Sumatra), *gutta-dadu* or *-seroja* in Banka Island, *gutta derian* in Sokadana S.W. Borneo and E. Sumatra, *gutta-percha* in Malaysia generally, *gutta-taban* in the Riou Archipelago, and *ngiato-mera* or *to-oen* in Borneo; *Isonandra dasyphylla (bintang)*, is the *ngiato-bintang*; *I. Motleyana* is *kotian*; *I. macrophylla* is *ngiato-puti*; *I. Benjamina* is *ngiato-wangi*; *I. xanthochyma* is *ngiato-renkan*; *I. quercifolia* is *ngiato-tinang*; *I. rostrata* is the *ngiato-pisang* of Banka; *Dichopsis Krantziana (I. Krantzii)* is the *thior* of Cambodia and *chay* of Annam; *Chryso-phyllum rhodencurum* is *karetandjeng*; *Cocosmanthus macrophyllus* is *karetmondjeng*; *Ceratophorus (Azaola) Leerii* is *balam-tandok*, *-tjabe-trong* or *sonte*, or *kolan*; *Ceratophorus longipetiolatus* is *benko*; *Sideroxylon, attenuatum* is *balam-tima* or *karet-pantjal*. He indentifies *ngiato-dokang* as a *Bassia sp.*; and further enumerates as guttapercha-yieldigg plants *Bassia sericea Isonandra lamponga*, *I. microphylla* and *I. acuminata*.]

Commercial guttapercha is essentially *gutta taban*, derived from *Dichopsis* [*Isonandra*] *Gutta*, of which there are a white-flowered and a red-flowered variety in Perak, known locally as *ngiato-puti* and *ngiato-mera*. The supplies from this species are supplemented by some of those previously mentioned; according to Burbidge, the guttapercha obtained from the Lawas district of Borneo is formed of the mingled saps of at least five species of *Dichopsis*, the juices of a *Ficus*, and of one or two species of *Artocarpeæ* being not infrequently added as adulterants. The *Dichopsis* [*Isonandra*] *spp.*, flourish best in light rich loam with a rocky subsoil. Many of the most valuable varieties are confined to the hill-slopes at a distance from the sea, each forming a distinct grove of 200-500 trees. Small plants (1-8 ft.) of *D.* [*I.*] *Gutta* are abundant on the granitic formations in Perak up to 3,500 ft. All species are difficult to propagate, except from seed, and are very slow (25-30 years) to attain maturity. For their cultivation, it is recommended to take plants not more than 1 ft. high from the jungles; it is necessary to lift them very carefully, as they have long tap-roots, which are liable to be broken or injured, thus greatly retarding the growth of the plant, or killing it outright. These facts need to be taken into consideration in view of the rapid extermination of the trees which is now taking place. Doubtless large quantities of guttapercha, as of indiarubber, are still to be derived from the little-known interiors of Malacca, Borneo, and Sumatra if at an increased cost; but cultivation, and some system of obtaining the product short of killing the tree, will have soon to be adopted in earnest, if a supply is to be maintained.

In Perak, the guttapercha trees are most abundant on Gunong Meeru, Gunong Sayong, and Bujong; a few large trees still exist on Gunong Babo and the Thaipeng range. In Borneo and Sulu, the Kadyans and their Murut neighbours collect considerable quantities of the gum in the surrounding forests, and convey it to Labuan for sale. A writer in the "Journal of the Indian Archipelago" some years since says:—"To the north, the gutta collectors have reached as far as Perak on the Peninsular side of the Straits of Malacca . . . and, on the Sumatran side, as far as Pane and Bila. To the south, the whole of the Johore Archipelago, and the adjoining countries on the E. coast of Sumatra, as far as Palembang (including the forests on the Kampar, Indragire, Tunkul, Rice, Jambi, aud Palembang, rivers) now furnish *taban*. On the E. coast of the Peninsula, the knowledge of it has not yet advanced beyond Pahang. To the eastward, it has reached some of the rivers of Borneo, such as Brunei and Sarawak on the north, Pontianak on the west, and Koti and Passir on the east. It thus appears probable that the range of the *taban* embraces the whole of Borneo." Another author states that this tree is one of the most common in Johore. It is not found in the alluvial districts; but in undulating ground, such as that occupying the centre of the Malay Peninsula between the Indian and Batu Pahat, it occurs frequently, and, in some places, abundantly.

Generally, the collection of guttapercha is carried on immediately after the rainy season: in the dry season, the flow is very tardy, while during the rains, fever prevails, and the exudation is liable to be washed away. In Perak, no particular season seems to be recognized, and Murton was unable to learn whether the yield of the trees varies with the season; but he is of opinion that in wet seasons the guttapercha must contain more water, and need more boiling for its removal. The methods adopted for extracting the guttapercha vary somewhat among the Chinese, Malays, and Dyaks. The mature trees are felled just above the buttresses, by means of axes wielded by men standing on a stage 14-16 ft. above the ground, and the branches are immediately lopped off to prevent the sap ascending to the leaves. In Perak, the felling takes place at 5-6 ft. from the earth, and the top of the trees is also cut off at the point where it becomes too small for ringing. The ringing consists in making incisions in the bark of the felled trunk. The Binna people of the Malay Peninsula cut the bark with a *golo* (small knife) or *parang* (bill-hook) at distances of 6-18 in. apart, around so much of the trunk as is accessible while lying on the ground, at the same time removing about 1 in. of the rough outer coating of the bark on each side of the wound, but without peeling off any of the inner bark. The Malays of the same region strip off a ring of the soft bark about 1 in. wide in each case. In some districts, the bark is beaten with mallets, to accelerate the flow of the sap. The latter exudes for about an hour from each incision, and is caught in palm-leaves, coconut shells, and other receptacles, much however, escaping to the ground and being lost. The extreme yields may be stated at *2 catties* and *20 catties* (of $1\frac{1}{3}$ lb.) per tree, the average being 3-5 *catties*. The difference in yield are not readily apparent, as the trees are usually about the same age. The crude juice, if in small quantity, may be readily inspissated or concreted by rubbing between the hands. But this is rarely done, the rule being to boil the article in water in a *kwali* or iron pan about 15 in. diam. and 6 in. deep, with the addition of various adulterants. The boiling is done partly for the purpose of driving off the water which usually gets mixed more or less with the juice, and gives a stringy and deteriorated appearance to the guttapercha. Among adulterants other than the juices of allied plants, one of the most important is coconut-oil, to improve the appearance; lime-juice (1 pint to 3 gal.) has the property of coagulating the guttapercha immediately on ebullition. Generally in Borneo some 20 per cent of scraped bark is added indeed, it is said that the Chinese traders, who buy up the gutta from the gatherers, would refuse the pure article in preference for that containing bark, to which the red colour is mainly due. On reaching the export warehouse, the various kinds are assorted and sophisticated ready for commerce. The article is exported either in the form of balls weighing *13-20 catties* (of $1\frac{1}{3}$ lb.), or in large blocks, usually the latter for foreign ports.

The trade in gutttapercha is of considerable and growing importance. Our imports of the raw article in 1880 were:—From the Straits Settlements, 62,862 cwt., value 505,821*l*; other countries, 2,994 cwt., 22,051*l*; total, 65,856 cwt., 527,872*l*., being an advance on previous years. Our imports from the Straits Settlements have increased from 19,665 cwt. in 1876, to 21,887 in 1877, 31,036 in 1878, and 49,387 in 1879. From Borneo direct, we received 22 cwt. value 350*l*., in 1876, but none is recorded since. The exports of guttapercha and indiarubber combined from Borneo to Singapore in 1879 were valued at 437,027 dollars, or 91,047*l*. The proportion from each Bornean port was:—Brunei, 27,720 dol.; Labuan (received from the coast), 47,513 dol.; Sarawak, 361,794 dol. Of the figure for Sarawak, guttapercha represents 320,507 dol., leaving only 41,287 dol. for indiarubber. The little port of Sandakan shipped 6,277 dol. worth of guttapercha. The exports of guttapercha from Java for the year 1877-8 were 1,113 *piculs* (of $135\frac{1}{2}$ lb.) to Holland, and 6 to Singapore; in 1878-9, 332 to Holland, 116 to Singapore, and 34 to England; crop of 1879, 555 to Holland, and 274 to Singapore. It has been estimated that the shipments of guttapercha from Sarawak alone during the years 1854-75 have totalled over 90,000 *piculs* (of 133⅓ lb.) representing the destruction of at least 3 million trees. Our re-exports of guttapercha in 1880 were :—4524 cwt. 53,949*l* to Germany ; 1,796 cwt., 16,100*l*, to Holland ; 1,137 cwt. 13,541*l*., to the United States ; 1,072 cwt. 4,604*l*. to other countries ; total, 8,529 cwt., 88,194*l*.

The physical and chemical properties of guttapercha, and its industrial applications, have been described in a section of the article on Indiarubber Manufactures, pp. 1162-4. It may be added that while exposed to the air and alternations of temperature, it oxidizes and decays rapidly lasting only about 10 years on telegraph wires suspended in tunnels, but about 20 years when enclosed in iron pipes; yet in the sea 20 years' exposure produces no visible deterioration.

The approximate London market value of guttapercha is 6*d*.-3*s* 6*d*. a lb. for genuine, and 3*d*.-2*s*. a lb. for re-boiled.

GUTTASHEA.—This name has been conferred upon a substance, somewhat resembling guttapercha, found in appreciable proportion (½ per cent) in sheabutter (see Oils and Fatty Substances, p. 1410). Beyond what is there stated concerning it, Dr. Letts, who experimented upon the substance for Thomas Bros., Bristol, obligingly writes as follows :— "I did not succeed in isolating from the gum any very definite product. To the best of my recollection, the portion soluble in ether separated gradually as an almost colourless solid, but I could not determine whether or no it was crystalline. I remember that I could get no definite salts or other compounds from either it or the insoluble residue. The only other fact I considered of importance was the odour which the gum evolved on dry distillation, which was exactly like that of indiarubber (when heated). This led me to think that the gum might be allied to caoutchouc." It has been separated in a manner to admit of its industrial utilization, but no application has yet been found for it.

HARDWICKIA BALSAM.—An important oleo-resin is obtained from *Hardwickia pinnata*, a large tree, very common in the dense moist forests of the S. Travancore ghats, and found also in S. Canara. The method adopted by the natives for extracting the balsam is paralled with that current in Brazil for procuring copaiba (see pp. 1639-40). The product is a thick, viscid fluid, bearing the closest likeness to copaiba, from which it may, however, be distinguished by the tests given on p. 1640. It is used medicinally in India as a most efficient substitute for copaiba.

See also Gurjun, p. 1651.

HOG.—The term "hog-gum" (whice must not be confounded with the inferior tragacanth bearing the same name, see p. 1686) is applied in Jamaica to a yellow resin resembling Burgundy pitch in appearance, which escapes as a pellucid juice from incisions in the trunk of *Moronobea coccinea*. It is used for making pitch plaisters and as a substitute for copaiba in Jamaica. In Brazil and Guiana where it is known as *mani* or *oanani*, it is converted into torches, and employed in pitching boats.

INDIARUBBER (FR., *Caoutchouc* ; GER., *Kautschuk*).—The term "Indiarubber," often and conveniently shortened to "rubber" is applied to a large class of inspissated plant-juices, chiefly yielded by the species named on pp. 1627-8. In England, the name "caoutchouc" is restricted to the hydrocarbon which constitutes the main ingredient of commercial rubbers. The plan on which the present article is framed is to commence with a description of the origin and production of the commercial rubbers in their alphabetic order—African (including Mozambique, Madagascar, Liberian, &c); Assam, Java, Penang, and Rangoon ; Central American (including Cartagena, Guatemala, Guayaquil, Honduras, Mexican, Nicaragua, and W. Indies) ; Para ; Pernambuco or Mangabeira —following with other kinds which as yet have no industrial importance, and concluding with statistics of production, export, price, &c. The industrial applications of the rubbers have already been described in the article on Indiarubber Manufactures, pp. 1142-64

AFRICAN.—Much ignorance still prevails concerning the sources and collection of the African rubbers. The Mozambique and Madagascar kinds are obtained from the climbing shrubs *voa-here* or *voa-canja* (*Vahea madagascariensis*), *voa-hine* (*V. comorensis*) and *V. gummifera*. The product of one of these species is said to be much superior to the others, but all are mixed indiscriminately by the natives. The preparation consists in treatment either with salt water or artificial heat. The Mozambique article occurs in orange-like balls; in "sausages," formed of slender strings of rubber wound upon a stick, which is finally withdrawn; and occasionally in smooth pieces of various size termed "cake" or "line." The Madagascar sort consists of shapeless lumps, the better quality having a pink colour, and the lower a black.

Some rubber is produced in Mauritius by *Cryptostegia grandiflora*, and some by *Willughbeia edulis*, the latter found also in Madagascar, Chittagong, and Silhet.

A belt of rubber-yielding plants of different species extends across Tropical Africa from ocean to ocean. Within 20 miles of the coast from Liawa and the Lindi estuary (Masasi and Rovuma, E. Africa, 11° S., 38° E.), the forest becomes almost entirely formed of indiarubber vines, affording an abundant supply of fine rubber, at present gathered only in a very desultory manner by the natives, who gash the plants, and collect the exuding juice, which issues in a liquid form, and dries hard after short exposure to the air. Rolled into orange, like ball, it is taken to Lindi, where it is purchased by the Banyan merchants at about a quarter its value. Dr. Kirk has determined the plant which yields the best E. African rubber, and has obtained seeds of the species for introduction into India. It occurs in great abundance along the newly-made road from Dar-es-Salaam, in a W.-S.-W. direction, for about 100 miles towards the interior of E. Africa, through the Wazamaro country; it is apparently but little effected, except in the immediate neighbourhood of the villages by the reckless mode of tapping employed. In many parts, a native can still collect 3 lb. of rubber daily. There are five species, but only one is considered worth tapping. Specimens received from him at Kew have been named *Landolphia florida* and *L. Kirkii*, the latter of which yields the best rubber. *Landolphia* vine is known from Pangani inland all the way to Handei (in Usambara, E. Africa); at Magila, the rubber is made into balls for export. Dr. Kirk states that *L. owariensis* is common along the maritime region of E. Africa, and abundant at the mouth of the Zambesi; being found largely, at Shupanga on that river at 100 miles from the coast. The produce of this has been shipped from Quillimane for America. The natives of the Marutse-Mabunda empire, on the Upper Zambesi, trade in rubber with the tribes to the west. The district called Mungao, extending from S. lat. 9° 25′ to Delgado in 10° 41′, yielded 90,000*l*. worth of rubber in 1877, when the industry had been only 3 years in existence. In 1878, Kilwa and Mombasa added largely to the supply. On the Victoria Lake, are one or two kinds of trees producing rubber of good quality. Rubber plants grow on the slopes of the Cameroons mountains (W. Africa), but the people do not yet know their value. Rubber trees abound on the river Djour in the province of Bahr el Ghazal.

The *Landolphia spp.* are principal among the rubber plants of W. Africa. The rubber is collected from *L. owariensis*, extending from 10° N. to 10° S. on the coast of W. Africa, and most abundant in the highland districts of Angola; *L. florida*, frequent in inner Angola up to 1,500-2,500 ft., and in Liberia; and *L. Heudelotii* in Senegal. According to Speke and Grant, the natives say that the best rubber is produced by *L. florida*. The plants of this genus are woody climbers, growing well in damp rocky ravines scarcely available for other culture. Being climbers, they could not be grown in separate plantations, but would probably flourish in any tropical jungle, where trees already existed for them to ascend. Every part of the stem exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly as to form a ridge on the wound, which stops its further flow. The blacks collect it by making long cuts in the bark with a knife, and as the milky juice gushes out, it is wiped off continually with the fingers, and smeared on their arms, shoulders, and breast, till a thick covering is formed. This is peeled off their bodies, and cut into small squares, which are then said to be boiled in water. According to other accounts, the natives cut off a piece of the bark, and the milky juice is allowed to run into holes in the ground, or upon leaves. In some districts, they simply let the juice trickle down their arms, going from tree to tree till sufficient has accumulated, then peeling it off from the elbow in the form of a tube. Elsewhere, it is said to be collected and left to inspissate in wooden vessels. Collins remarks that, if the incisions be allowed to penetrate too deeply, they liberate a gummy substance, which mingling with the rubber, depreciates its value. These vines may be tapped for rubber when 3 years old. Christy suggests their cultivation in plantations, and annually cutting down the young shoots almost to the ground, then crushing the stems between rollers, and treating the whole mass with carbon bisulphide. which dissolves the rubber, but not (he says) the injurious gummy matter. The rubber of these vines is of fairly good quality when carefully prepared. It should be made in separate sheets or cakes, 1-2 in. thick and 6 in. or so in diameter. Iron or stone vessels are superior to clay for collecting the juice. The better kinds are said to be prepared with the addition of 3 per cent of strong liquor ammoniæ. When any liquid is added in the preparation, the sheets must be very thin, to facilitate drying. This question of drying seems to have much to do with the quality of the rubber, and the inferiority of African to Para rubber is largely attributed to its being sent into commerce in a raw, green state, whence possibly also arises its disagreeable odour generated by decomposition. The desirablity of introducing *Attalea excelsa*, for the purpose of employing its nut (the *urucuri*) in curing African rubber, as in Para (see p. 1661), has even been discussed; but the slow smoky fire from any oily nut would probably have the same effect.

Another important W. African plant is *Urostigma Vogelii*, with possibly some other species. The tree (20-30 ft.) grows near the sea, at elevations of 50-60 ft., but does not flourish in marshy ground. The natives pollard the trees at 10-12 ft., and cut back the branches, thus obtaining a free and regular flow of sap. The cuttings are easily propagated, and grow vigorously. The trees are tapped at about 5 years, by making slashes or incisions in the trunk; the juice is collected in vessels, inspissated by the use of acids, and made up into balls the size of a large orange. Though often sent in a dirty state, the rubber is of good quality, and said to be the best of the Liberian. The juice obtained from trees less than 5 years old is watery, and does not afford such good rubber. Christy considers this a desirable species for cultivation in the lowlands of S. India, Ceylon, Java, Sumatra, Penang and Siam.

A considerable proportion of W. African rubber is obtained from a plant which Holmes has determined to be *Tabernæmontana crassa*. In Senegambia, the *anjouan (Vahea senegalensis)* contributes to the supply. In Sierra Leone, rubber is collected from *Ficus Brasii*; and some *Ficus spp.* yield it in Angalo on the W. coast, and at Inhambane on the E. A specimen of rubber from the W. coast of Africa is attributed to an undescribed species of *Carpodinus*; and in Reunion, some is said to be derived from *Periploca graca*.

The rubbers sold under the general name of African, omitting Mozambique and Madagascar, occur as shapeless lumps (" knuckles") from the Congo; "negroheads" or " balls" of scrap, and smooth cakes, from Sierra Leone; "Thimbles," " nuts," and " negroheads" from the Portuguese ports; " tongues" from the Gaboon; and " balls" from Liberia. The African rubbers are more adhesive and less elastic than the Para article, and command a lower price; the inferiority could be much reduced by an improved system of preparation.

Assam, Java, Penang, and Rangoon.—Assam rubber is derived almost entirely from *Ficus elastica*, a small portion being obtained from *Urostigma laccifera*.

Ficus elastica grows wild along the foot and in the low tropical valleys of the Himalayas, from the Mechi River on the Nepal boundary at 88° E. long. to the extreme eastern limit of Assam, in 79° E. long., as well as along the feet and in the valleys of the Southern mountains of the Brahmaputra valley, viz., the Patkye, Naga, Khasi Jynteah, and Garrow Hills. It is not abundant until east of the Bor Nuddi, where it is common in the forests at the feet of the hills in the Khaling, Buri goma, and Kuriapara Duars, between the Bor Nuddi and Mura Dunsiri Nuddi; the rubber has been exported from these forests, which extend over about 40 sq. miles, as well as from the low valleys of the Bhutan Hills, immediately above them, and especially from the forests in the neighbourhood of the exit of the Nunai Nuddi in the Khaling Duar and the adjoining hills, and those between the Dimjany and the Ruta Nuddis. In the Chardwar forests, between the Mura Dunsiri or Ruta Nuddi and Borali River, the plant is abundant. Butween the Bilsiri and Goboru Nuddis, it is found as far as 16 miles from the hills, but the drier climate renders the produce much less plentiful. In the Nowdwar forests, where the climate is less moist, only the rubber obtained from trees close to the hills is good. In the Chydwar forests, the trees are found only immediately along the foot of the hills. The plant may be seen in parts of Sikkim, in the moist but rocky side-valleys of the torrents that feed the Teesta and Mahanadi rivers. It is also very abundant in the moist forest of the northern rainy zone of Burma, beyond British territory. It flourishes best in a very moist climate and a mean temperature of 98° F. in the shade, but will not endure stagnant water about the roots.

The collection of the rubber in Assam is conducted under rigid restrictions in the case of all trees growing in the timber reserves, but cannot be enforced in the case of scattered trees. Immense forests of the trees existed on both banks of the Subansiri river, and on other streams, but the reckless treatment they received from native lessees of the forests caused their ruin. In 1876, the leasing of these forests ceased, but there is now little or no rubber left in the plains of the Lakhimpur district. It is estimated that the forest of Cachar could yield upwards of 2,000 cwt. of rubber annually. One distirict in Assam, 30 miles by 8, is said to contain 43,000 trees, many of them being 100 ft. high. According to Murton, there is little doubt that this same plant, *Ficus elastica*. affords the *gutta-rambong* of the Malay Peninsula, produced in the interior of Perak and on the Patani side of the Peninsula.

The natives who tap the wild trees slash every part of them within reach with their *daos* or knives. The incisions on the lower part of the stem, and on the roots which run some 30-40 ft. on the ground, are 6-18 in. long, and are made diagonally through the bark and into the wood, in a elliptical form, measuring about 3 in. across the centre. The exudation from these wounds is received in holes dug in the earth, or in leaves folded conically; that from the smaller cuts on the upper branches is allowed to concrete on the spot. According to Collins, the yield of a tree in August is about 50 oz. of milk, giving 15½ oz. of rubber; sometimes the proportion of rubber falls so low as 10 per cent. He also observes that "during the cold season, October-March, the milk is scantier, but richer than in the warm weather, March-October." Mann finds the best tapping season in Assam to be February-April. Hunter states that the trees "yield most during the rains;" he adds that a high yield for the first tapping of a tree 18 in. 6 ft. in girth is 35-40 lb. of rubber, it is then allowed 3-4 years' rest, when a second but much smaller collection is made. Markham asserts that the trees may be tapped at 25 years, and that after 50 years they will yield 40 lb. of rubber every 3rd year. Murton says that in the Malay Peninsula the milk is obtained from the large roots, which are tapped 10-12 times in a year; a *picul* (133⅓ lb.) is sometimes taken from a large tree, but the usual yield is about ½ *picul*. This kind is said to require no preparation for market, and to present the appearance of long strings irregularly welded together, the best quality being gummy-looking, of very firm texture, and reddish-brown colour, while the inferior qualities have a large admixture of bark and are much drier, without gum-like consistence of the better grades. In Assam, on the other hand, it is the "loaf" rubber obtained from the lower parts of the stem and roots that requires artificial preparation, while none is bestowed upon the produce of the smaller branches. The treatment consists in pouring the milk into boiling water and stirring until it assumes sufficient consistance to admit of being handled without becoming clammy or sticky. The plan adopted by a European house at Texpore is to run the milk into wooden bins 6 ft. sq., partially filled with water, on which the rubber floats after a time. The latter, while still liquid, is removed and boiled over a slow fire in iron pans 4-6 ft. diam., and 2-2½ ft.

deep, 2 parts of water being added, and the whole stirred constantly. When coagulated, the rubber is removed with iron forks, pressed, again boiled and pressed, sun-dried and washed over with lime.

The rapid destruction by the natives of the wild rubber trees in Assam has called forth efforts to establish their cultivation in regular plantations. That at Chardwar has an area of 80 sq. miles, some 700 acres being under cultivation already. In 1878, it was stated that the planting had scarcely emerged from the experimental stage, for though no doubt remained that the tree would grow luxuriantly in the locality chosen, there was much variation in the degree of success gained by the several methods of planting. The plants put out in cane baskets in the forks of trees, though alive and healthy, remained nearly stationary; and many of those simply planted in the ground also did badly thus condemning these two plans. All those planted on low split stumps in earthenware cylinders on low stumps of trees, on piles of wood put crossways and mixed with earth, and on small mounds of earth 2-3 ft. high, did remarkably well, drainage about the roots being ensured by these modes. It has been proved that the best cuttings do not transplant so well as seedlings, and that raising plants from seed will be the method of propagation to be chiefly depended on.

Assam rubber has a peculiar mottled appearance, and varies in colour from cream or flesh tints to bright pink or reddish; it is very glossy, and sometimes covered with a greyish-white film, which may arise from oxidation or from some foreign application. Its form is either that of irregular lumps ("slab" or "loaf") produced as already described, or "balls" of the unprepared stringy substance obtained from the smaller branches. The impurities (bark, sand, clay) often reach 35 per cent especially in the "balls." It arrives in baskets made of split rattan, covered with gunny-sacking, and weighing, about 3 cwt. each.

Java rubber is also obtained from *Ficus elastica*, according to De Vrij. It is prepared by allowing the milk to concrete in the incisions made in the tree. It closely resembles Assam rubber, but has a deeper tint, with occasional reddish streaks.

Penang rubber is presumably identical in origin, no evidence being forthcoming in support of Wallich's statement that it is afforded by *Cynanchum ovalifolium*.

Rangoon rubber is also attributed to a *Ficus*, proably *F. hispida*.

These three kinds may be classed with Assam rubber for all techincal purposes.

Attention has recently been called by G. W. Strettell to a troublesome climbing "weeds," *Urceola* [*Chavannesia*] *esculenta*, very common in the Burmese forests, as a valuable source of rubber. It is urged that its cultivation could be made highly profitable. Assuming the plants to be placed 30 ft. apart, 400 acres would contain 19,200 of them, which are estimated to yield 1 *viss* (3 lb. 2 oz.) each per annum, worth 20*l*. per 100 *viss*, or 3,840*l*. It is supposed that the cost of starting the plantation would be trifling, not exdeeding 8*s*. per acre, per annum on the first 7 years, making a total for that period of 1,120*l*. The further cost of tapping, pressing, and preparing the juice is placed at 12½ per cent of the profits, leaving a net asset of over 3,000*l*. per annum. The milk is said to coagulate more readily than that of *Ficus spp*. The incision adopted by Strettell is arrow-like, and made on the sides of the stem. The rows of cuts are 3 ft. apart, and arranged to be in vertical lines. Funnels formed of the leaves of *Butea frondosa* are selected for catching the exudation. The best season for tapping is about the end of April; between October and March, circulation is slow and the milk is scarce, but during the rain, the milk is more watery and abundant.

BORNEO.—The sources of Borneo rubber are not very accurately known. One authority names as the chief plant *Urceola elastica*, a climber with a trunk as thick as a man's body, and a soft thick bark, capable of being tapped at 3 years, and soon shooting up after having been cut down. Of this, Burbidge specifies 3 varieties, known respectively as *petabo*, yielding the best rubber, *menungan*, the most prolific, and *serapit*, giving the lowest quality. On the other hand, the *petabo* plant has been indentified at Kew as a *Leuconotis sp.* Again Burbidge himself more recently writes that the Bornean rubber or *gutta-susu* is the mixed saps of 3 species of *Willughbeia*, with the milks of 2 or 3 other plants surreptitiously introduced to increase the quality ; and he gives the Malay names of the 3 species as *manungan*, *manungan puti*, and *manungan manga.* Their stems have a length of 50-100 ft., and a diameter rarely exceeding 6. in. He adds that they are being slowly but surely exterminated by the collectors in Borneo, as throughout the other Malay islands, and on the Peninsula, where they likewise abound : on the other hand, they grow rapidly, and readily lend themselves to both vegetative and seminal methods of propagation, and hence are especially deserving of the Government of India where they may reasonably be expected to thrive. The stems of these creepers are cut down to facilitate the collection of the creamy sap, being divided into sections measuring a few inches to 2·3 ft. long ; the escaping milk flows into jars or buckets, the exudation being sometimes hastened by applying heat to one end. When sufficient sap has been thus collected, it is coagulated into rough balls by the addition of salt water or nipa salt (the latter obtained by burning the foliage of the *nipa* or *susa* [*Nipa fruticans*]. It reaches Liverpool in porous or spongy balls and shapeless lumps, internally white or pinkish, and saturated with salt water in such quantity as to cause a loss of 20-50 per cent in weight on trying.

Burbidge remarks that there are many milk-yielding species of *Ficus* in the Bornean forests, which, with careful experiment, may possibly be made to contribute remunerative quantities. The Malayan representatives of the *Artocarpæ* also deserve examination.

According to Murton, the *gutta-sing-garip* of the Malay Peninsula is identical with the *gutta-susu* of Borneo. There are two varieties of the plant producing it : one has very dark-coloured outer bark, with lighter-coloured warts, and red inner bark ; the other has a light cork-coloured outer bark, with longitudinal channels, and light-yellow inner bark. The produce of the former is considered superior. The stems are sometimes cut down, but are generally ringed at intervals of 10-12 in., and the milk is allowed to run into vessels made of palm-leaves or coconuts ; the flow continues for some time, but after 10 minutes, the substance is very watery and thin. One plant will yield 5-10 *catties* (of $1\frac{1}{3}$ lb.) of coagulated rubber. When raw, the juice has the appearance of sour milk, it is coagulated by the addition of salt or salt water, and resembles Bornean *Gutta-susu* in all respects.

CEARA.—The rubber known in commerce as "Ceara scrap" is produced by a distinct species from the other Brazilian and Central American rubbers, which has been named *Manihot Glaziovii.* It is a tree of 30 ft. in height, with a dense rounded crown, and attaining a diameter of 4-5 in. in 2 years. It grows wild in the flat country in the Brazil running inland from the coast-town of Ceara in 4° S. lat., mostly, so far as is known, at an altitude of about 200 ft. The district possesses a very dry arid climate for a considerable portion of the year ; the rainy season lasts from November to May-June, when torrents of rain fall for several days in succession, followed by fine weather. There are years when scarcely any rain falls. The daily temperature averages about 82°-90° F. The soil frequented by the tree is sandstone, gravel, or granite, its dryness and poverty being indicated by absence of all ferns, weeds, grasses, and mosses.

The native system of bleeding the trees and collecting the rubber is sufficiently simple. The collector commences by sweeping away loose stones and dust from around the foot of the tree, and spreading some large leaves to receive the milk as it flows from the tree. The outer surface of the bark of the trunk is then stripped off to a height of 4-5 ft., as shown in Fig. 1173,* and the milk exudes and runs down in many tortuous courses, a portion usually falling upon the ground. After several days the juice becomes dry and solid, when it is

* Those who want to see illustrations, can refer to page 1658 of Spon's "Encyclopœdia of the Industrial Arts, Manufactures, and Commercial Products," Div. V.

pulled off in strings and rolled up in balls, or put into bags in loose masses. The paring should only be deep enough to reach the milk-ducks, which reside in the middle layer of the bark; but this circumstance is seldom regarded by the collectors, and many trees are prematurely destroyed by the careless wounding of the wood. The operation is conducted only during the dry season.

The habits and habitat of this plant immediately pointed it out for cultivation in a systematic manner in some of our warmer possessions, and the success attending the experiments is the more desirable since the late drought in Brazil caused the death of immense numbers of the tree. It has proved itself to be well adapted for culture in Ceylon, Upper India, Zanzibar, and Jamaica, but the climate of the Malay Peninsula is too moist for it. The experience gained thus far in its cultivation may be briefly stated. Seeds are early produced, if the tree is not shaded. They should be buried in brown sand, and kept moist until there are indications of growth, when they may be planted out permanently. In some situations, where the ground is rough and strong, they might be sown broadcast. Plantations may also be formed by cuttings, which take root as easily as a willow. They should be from the points of strong shoots, and about 1 ft. in length. In planting, each cutting may be put down in the soil to a depth of 6 in. If scarce, the entire shoot may be cut into pieces, each possessing a bud, all of which will grow if covered with ½ in., 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 debris, about the size of a mole-hill, piled over each, care being taken that the extreme point of each cutting with a bud is left uncovered. Wherever there is any sort of stunted tree or shrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper. There can be no doubt of the hardiness of the species, its readiness of culture, and adaptability to circumstances. It grows quite as readily from seed as from cuttings, and, though a native of a tropical sea-level, thrives well in Ceylon up to at least a level of 3,000 ft. and on the most barren soils. It would seem especially adapted for the dry and barren districts of the E. and N. provinces of Ceylon, 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.

The seed-coat is of remarkable thickness, and very hard, and the natural process of germination occupies, it is said, more than a year. All that is necessary to hasten this, is to assist the seed-coat in splitting, which is best effected by holding the seed firmly, and rasping off with a file both edges at the radicular end, recognized externally by possessing at its side a flat two-lobed appendage, technically known as the caruncle. It is best not to file off the actual end, as the radicle of the embryo may then be injured. After this treatment, properly performed, the young plant appears above ground in 2-3 weeks. The seedlings require no particular attention. They grow rapidly, and may be finally planted out at distances of 20 ft. The trees at Peradeniya (Ceylon) flowered at the age of 18 months; at 2½ years, the larger ones formed branching trees about 25-30 ft. high, with a stem 1 ft. 9 in. in circumference, at a yard from the base, and a smooth, silvery, birch-like bark, readily peeling off. The best system of tapping the trees under cultivation has yet to be proved. Some improved methods are described later on in the present article (see p. 1666).

This rubber is considered almost next to Para in value, being dry, very elastic, and free from stickiness; its one drawback of containing wood and other foreign matter, in such quantity as to cause a loss of often 25 per cent in washing, may doubtless be altogether removed by the exercise of care in the collecting.

Central American.—The Central American, Cartagena, and Guayaquil rubbers are yielded chiefly by the *ule*, (*Castilloa elastica*), a lofty tree with a trunk 8 ft. diam., found in Mexico, Guatemala, Salvador, Honduras, Nicaragua, Costa Rica, Panama, the W. coast of S. America down to Guayaquil, and the slopes of Chimbrazo, as well as in Cuba and Hayti. This extensive geographical range shows the tree to be capable of existing under considerably varied climatic conditions. The forests in which it grows are usually at or near sea-level, but it has been observed at an elevation of 1,500 ft. on the Pacific coast. The soil is various, but the tree avoids, marshy or boggy land, and manifests a preference for warm, deep loam or sandy clay, and it especially affects the margins of small running streams, where it occurs in little groups. A moist climate and high equable temperature are essential; the trees thrive best in dense, steaming, hot forests, and are particularly abundant where it rains during 9 months of the year, and the temperature ranges between 75° and 88° F. A second smaller species, *C. Markhamia*, also occurs in Panama.

In Panama, the usual method of collecting the milk is by felling the tree, and then making deep notches around the trunk at distances of about 1 ft. apart, as shown in Fig. 1174*. Broad leaves placed beneath the notches receive the milk, which is afterwards collected in a large calabash or other vessel, poured into a hole in the ground, and thatched over with leaves, where it coagulates in about 2 weeks. Another plan is to bruise a handful of the leaves of the *Ipomœa bona nox*, and stir them about in the milk, which is thereby thickened in about an hour to a jelly-like porous mass, profusely exuding a black ink-like water when touched. The article thus produced is inferior. It is sometimes sliced into flakes 1. in. thick and sun-dried. In Nicaragua, it is found that though the tree yields the juice at all seasons, the best time for tapping is April, when the old leaves begin to fall and the new ones appear. During the rainy season, May-September, the richness of the juice diminishes. From that time till January, the rains decrease, the milk increases in richness, the tree prepares to flower, and the fruit appears in March, during which month and the succeeding one the milk contains the greatest proportion of rubber, the difference amounting to 60 per cent more in April than in October. A tree about 18 in. diam. (probably 6 years old) tapped skilfully in April will yield some 20 gal, of milk capable of giving 50 lb. of rubber. This is a maximum figure, and the average is somewhat less. A tree of 20-30 ft. to the first branches is expected to afford 20 gal. of milk, and each gallon of milk to render 2 lb.-2 lb. 2 oz. of good dried rubber. By the Panama system of destroying the tree, the produce often amounts to 100 lb. of rubber from a tree. The Nicaraguan mode of tapping is as follows. The collector ascends the tree by climbers or a ladder as high as possible, and then commences a series of incisions with a sharp *machette* or axe in one of two ways. One is to make a long vertical cut, with diagonal cuts running into it, as in Brazil; the other is by encircling the tree with spiral cuts at an inclination of 45°; if the tree be large, two such spirals are made, either crossing or paralleled with each other. At the bottom of the trunk, and iron spout is driven in, and the milk is received into iron pails. In the evening, the milk is freed from foreign matters by passage through a sieve, before transference to the barrels in which it undergoes coagulation This last condition is brought about by the addition of plant-juices. notably that of the *achete* (*Ipomœa bona nox*), as in Panama. The plant is collected, moistened with water, and bruised, and the juice, after straining, is added to the milk, in the proportion of 1 pint to 1 gal. After this operation, the rubber appears as a soft mass floating in a brown fluid, and smelling like new cheese. The mass is pressed under a plank or iron roller into a *tortilla* or cake, usually weighing about 2 lb. when dry, and representing 1 gal. of milk. When the *achete* or other suitable plant is not procurable, water in the proportion of 2 to 1 is added to the milk, and the whole is allowed to stand for 12 hours. The residue which separates from the water is poured into underground vats and left to dry for 12-14 days. Sometimes the milk is simply poured on a prepared spot of ground, and the watery portion left to evaporate or disappear as it may; the rubber, when outwardly dry, is pressed to remove *bolsas* or bubbles of watery liquid. Slabs made in this

* Those who want to see illustrations can refer to p. 1659 of Spon's "Encyclopœdia of the Industrial Arts, Manufactures, and Commercial Products," Div. V.

way are sometimes called *meros.* The rubber which is allowed to dry in the iron spout conducting from the tree trunk is rolled into balls, and called *cabezza* ; that which dries in the wounds on the tree is termed *bola* or *burucha*, and is esteemed in New York. The loss by drying (*merma*) is estimated at about 15 per cent. A recent traveller in Central America states that the *ule* tree "yields many gallons every 2 years ;" but in Panama, the tree is totally destroyed in obtaining the milk, and elsewhere the tapping is said to be so injuriously done as to be little better than immediate destruction.

There are several commercial varieties of the rubber obtained from *Castilloa spp.* Cartagena rubber arrives from New Granada (Colombia) in black sheets ⅜ in. thick, having a somewhat rough or "chewed" appearance, and more or less "tarry" or sticky. It also occurs in strips or scraps pressed together in bags. It loses about 35 per cent of its weight on drying. Guayaquil rubber comes from Ecuador in large flakes and lumps, the better quality being whitish coloured, while the inferior is porous and saturated with a fœtid black liquid. Its loss by washing sometimes reaches 40 per cent. This and the preceding kind go chiefly to America. Nicaragua rubber, which mostly reaches the same market, loses only 15 per cent by drying. The best of the Central American rubbers is that known as "W. Indian," not from its being produced in the W. Indies, but coming in steamers sailing thence. It consists of blocks which in the first quality are formed of thin separable sheets, and, in the second, of conglomerated "scraps" with fragments of bark. Honduras rubber is of good quality, and free from "tarry" matter. Guatemala rubber is one of the lowest and least regular kinds ; the best specimens are whitish, while the "lower" are black and "tarry." This rubber arrives in sheets compacted together, whence a thick resinous fluid exudes on pressure ; this fluid, on evaporation, leaves a hard resinous substance uneffected by steam.

The wasteful and destructive local methods of collecting the milk of this genus are causing its rapid extermination in the countries where it is indigenous. Attention has been directed to its naturalization in our tropical possessions, but though the plant is of rapid growth, it will scarcely thrive in regions that are not equally suited to the *Hevea spp.*, and its rubber is much inferior. It has been introduced successfully in Ceylon, Singapore and Perak. With regard to its culture, it may be observed that trees in good situations will produce seeds early, but these need to be planted without delay, as drying destroys their vitality. Flowering occurs in January, and the fruits ripen in April (in Brazil). Stout branches, cut into pieces, each possessing a bud, and covered lightly with soil, will generally be found to grow. Strong cuttings 1ft. long and furnished with buds, planted in the usual way, sooner develop strong plants. But the propagation of this tree is not reckoned so easy as that of the Ceara rubber (*Manihot Glaziovii*). In setting out young plants, the petiole or leaf-stalk of the lowest or oldest leaf should be buried in the soil ; this simple device ensures the immediate and vigorous growth of the plant, and a symmetrical stem. When the planting leaves much bare stem above ground, the growth is slow, the plant long remains "leggy," and never forms a good tree. The plant has the curious habit of dropping its young branches, which disarticulate by a regular joint, and leave a clean scar on the surface of the stem. It is believed that after 6 years the trees might be judiciously bled every 3 years.

PARA.—Para rubber, which is second to none in importance, is afforded by several species of *Hevea* [*Siphonia*], the most important being *H. brasiliensis*, *H. guianensis*, and *H. Spruceana*. These trees inhabit the dense, steaming forests on the Amazon and its tributaries, other species replacing them in some of the adjacent countries, *e.g.*, *H. paucifolia* in British Guiana, where Prestoe believes it will be found in considerable abundance. Brazil is being gradually but surely denuded of its rubber-trees, collectors being now driven to the Tocantins, Madeira, Purus, and Negro rivers in search of supplies. A recent traveller states that, in Bolivia, extensive rubber forests are at present profitably worked on the Lower Beni, and it is natural to suppose that they exist to an equal extent on the Mayutata and Aquiry ; those on the Mamore and Lower Itenez, though giving rubber of a superior quality, do so in less quantity.

In the Para district of the Lower Amazon, the temperature varies between 74° and 95° F., the mean of the year being 81° F., the supply of moisture is also very regular. On the Upper Amazon, the atmosphere is densely vapour-laden. The soil frequented by these trees is extrenely rich mould. The trees will grow on the *terra firma* when planted, but their seeds naturally lodge in lowland swamps. All the species flourish best on rich alluvial clay slopes by the side of running water, where there is a certain amount of drainage; those growing on land which is periodically inundated (even to a depth of 5 ft.) are more prolific than those on very low or on elevated ground.

The methods adopted for tapping the trees are described at length by Cross, The collectors begin work immediately at daybreak, or as soon as they can see to move about among the trees. Rain often falls about 2-3 o'clock in the afternoon, so 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 down at the base of each tree a certain number (3-12) of small cups of burnt clay. 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 of rubber and for what may adhere to the bottoms of the cups, these promiscuous gatherings being termed *sernamby*, and forming the "negrohead" of the English market. The cups are sometimes round, but more frequently flat or slightly concave on one side, so as to stick easily, when, with a small portion of clay, they are pressed against the trunk of the tree. The contents of 15 cups make about 1 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 1 in. or more into the wood. The cut is 1 in. 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 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; if requisite, he smooths the clay so that the milk may trickle directly into the cup. At a distance of 4-5 in., 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 a height of about 6 ft. 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 9-10 o'clock in the morning, because the milk continues to exude slowly from the cuts for three hours, or perhaps longer. 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* (inundated land) or on 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 6-8 in. 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 the 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; in the course of working, the upper row descending daily 6-8 in., while the lower one ascends the same distance, the 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, Cross believes it impossible 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. It has been supposed that the quality of the milk is better in the dry season than during the rains. In the rainy season the milk probably contains a greater proportion of water; but, on the other hand, a larger quantity of milk then flows from the tree. No doubt the dry season is the most suitable for rubber collecting, although, wherever a plantation is provided with a preparing-house, convenient tapping may certainly be always carried on when the weather is fine. It is a common report that the trees yield the greatest quantity of milk at full moon. Even if this were found to be true, it would probably make little difference, as tapping must be carried on when circumstances are most favourable.

There are two other methods adopted in tapping, which are chiefly confined to the Upper Amazon and its 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 3 ft. 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. The respective methods are illustrated in Figs. **1175**, 1176, 1177. Fig. 1178 shows the exhausted tree in a state of decay.*

Going from tree to tree, the collector empties the contents of the cups 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 (10-100 yd.) apart, and it is surprising that the natives have not yet seen the advantages that would be derived from forming plantations, whereby more than twice the quantity of rubber might be collected in one-fourth the time, and at far less cost and labour.

The common method of preparing the rubber is represented in Fig. 1179.* The jars *a* are 18 in. high, and the bottoms are broken out. At the base, they are 7 in. diam., bulging out in the middle to 12 in., and narrowed at the mouth to a breadth of 2 in. Where a number of men are collecting for one master, much larger jars are in use. The milk, on being put into a large flat earthen vessel *b*, is placed on the floor in a convenient position. Adjacent thereto, the jar is set on three small stones, which raise it to 1½ in. above the floor. The narrow space between the base of the jar and the floor allows the entry of air, which causes a current of smoke to ascend with remarkable regularity and force. When the fire commences to burn strongly, several handfuls of nuts [preferably *urucuri* (*Attalea excelsa*), but failing them, those of *Euterpe edulis* and other palms], are put on, then some more wood and nuts alternately. The latter are dropped in at the mouth of the jar, until it is filled to within 4 in. of the top. Due care is taken that a sufficient proportion of wood is put in with the nuts. The mould *c* on which the rubber is prepared resembles the paddle of a canoe; in fact, at many places on the Amazon, this is the article most frequently used, if there is much milk, and the rubber is prepared in bulky masses. Occasionally the mould is slung to the roof, as the weight in handling it during the process would otherwise be very fatiguing. A little soft clay is rubbed over it to prevent the rubber from adhering, and it is afterwards well warmed in the smoke. The operator holds the mould with one hand, while with the other he takes a small cup and pours two or three cups of milk over

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* Those who want to see illustrations can refer to pp. 1622 and 1623 of Spon's "Encyclopœdia of the Industrial Arts, Manufactures, and Commercial Products," Div. V.

it. He turns it on edge for a few moments above the dish, until the drops fall, then quickly places the flat side 2 in. above the jar mouth, and moves it swiftly round, as if describing the form of a cipher, with his hand, so that the current of smoke may be equally disturbed. The opposite side of the mould is treated in the same way. The coating of milk on the mould, on being held over the smoke, immediately assumes a yellowish tinge, and although it appears to be firm on being touched, is yet found to be soft and juicy, like newly-curdled cheese, and to be sweating water profusely. When layer after layer has been repeated, and the mass ("biscuit") is of sufficient thickness, it is laid down on a board to solidify ; in the morning it is cut open along the edge on one side, and the mould is taken out. "Biscuit" rubber, when fresh, is often 4-5 in. thick. On being hung up to dry for a few days, it is sent to market. The rapid coagulation of the milk seems to be simply produced by the high temperature (about 180° F.) of the smoke. Cross thinks that with a strong current of heated air, or a good pressure of steam from a pipe, or by putting the milk in shallow vessels, and evaporating the moisture by the heat of boiling water, a similar result would be obtained. The finely divided particles of soot which form a large proportion of the smoke undoubtedly absorb a considerable amount of moisture, although at the same time forming an impurity.

A more modern method of preparing the milk is by treatment with an aqueous solution of alum, and subjecting the coagulated mass to pressure, in accordance with Strauss' proposition. This plan is said to be in favour, as being capable of performance at a distance from the unhealthy locality where the milk is produced. The proportion of alum solution required is very small, but varies with the character of the milk. The latter should be previously strained free from extraneous matters. Coagulation ensues in 2-3 minutes. The rubber is then exposed to the air on sticks, and allowed to drain for 8 days. It is sometimes subjected to expression. The drawback of the process is the "wetness" which the rubber acquires from the presence of saline particles which are never completely removed by pressing.

The excellent quality of this rubber has commended the plant to the attention of agriculturists in India and elsewhere. The result of experiments hitherto seems to be favourable to its establishment in Ceylon, Malabar, S. Burma, Zanzibar, and Jamaica, but not in Central and N. India.

The propagation and planting may generally be combined in one operation, the object being to reduce the expense, simplify and accelerate the work, and promote the more perfect development of the primary roots and trunk. The green-coloured terminal shoots of succulent growth, with the leaves fully matured, make the best cuttings. These should be cut off low enough, so that there is a joint at the base. When it is desirable to plant in dry firm land, a spadeful of soil should be turned over at each place, and the cutting planted in a sloping position. It should be covered with mould to within 3 in. of the plant. The portion above ground should rest on the earth on one side of its termination, so as not to suffer during hot sunshine. In all stages, the crowns of the plants may be exposed to the rays of the sun. Plants intended for cutting stocks may be planted in open places, in the richest dark loam capable of producing a luxuriant rank crop of sugar-cane. Seeds might be planted out permanently at once, also in the same way as the cuttings. These would prosper much better if at the time of planting a handful of wood-ashes were added to the soil with each seed. Good ashes may be obtained by the burning of any description of green wood or newly-felled piece of forest. If the wood is allowed to rot before burning, almost the whole of the fertilizing principle will be found to have vanished. If stored in a damp place, the value of the product is diminished. 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 end 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 3-4 in. 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.

Para rubber occurs in commerce in two forms : "biscuits," prepared as described on pp. 1622-3, containing about 15 per cent of water; and rounded balls of "negrohead," containing 25-35 per cent of woody fragments, and other impurities. Occasionally an intermediate quality callled "entrefine" appears. Adulteration is sometimes practised by the addition of the juice of the cow-tree or *massaranduba* (*Mimusops elata*).

Pernambuco or Mangabeira.—The *mangaba, mangabeira,* or *mangabiba* tree (*Hancornia speciosa,*), a native of the high plateaux of S. America, between 10° and 12° S. lat., at 3,000-5,000 ft. elevation, affords a kind of rubber. The inhabitants of Pernambuco are now developing the supply of this article, which is collected by making oblique cuts penetrating the bark round the trunk, and attaching receptacles thereto. The juice is coagulated by Strauss' method (see above), and after 30 days' drying is sent to market in cases and barrels. It occurs in the form of "biscuits" and "sheets." Like all rubber coagulated by saline solutions, it is very "wet," and does not rank high in value. It may be remarked that these trees do not seem to have suffered from the recent droughts in Brazil. Further, that the rubber might be much improved in quality by a better method of preparation.

Other Rubbers.—There are a few other rubbers which are prepared as articles of commerce, but as yet scarcely known in British markets. "Palay" rubber is obtained from *Cryptostegia grandiflora*, a common plant on the coast of India. In Chittagong it is furnished by *Willughbeia edulis* and *W. martabanica.* Sumatran rubber is yielded by *W. prima*, and is exported to Holland. Malacca rubber is ascribed to *Urceola elastica.* The rubber of the Malay Archipelago is attributed to *Alstonia costulata* and *A. scholaris* ; and Fijian rubber is produced by *A. plumosa.* In N. Australia rubber has been procured from *Ficus macrophylla* and *F. rubiginosa* ; the latter is hardy, and has been recommended for culture.

Many other plants afford juices which coagulate on exposure, and bear more or less general resemblance to indiarubber. They may possibly be utilized when better known. They are chiefly as follows :—*Ficus anthelmintica*, the *cuaxinduba* of Brazil ; *F. Doliaria*, the *copaub-ucu* of Brazil ; *F. elliptica* of S. America ; *Cecropia peltata* of Tropical America ; *Artocarpus incisa*, the bread-fruit tree in Malaysia and Oceania ; *Galactodendron* [*Brosmium*] *utile*, in S. America, especially Venezuela ; *Lactaria calocarpa* and *L. Moorei* of New South Wales and Queensland ; *Tabernæmontana spp.*, in New South Wales, Queensland, and Malaysia ; *Plumaria phagædanica*, the *sucuuba* of Para (Brazil); *Cameraria latifolia* in Cuba ; *Gymnema lactiferum* of Ceylon ; *Chrysophyllum spp.* of Brazil ; *Sideroxylon spp.* of Malaysia ; *Kakosmanthus macrophyllus* of Java ; *Imbricaria coriacea* of Mauritius, Madagascar, and Java ; *Ceratophorus spp.* of Malaysia ; *Macaranga tomentosa* of the E. Indies ; *Sapium scoparium* of the Antilles ; *Hippomane Mancinella* of Tropical America ; *Euphorbia corollata* in Canada.

Commerce.—The commerce in rubbers, which may be said to be a growth of the last 25 years, has now attained great importance. Our imports of Indiarubber (termed "caoutchouc" in the Returns) were 158,692 cwt., value 1,536,660*l.* in 1876 ; 159,723 cwt., 1,484,794*l.*, in 1877 ; 149,724 cwt., 1,313,209*l.*, in 1878 ; 150,601 cwt., 1,626 290*l.*, in 1879 ; 169,587 cwt., 2,387,947*l.*, in 1880. The imports of 1880 were contributed as follows:—Brazil, 76,466 cwt., 1,297,373*l.*; W. Coast Africa, foreign, 22,922 cwt., 276,741*l* ; Straits Settlements, 11,582 cwt., 114,989*l.*; Bengal and Burma, 10,264 cwt., 114,416*l.* ; E. Coast Africa, 9,382 cwt., 129,886*l.* ;

W. Coast Africa, British, 7,271 cwt., 86,669*l.*; Aden, 6,720 cwt., 84,780*l.*; British S. Africa, 4,620 cwt., 42,653*l.*; Portugal, 3 871 cwt., 55,804*l.*; United States 3,799 cwt., 48,039*l.*; Central America, 2,440 cwt, 29,005*l.*; Holland, 1,576 cwt. 17,269*l.*; Mauritius, 1,550 cwt., 19,927*l.*; New Granada, (Colombia), 1,024 cwt., 12,165*l.*; other countries, 6,1?0 cwt., 58,251*l.*; total 169,587 cwt., 2,387,947*l.* Our exports in 1880 were as follows:--United States, 21,941 cwt., 282,894*l.*; Germany, 18,921 cwt., 269,086*l.*; Russia, 16,189 cwt., 261,252*l.*; France, 9,920 cwt., 112,597*l.*; Holland, 7,182 cwt., 101,068*l.*; other countries, 2,579 cwt., 36,878*l.*; total, 76,732 cwt., 1,063,775*l.*

A review of the fluctuations in the supplies during the past 5 years shows the following facts. Holland sent us 2,651 cwt, in 1876, 1,059 in 1878, and 1,576 in 1880. Portugal: 3,329 in 1877, 2,285 in 1879, 3,871 in 1880. Portuguese W. Africa: 3,881 in 1877, 1,822 in 1878, 5,248 in 1880. Portuguese E. Africa: 617 in 1876, 131 in 1877, 1,497 in 1880. Fernando Po: 241 in 1876, 52 in 1877, 277 in 1878, 117 in 1879, 248 in 1880. W. Coast Africa: 16,841 in 1876, 9,632 in 1878, 17,426 in 1880. E. Africa (native states): 1,263 in 1876, 7,855 in 1880. Madagascar: 32 in 1876, 83 in 1877, nil in 1878, 110 in 1879, 501 in 1880. Borneo: 15 in 1876, none since direct. Central America: 5,425 in 1876, gradually falling to 2,440 in 1880. Mexico: 62 in 1876, 291 in 1878, 50 in 1880. New Granada (Colombia): 3,398 in 1876, gradually falling to 1,024 in 1880. Venezuela: 521 in 1876, 354 in 1877, 710 in 1878, 482 in 1879, 986 in 1880. Brazil: 80,828 in 1876, 90,917 in 1878, 76,466 in 1880. Gambia and Sierra Leone: 2,827 in 1876, 5,641 in 1877, 3,808 in 1879, 7,104 in 1880. Gold Coast: 585 in 1876, 12 in 1879, 167 in 1880. Cape: 774 in 1876, 2,120 in 1877, 1,431 in 1878, 4620 in 1880. Aden: 2,494 in 1876, 1,254 in 1878, 6,720 in 1880. Mauritius: 1,790 in 1876, 570 in 1879, 1,550 in 1880. Bengal and Burma: 12,990 in 1876, 9 260 in 1878, 10,264 in 1880. Straits Settlements: 7,615 in 1876, 5,436 in 1878, 11,582 in 1800.

The exports of Bornean rubbers are included under guttapercha (pp. 1653-4) Of Brazilian ports, Ceara, in 1878, sent 40,377 *kilo.* to England, 258 to Hamburg, and 74 to Havre. Panama (in Colombia) sent 23,128*l.* worth of rubber to the United States in 1879. Costa Rica exported 27,854 lb of rubber in the year ending April 30, 1879; the quantities in previous years had been 57,213 in 1875, 59,427 in 1876, 90,576 in 1877, 78,231 in 1878; the shipments from the port of San Josè in 1880 were 11½ tons, 2,078*l.* Ecuador exported 7,059 *quintals*, value 24,707*l.*, in 1877; 6,561 *quintals*, 22,963*l.* in 1878 (of which 5,853 went to the United States, and 708 to England); 5,594 *quintals*, 33,564*l.*, in 1879; 7,995 *quintals*, 59,972*l.*, in 1880; in 1873, the exports were 16 365 *quintals*. Guatemala, in 1879, exported 1873, lb. to Belize, the value was 262 dol.; in 1877, the value was 2,723 dol. The exports from British India were 15,893 cwt., 108,645*l.*, in 1875; 15,258 cwt., 97,861., in 1876; 13,308 cwt., 90,199*l.*, in 1877; 13,794 cwt., 89,381*l.*, in 1878; 10,033 cwt., 61,685*l.*, in 1879. The exports from the Lakhimpur districts in 1871 were 250 tons, value 8,340*l.* Assam exported 11,000 *maunds* (of 82 lb.) in 1873, and Sikkim 700. The exports from Java were 704 *piculs* (of 135½ lb.) for the 1876 crop; 15 to Holland and 10 to Singapore for the 1877 crop; 47 to Holland and 15 to Singapore for the 1878 crop; 135 to Holland and 58 to Singapore for the 1879 crop. The values of exports of rubber from Madagascar to Mauritius have been 37,458*l.* in 1873, 21,452*l*, in 1874, 14,539*l.* in 1875, 9,770*l.* in 1876, 4,672*l.* in 1877. The Venezuelan exports were 2,545 lb. in British vessels, and 53,403 lb. in American, in 1878; and 27,563 lb. in American vessels in 1879. Mozambique exported 443*l.* worth in 1873, 22,198*l.* in 1876, and over 50,000*l.* in 1879; the figures have now probably reached their maximum, until roads shall have been made into the interior.

Values.—The approximate relative market values of the principal commercial rubbers entering London are as follows:—Para, fine, 2-3*s.* a lb.; negrohead, 1*s.* 6*d.*-2*s.* 6*d.* Central American, 1*s.* 6*d.*-2*s.* 6*d.* Assam and Pegu, 9*d.*-2*s.* 6*d.* Other E. Indian, 1*s.*-2*s.* 6*d.* Madagascar and Mozambique, 1*s.* 3*d.*-2*s.* 8*d.*

Suggested Improvements in Collecting and Preparing Rubbers.—The time of year at which the sap ascends to the flowers as an effect on the quantity of rubber yielded. Too frequent tapping causes each successive yield to be less rich in rubber and more watery, and permanently injures the trees. Judicious tapping has no ill result. As to the manner in which the tapping should be performed, this will vary somewhat according to circumstances. Some remarks on tapping and barking other kinds of tree will be found under Cinchona (see Drugs, p. 803), manna (see Drugs, p. 817), and maple-sugar (see Sugar); also under Copaiba, Gurjun, Peru, Tolu, Turpentines, and Varnishes, in the present article. The Brazilian plan of a perpendicular incision, with oblique tributary cuts on each side, has much to recommend it. Paring the bark, after the Ceara method, might also be advisable. The one great object to be kept in view is the avoidance of injury to the cambium layer. This is best effected by using an implement which is so made that it can only just remove or penetrate the bark sufficiently deep to reach the laticiferous vessels, residing mostly in the *mesophlœum* or middle layer of the bark. A modification of the knife used in marking standing timber, with the addition of a shoulder to adjust the amount of penetration, and a long handle, would probably meet all requirements. A clean cut, as opposed to a ragged one, not only heals readily, but keeps the product free from woody impurity.

The collected milk should be coagulated as rapidly as possible, for decomposition soon sets in, and materially modifies the character of the article. Some of the milks keep much longer than others without undergoing great change, but the collection of the day would always be best dealt with during the same day. It is undoubted that an effectual evaporative process for removing the water will produce a better article than any of the saline solution methods. A convenient form for the prepared rubber is thin (1-2 in.) sheets, which are easily packed into bales, and enable the amount of impurity to be readily arrived at.

CHEMISTRY, MANUFACTURE, AND INDUSTRIAL USES.

The remarkable body known as india-rubber is composed of carbon and hydrogen alone, but its exact chemical nature is not by any means known with certainty. The analyses of Faraday indicate that its ultimate composition is 87·5 per cent of carbon and 12·5 per cent of hydrogen; but there appears to be good ground for regarding the substance as a polymer of the group $C_{10}H_8$, or as $(C_{10}H_8)x$. There are, however, no data for estimating the value of x in this case. It will be noticed, too, that the formula given requires considerably less hydrogen than the proportion indicated by Faraday's analysis; but the difficulties of obtaining such a body as caoutchouc in a fit condition for analysis are so great as to render this discrepancy a matter of comparatively small import. The action of cold and heat on india-rubber presents many points of interest. When exposed to a temperature approaching 0° C., it gradually loses its softness and ready extensiblity, and finally becomes rigid and inelastic; but its normal condition may be restored by submitting it either to a temperature of 35° or 40° C., or to a tension sufficient to stretch it to about twice its natural length. In the latter case it is probable that the change is really due to heat arising from the physical disturbance consequent upon the act of stretching. The effects of heat are more complex and varied than those of cold; and with caoutchouc at an ordinary temperature say 15° C., the primary effect of heat is to increase its flexibility and elasticity. This is well illustrated by the fact that a strip of rubber stretched by a weight contracts when it is heated to a temperature of about 40° C. This diminution as regards length is, however, accompanied by a more than corresponding increase in thickness, on account of the expansion in volume due to an elevatad temperature. When caoutchouc is exposed to a temperature ranging between 100° and 120° C., it becomes considerably softened, and almost entirely loses its elasticity; but, if of good quality, it slowly recovers its former condition under the influence of a moderate degree of cold. When, however, the heat is pushed to 150°; it becomes viscous, and at 200° it fairly melts, forming a thick liquid which possess the same composition as ordinary caoutchouc, but has no tendency to resume its original condition even when exposed to cold for a prolonged period. At a still higher temperature, caoutchouc yields a variety of volatile hydrocarbons; and on subjection to dry distillation in a retort, its conversion into these bodies is tolerably complete, only a trifling carbonaceous residue remaining behind. Among the most notable volatile products resulting from the dry distillation of caoutchouc may be mentioned *caoutchin*, an oil-like body having a composition and vapour volume corresponding to the formula $C_{10}H_8$, and boiling at 171° C.; and *isoprene*, another hydrocarbon oil identical in composition with caoutchin and with caoutchouc itself, and boiling at 38° C. Other hydrocarbon oils are also formed, as, for example, *heveene* and *caoutchene*,—these being menbers of the $C_n H_{2n}$ series. The former boils at 228°, and the latter at 14·5°. The mixed products of the dry distillation of caoutchouc, often described under the name caoutchoucin, form an excellent but rather expensive solvent of this body. When exposed to the air, caoutchouc gradually oxidizes and undergoes deterioration; the oxidation is often much favoured by exposure to sunlight or to alternate conditions of dampness and dryness. The deteriorated caoutchouc is either somewhat soft and deficient in tensile strength or brittle and resinous in its nature. Spiller found 27·3 per cent of oxygen in a resinous product resulting from the decay of coautchouc. Ozone rapidly attacks and destroys the substance.

Dilute acids or alkalies have little or no action on caoutchouc, but strong and hot sulphuric acid chars and concentrated nitric acid rapidly oxidizes and destroys it. The moderate action of either chlorine, bromine, or iodine hardens or vulcanizes it; but if allowed to act freely, they completely destroy it. The action of sulphur will be considered below.

Caoutchouc, when pure, is odourless and nearly white, and possesses a specific gravity of ·915. It is porous and cellular in texture, and absorbs from 10 to 25 per cent by weight of water when long soaked in it. Alcohol is similarly taken up. Up to this point caoutchouc has been referred to as if it consisted of one substance only, but as a matter of fact all ordinary samples contain two distinct modifications, viz. the hard or fibrous and the soft or viscous. These two caoutchoucs are identical in composition, and similar as regards general properties and reactions. On subjecting a piece of raw caoutchouc, however, to the action of such a solvent as cold benzol, the essential difference between the two forms manifests itself. The fibrous or hard constituent merely swells up to many times its original bulk, but the viscous yields a true solution. In a high class rubber, such as that imported from the province of Pará, the former modification is the principal factor; in a caoutchouc of low quality, such as "African tongue," the latter. Freshly cut surfaces of caoutchouc unite together firmly; and this circumstance is due to the presence of the viscous variety; vulcanization by hardening this destroys the adhesive property.

Certain liquids, such as benzol and its homologues, carbon disulphide, petroleum, ether, volatile oils, chloroform, and melted naphthalene, dissolve caoutchouc more or less perfectly; but unless the subtsance has been subjected to the process of mastication, its fibrous constituent appears, not to dissolve in the strict sense of the term, but rather to swell up forming a past analogous to starch which has been acted on by hot water. Carbon disulphide and chloroform, however, exercise a more powerful solvent action on the fibrous parts of india-rubber than benzol or essential oils; and Payen has found that carbon disulphide to which 5 per cent of absolute alcohol has been added forms one of the best solvents. One part of masticated caoutchouc dissolved in thirty parts of this solvent forms a liquid which can be filtered through paper, and which leaves a film of exquisite tenuity and purity when allowed to dry on a level glass plate.

Most fatty matters exercise a remarkable destructive action on caoutchouc, causing it to become first soft, and afterwards hard and brittle. It has often happened that traces of fatty oils in the liquids employed for dissolving india-rubber, or fatty matter in the textile basis, have led to the destruction of waterproof goods. A like cause has in many cases led to the rapid deterioration of the caoutchouc threads in elastic webbing.

In the industrial working of india-rubber, the first matter to be attended to is the removal of the various impurities present in the crude material. These are in some cases natural products which have originated with the caoutchouc, while in other cases they owe their presence to careless collection or to adulteration. Among the impurities of the former class may be mentioned various gum-like or mucilaginous matters, and acid products arising from their decay or oxidation. A remarkable volatile body, which is probably of the nature of a polyatomic alcohol, has been discovered by Gerard* in the crude caoutchouc from the Gaboon. This substance, called by the discoverer *dambonite*, has a composition corresponding to the formula $C_4H_8O_3$, is sweetish to the taste and soluble in water, and crystallizes in needles which melt at 190° C. and volatilize between 200° and 210°. The admixtures may range from fragments of bark or wood to stones or large lumps of clay, such as are sometimes introduced into negrohead rubber,—hay or a similar substance being also placed inside to make the mass about equal in specific gravity to the genuine article. Alum and sulphuric acid are often employed to effect the coagulation of the juice; and traces of the latter remaining in the rubber appear, in some instances, to work mischief.

All the above-mentioned impurities are in actual practice very efficiently removed by the following process:—The lumps of crude caoutchouc are first softened by the prolonged action of hot water, and then cut into slices by means of a sharp knife,—generally by hand, as thus any large stones or other foreign substances can be removed. The softened slices are now repeatedly passed between grooved rollers, known as the washing rollers (fig. 7), a supply of hot or cold water being made to flow over them. Solid-impurities speedily become crushed, and are carried away by the water, while the rubber takes the form of an irregular sheet perforated by numerous holes. The washed product contains in its pores a notable proportion of water, which is removed by hanging the rubber for some days in a warm room. It is now ready either for incorporation with sulphur and other solid bodies, or for agglomeration into solid masses by means of the masticating machine,—an apparatus which consists of a strong cylindrical cast-iron casing, inside which there revolves a metal cylinder with a fluted or corrugated surface. Some of the rubber having been placed in the annular space between the inner cylinder and the outer casing, the former is made to revolve; and the continued kneading action to which the rubber is subjected works it into a solid mass, something like a gigantic sausage. Before commencing the mastication it is generally necessary to warm the apparatus by means of steam; but as the operation proceeds the heat produced requires to be moderated by streams of cold water flowing through channels provided for the purpose. The inner cylinder is generally placed somewhat excentrically in the outer casing, in order to render the kneading more perfect than would otherwise be the case.

To convert the masticated rubber into rectangular blocks, it is first softened by heat, and then forced into iron boxes or moulds. The blocks are cut into thin sheets by means of a sharp knife, which is caused to move to and fro about two thousand times per minute, the knife being kept moistened with water, and the block fed up to it by mechanical means. Cut sheets are largely used for the fabrication of certain classes of rubber goods,—these being made by cementing the sheets together with a solution of rubber in coal-naphtha or benzol. Most articles made of cut sheets rubber would, however, be of very limited utility were they not hardened, or vulcanized by the action of sulphur or some compound of that element. After vulcanization, rubber is no longer softened by a moderate heat, a temperature of 160° C. scarcely effecting it, nor is it rendered rigid by cold, and the ordinary solvents fail to dissolve it. It must, however, be distinctly understood that it is not the mere admixture but the actual

* *Compt. Rend.*, lxvii. p. 820, and *Zeitschrift fur Chem.*, 1896, p. 66.

combination of sulphur with india-rubber that causes vulcanization. If an article made of cut sheet be immersed for a few minutes in a bath of melted sulphur, maintained at a temperature of 120° C., the rubber absorbs about one-tenth of its weight of that element, and, although somewhat yellowish in colour from the presence of free sulphur, it is still unvulcanized, and unaltered as regards general properties. If, however, it be now subjected for an hour or so to a temperature of 140° C., true combination sets in, and vulcanized caoutchouc is the result. When a manufactured article has been saturated with sulphur in the melted-sulphur bath, the heat necessary for vulcanization may be obtained either by high-pressure steam, by heated glycerin, or by immersion in a sulphur-bath heated to about 140° C. In this last case absorption of the sulphur and its intimate combination with the rubber occur simultaneously. Cut sheets, or articles made from them, may be saturated by being laid in powdered sulphur maintained for some hours about 110° C. Sheets sulphured in this way can be made up into articles and joined together either by warming the parts to be united, or by means of india-rubber solution ; after which the true vulcanization, or "curing" as it is termed, can be brought about in the usual way. Another method of vulcanizing articles made from cut sheet rubber consists in exposing them to the action of chloride of sulphur. Either they are placed in a leaden cupboard into which the vapour is introduced, or they are dipped for a few seconds in a mixture of one part of chloride of sulphur and forty parts of carbon disulphide of purified light petroleum. Vulcanization takes place in the instance without the action of heat ; but it is usual to subject the goods for a short time to a temperature of 40° C. after their removal from the solution, in order to drive off the liquid which has been absorbed, and to ensure a sufficient action of the chloride of sulphur. Treatment with a warm alkaline solution is afterwards advisable, in order to remove traces of hydrochloric acid generated during the process. Another very excellent method of vulcanizing cut sheet goods consists in placing them in a solution of the polysulphides of calcium at a temperature of 140° C. Rubber employed for the manufacture of cut sheet is often coloured by such pigments as vermilion, oxide of chromium, ultramarine, orpiment, antimony, lamp black, or oxide of zinc, incorporation being effected either by means of the masticator or by a pair of rollers heated internally by steam and so geared as to move in contrary directions at unequal speed. Most of the rubber now manufactured is not combined with sulphur when in the form of sheets, but is mechanically incorporated with about one-tenth of its weight of that substance by means of the mixing rollers,—any required pigment or other matters, such as whiting or barium sulphate, being added. The mixed rubber thus obtained is readily softened by heat, and can be very easily worked into any desired form or rolled into sheets by an apparatus known as the calendering machine. Vulcanization is then ensured by exposure for half an hour or more to a temperature of 135°—150° C., usually in closed iron vessels into which high-pressure steam is admitted. Tubes are generally made up around mandrels, and allowed throughout the curing to remain imbedded in pulverized French chalk which affords a useful support for many articles that tend to lose their shape during the process. Of late years a considerable amount of seamless tubing has been made, much in the same way as lead piping by forcing the mixed rubber through a die, and curing as above. The calendered sheets are generally cured between folds of wet cloth, the markings of which they retain ; and hollow articles, such as playing balls or injection bottles, are vulcanized in iron or brass moulds, tinned inside and very slightly greased. Before it is put in, the article is roughly put together, and the expansion of the included air forces the rubber into contact with the internal surface of the mould, or a little carbonate of ammonia is enclosed. Belting intended for driving machinery is built up of canvas which has been thoroughly frictioned with the soft mixed rubber, and is cured by placing it in a kind of press kept by means of steam at a dry heat of about 140° C. Packing for the stuffing boxes of steam engines is similarly prepared from strips of rubber and frictioned canvas, as also are the so-called insertion sheets, in which layers of rubber alternate with canvas or even wire gauze. India-rubber stereotypes are now extensively made use of as hand stamps, and attempts have been made to introduce them for press and machine printing. A plaster cast of the type is, when dry, saturated with shellac varnish and re-dried. Rubber mixed in the usual way with about 10 per cent of sulphur is now softened by heat, forced into the mould, and retained there by pressure during the operation of curing, which is usually effected in an iron box heated over a gas burner to 140° C.

The ordinary macintosh or water proof cloth is prepared by spreading on the textile fabric layer after layer of India-rubber paste or solution made with benzol or coal-naphtha. If cotton or linen is used it is usual to incorporate sulphur with the paste, and to effect vulcanization by steam heat; but, when silk or wool is employed, no sulphur is added to the paste, the dried coating of rubber being merely brought into momentary contact with the mixture of chloride of sulphur and carbon disulphide already mentioned. Double texture goods are made by uniting the rubber surfaces of two pieces of the coated material. Air goods, such as cushions, beds, gas bags, and so forth, are made of textile fabrics which have been coated with mixed rubber either by the spreading process above described, or by means of heated rollers, the curing being then effected by steam heat. The manufacture of overshoes and fishing boots is an analogous process, only the canvas base is more thickly coated with a highly pigmented rubber of low quality. The articles are first fashioned by joining the soft material; they are then varnished, and afterwards cured in ovens heated to about 135° C. The fine vulcanized "spread sheets" are made by spreading layers of india-rubber solution, already charged with the requisite proportion of sulphur, on a textile base previously prepared with a mixture of paste, glue, and treacle. Vulcanization is then effected by steam heat, and the preparation on the cloth being softened by water, the sheet of rubber is readily removed. The required thickness of the spread sheet is very often secured by the rubber-faced surfaces of two cloths being united before curing. The threads used in making elastic webbing are usually cut from spread sheets. The manufacture of springs, valves, and washers does not require any very special notice, these articles being generally fashioned out of mixed rubber, and vulcanized either in moulds or in powdered French chalk. Rollers are made to adhere to their metal spindles by the intervention of a layer of ebonite, and after vulcanization they are turned. In order to make spongy or porous rubber, some material is incorporated which will give off gas or vapour at the vulcanizing temperature,--such as carbonate of ammonia, crystalized alum, and finely ground damp sawdust. Uncombined sulphur is injurious, and often leads to the decay of vulcanized goods; but an excess of sulphur is generally required in order to ensure perfect vulcanization. Sometimes the excess is partially removed by boiling the finished goods with solution of caustic soda or some other solvent of sulphur. In other cases the injurious effects of free sulphur are obviated by using instead of it a metallic sulphide,—generally the orange sulphide of antimony; but, for the best results, it is necessary that this should contain from 20 to 30 per cent of uncombined sulphur.

When the vulcanization of rubber is carried too far—say from the presence of a very large proportion of sulphur and unduly long action of heat, the caoutchouc becomes hard, horn-like, and often black. Rubber hardened by over vulcanization is largely manufactured under the name ebonite or vulcanite. It is usually made by incorporating about 40 per cent of sulphur with purified Borneo rubber by means of the usual mixing rollers, shaping the required articles out of the mass thus obtained, and heating for six, eight, or ten hours to from 135° to 150°. Ebonite takes a fine polish, and is valuable to the electrician on account of its insulating properties, and to chemist and photographer because vessels made of it are unaffected by most chemical reagents. A kind of vulcanite which contains a very large proportion of vermilion is used, under the name of dental rubber, by making artificial gums.

The following list of works and papers on the rubber industry enumerates the writings which are calculated to be especially useful to the enquirer:—Charles Goodyear, *Gum Elastic and its Varieties*, New Haven, U. S. A., 1853; Friedrich Harzer, *Gutta-Percha and Kautschuk ihr Vorkommen*, &c., Weimar, 1853; Paulin Desormeaux, *Nouveau manuel complet du fabricant d'objects en* *caoutchouc en gutta-percha, et en gomme factice* 424 pp., Paris 1855; C. H. Schmidt, *Der Fabricant von Kautschuk und Gutta-Percha Waaren* 207 pp., Weimer 1856; Thomas Hancock, *Origin and Progress of the India-Rubber Manufacture in England*, London 1857; Heinrich Keysserling's edition of Friedrich Harzer's *Gutta-Percha und Kautschuk*, 237 pp., and atlas, Weimar, 1864: *Abridgments of specifications relating to the Preparation of India-rubber and Gutta-percha*, 1791-1866, 262 pp., printed by order of the Commissioners of Patents, London 1875; "India-Rubber and Gutta-Percha," a series of articles in the *Universal Engineer*, vol. ii., Manchester 1879; Franz Clouth, *Die Kautschuk Industrie* 76, pp., Weimar 1879; T. Bolas, *Cantor Lectures on the India-Rubber and Gutta-Percha Industries*, London, 1880; M. Maigne, *Nouveau manuel complet du fabricant d'objets en caoutchouc*, &c., 2 vols, 506 dp., Paris, 1880. (T. B.)

NOTES ON CAOUTCHOUC.

BY G. W. STRETTELL.

NATURAL ORDER APOCYNACEÆ—*(Lind.)* DOGBANE TRIBE.

Chavannesia esculenta. Vernacular (in Burmah) "Kyet-poung-hpo."

DESCRIPTION.—Trees or shrubs, usually milky, allied to the *Asclepiadaceæ*, and differing from them in the contorted æstivation of the corolla, distinct filaments, granular pollen, and a peculiar hour-glass-like stigma.

DISTRIBUTION.—Natives of the tropics of Asia, America and Africa. Known species, 570. *Ill. Gen.*,—Allamanda, Carissa, Cerbera, Taughinia, Urceola, Vinca, Plumiera, Balfouria, Strophanthus, Nerium, Apocynum, Echites, Cleghornia, Mandevilla.

PROPERTIES.—Many of the plants are poisonous, some are drastic purgatives. The bark is sometimes tonic and febrifugal. The milk of several species supplies caoutchouc.—*V.K. p.* 599.

As far back as 1860 we find in Mason's *Burma* the following mention of a gum-elastic-yielding creeper, whose caoutchouc is scarcely inferior to that of the *Ficus elastica*, and which as recently as last August was valued by a European firm in Rangoon at R200 per 100 viss.

As indigenous creeper yields caoutchouc not at all inferior to that which is obtained from the elastic fig-tree. The Agricutural and Horticultural Society in reporting on a specimen sent them by Major Macfarquhar, of Tavoy, observed, with care in preparing, it would be equal to the best South American. I have never seen the plant in flower, but, to judge from the fruit, it belongs to the dogbani tribe, and *echites* group, for its seeds are comose above. It was stated in the *Friend of India* a few months ago that Captain Power had forwarded specimens of India rubber from Rangoon, the exudation of a plant supposed to be the *Urceola elastica*. In the absence of any description of the plant, we may suppose it identical with the one in the Tenasserim Provinces. Mr. Parish writes me—"I think you are right, and I believe the plant to be *Echites macrophylla* (Wight). It is a splendid creeper, and yields apparently excellent caoutchouc. I find it on Beluguen."

2. My attention was first drawn to this creeper when crossing the hills east of Talo last January, lat. 25° 33′, long. 97° 49′, elevation 2,300 feet. Halting at the Kachyen hamlet of Nansing to give my people a half hour's rest preparatory to making our next ascent and encamping for the night, my attention was drawn to a Kachyen girl busily engaged dyeing some homespun thread, with what appeared indigo, before arranging it for the loom. This turned out to be a mere decoction obtained from equal parts of the leaves of the *Ruellia indigofera* and *Chavannesia esculenta.** So good was the imitation

* Mr. S. Kurz, in reply to a reference I made, kindly wrote as follows.—"The drawing and Plant of *Chavennesia esculenta* is chiefly found in Tenasserim and Martaban, and was not known to occur also in Peru. I myself did not meet with

(*Note continued next page.*)

to what I mistook it for, that it would require some little experience in the two dyes to distinguish the difference, and I would strongly urge its introduction into the jail as a substitute for indigo.

3. The next morning, shortly after leaving Nansing, we came on this creeper growing in prolific abundance all over the forest, a large proportion of the trees being entwined by it. I collected specimens of the leaves and milk, which latter I found had partially consolidated within a few hours of tapping. Now, for the first time I learnt from my interpreter that this creeper was not only common to our own forests, but even cultivated by the people on account of its fruit, which has an agreeable acid taste, and, being in season when tamarinds are not procurable, is readily purchased by the Burmans for culinary purposes, and sells in Rangoon at an anna per bunch of ten pods.

4. On my return to Rangoon, I found Mr. Nepean had been writing on the subject of different milk-producing shrubs, one of which he reported to be *Landolphia owariensis*; but this was a mistake, and as he seemed quite to have lost the art of producing caoutchouc similar to the sample forwarded with his letter, I did not interest myself more in his writings, but worked out results for myself. I prepared specimens of Indiarubber obtained from the *Chavannesia esculenta* growing within a few miles of Magayee, and solicited the favor of Mr. Hervey, late Assistant Superintendent of Telegraphs, kindly submitting it to an electric test; his report I here quote verbatim:—

"I have carefully tested this piece (A) of rubber with the only apparatus we have for the purpose. It is not, I am sorry to say, as sensitive as it might be, but with a battery of 16 cells not the slightest current passed through it;—for insulation it may be said to be perfect, but to what degree I cannot say, as we have nothing to measure it by. The rubber was soaking in water all Saturday afternoon and yesterday, and has stood that test apparently without any change whatever."

5. I next addressed Messrs. Galbraith, Dalziel & Co. on the subject of its marketable value, and their reply I also quote *ipsissimis verbis*:—

"In reply to your favor of yesterday's date, No. 534, accompanied by specimens of caoutchouc, the quantity sent is scarcely sufficient to give a proper opinion of the quality: judging, however, from what you have sent, we consider the quality to be very fair, and at the present market value of about R200 per 100 viss. We will thank you if you will procure and send us a good parcel,—say about 100 viss,—which we will pay for at the foregoing rate if of equal quality to the specimens herewith referred."

6. I then subjected my manufacture to a few chemical tests, which gave the following results, and will be found to nearly correspond will those obtained from *Siphonia cahnchu.* It is insouluble in water, acids, or alchol, but dissolves in æther, bi-sulphuret of carbon, oil of sassafrass, and turpentine. When formed into solution by æther, its properties remain unchanged on evaporation of the menstruum. Specific gravity of consolidated caoutchouc, 1975.

7. More recently, Mr. Galbraith very kindly also had the specimens submitted to chemical analysis, which showed that "rubber tried by all the usual solvents gave the same results as ordinary rubber; it also produced oil-rubber by distillation."

8. The foregoing data, then, I think is sufficiently encouraging to warrant the cultivation of this creeper being introduced as a branch of forest administration on an extensive and systematic plan; and it is only astonishing that so valuable a product in which our forests abound should have remained thus long unutilized or thought of.*

(*Continued.*)

the plant, or more probably overlooked it. A very similar plant, of which I enclose a leaf, is common on the Pegu Yoma, and is *Anodendron paniculatum (a)*. It is easily distinguished by the nerves and tranverse venation beneath being very obsolete, while in your plant they are very prominent. It produces also caoutchouc, but of what quality I do not know." * * * *

[a] *Note.*—I have also specimens of this creeper, but the rubber is far inferior, and less elastic than C. *esculenta.*—G.W.S.

* *Chavannesia esculenta* is one of the several creepers for whose extermination in teak tracts an annual budget provision is made.

9. I will now deal with the system under which I would suggest this creeper be cultivated by the Forest Department; but before this can be successfully accomplished, we must have some more definite control over the areas within forest limits than what at present exists.

10. This creeper may be propagated either from seeds or cuttings. The former I would recommend, as natural reproduction is abundant wherever the creeper grows, and we can make certain of results if the plant lives; but not so with cuttings, which do not in every instance equal the parent tree—a phenomenon in vegetable physiology yet to be accounted for. Regarding the mode of planting, we must for the present follow the natural habit of the plant, which is to entwine itself round its more stalwart companions of the forest, reaching from one to another in the most fantastic forms and shapes, until its trunk has gained sufficient strength to make it independent of its original support, which may long since have fallen a victim to its suffocating embrace.

11. There is no necessity to preserve any fixed distance at which to plant this creeper, nor to go to any great expense in starting the system. Let seedlings be established at the base of every tree unsuited for other purposes, within a given area, which for the present need not exceed 400 acres. There are plenty of such sites to be found near the Magayee plantation, but it will be necessary at once to put a stop to the felling of all descriptions of trees, and to guard against fires and cattle-trespass.

12. Planting should commence immediately the rains have set in, and vegetable life has taken a fresh start; natural reproduction then being plentiful, seedlings may be collected and planted at a reasonable cost; but, to guard against blanks from any unforseen causes, nurseries of half-an-acre each should also be established in localities where artificial irrigation may be conducted at a reasonable rate. This will admit of the nursery operations being commenced about April, so that by the middle of the monsoon the seedlings will have made sufficient growth to admit of their establihing themselves in their new homes before the cold season comes on.

13. In respect to soil, the difficulty would be to name a class unsuited to this creeper, for I have seen it growing in luxuriant profusion in localities where the soil was antipodal, both as regards the organic and inorganic components. In the quasi-evergreen, mixed *Dipterocarpus* belt which intersects the vegetation of the plains and that of the more hilly tracts adjoining the Magayee plantation, the soil is all that could be desired; but care of course must be taken not to select marshy land, nor land where water is stagnant.

14. No indisputable information being obtainable as regards the rate of growth of this creeper, the following figures must be received with caution, though every effort has been made to secure the most reliable data by a comparison of statements made by the different parties who have propagated the creeper for the benefit of its fruit. The following measurements were obtained from creepers growing near Rangoon and Thamine:—

"No. I.—Growing on *Acacia concenna* of 18 feet high, with trunk 5 feet from the ground, 18 inches circumference. Thickest stem of *G. esculenta*, 9 inches circumference. Space covered by crown branches, 300 square feet, age said to be five years; growing on laterite soil.

"II.—Originally started on *Malicocca trijuga*, but now entwines three trees. Thickest portion of stem 11 inches. Soil, sandy loam. Said to be seven years old.

"No. III.—Originally entwined on Mango, now extends over four trees. Thickest portion of stem, $10\frac{1}{2}$ inches. Soil sandy loam. Said to be seven years old."

15. "Now, allowing the foregoing data to be approximately correct, and assuming the trees to be 30 feet apart, the following details will enable us to form a fair idea of the probable financial results. Area to be cultivated 400 acrse. Trees at 30 feet by 30 feet, equal per acre 48, or 19,200 creepers in 400 acres. Minimum yield of caoutchouc per annum, estimated at one viss per creeper, equals 19,200 viss, or at R200 per 100 viss, R38,400 per annum.

16. The cost of starting this project will be trifling in the extreme. All that will be necessary ought not to exceed, on an average of seven years,

R4 per acre per annum. After the first year the creepers will have attained a sufficient height to require little or no further attention, beyond, of course, protection from fire, &c. Thus, at the end of seven years the cost on 400 acres would represent R11,200 ; and even this expenditure might be reduced if Shans or others were induced to sell their labour for the privilege of cultivation within the area free of taxes ; while a still further reduction might be brought about by intermediate sowing, tapping each alternate creeper to death immediately it commenced to interfere with its neighbour.

17. At the expiration of seven years the expenses will embrace tapping, pressing, and preparing the caoutchouc, which I estimate at 12½ per cent. of the profits. According to these figures and the present market value of the Indiarubber of this creeper, the net assets of this scheme may be approximated at R33,600 per annum.

18. The milk of this creeper apparently more readily coagulates than that of the *Ficus elastica*, for I have known it resolved into a coagulum floating in an aqueous solution within a few hours, after collecting, and without exposure to the direct rays of the sun, or artificial heat of any sort. This consolidated mass should be collected at once, and all moisture expelled by means of graduated pressure, to be accomplished either by a sort of mangle, or press something on the principle of a cutch-press, the side being perforated, so as to admit of thorough drainage. The aqueous portion however, should not be thrown away, for it still holds in suspension particles of caoutchouc which will solidify and coalesce if subjected to artificial heat and a final system of pressing will produce rubber equally valuable to that in which the coagulum had formed unassisted.

19. The lactiferous vessels are those that yield the inspissated milk *sui generis*, and flows most abundantly from the *mesophlœum*. When tapping, care should be taken not to cut into the sap-wood. To those unacquainted with this subject, the most practical way of understanding what is implied by the *Cinenchyma* vessels and *mesophlœum*, is to cut a deep V into the wood and watch whence the inspissated secretions flow. This is the method I adopted to tutor a couple of my men, both of whom can now make the incisions and tap with unfailing accuracy.

20. The cut I adopt is in the form of an arrow, and the incisions are made on three sides of the stem. The tiers of arrows should be three feet apart, and so regulated that the cuts do not come in a perpendicular line with those below. At the point of the arrow I attach a funnel, formed out of the leaves of the *Butea frondosa*, which readily attaches itself to the tree, from the glutinous nature of the milk. Any other leaves will answer equally well if sufficiently large, and proof against cracking. I have named the *Butea frondosa* as the one I used and found to answer the purpose.

21. Burmans, like most other eastern races, are an improvident lot, and always ready to kill the goose for the golden egg : they will cut down a tree rather than climb it for the fruit, as I have often observed : and so with the tapping of trees,—if they are not looked after, to save trouble, they lop off the branches and collect the milk from the amputated ex-extremities.

22. The season for tapping these trees is about the end of April. Between October and March circulation is slow, and milk scarce : but during the rains the milk is more aqueous, and flows more readily. To give the system a start, and stimulate others to bring the caoutchouc into the market, I have arranged with a Burman to purchase any quantity of the milky emulsion at a fixed rate, to be delivered either at Rangoon or Magayee. The art of manufacturing caoutchouc not being known to the people about here, I have been in a measure obliged to agree to terms that under other circumstances I should have declined —I refer to delivering the milk in a liquid state, and also to its delivery at the former station ; but under other conditions, I found the plan was likely to fall through, and, as the system can be re-organized at any moment, we must not be too particular at the start off.

23. Since completing this paper, Mr. Galbraith, senior partner of Messrs. Galbraith, Dalziel, & Co., informs me that his chemical tests prove the rubber of *C. esculenta* to be purer, and better suited to their purposes, than that obtained from the *Ficus elastica*.

Tapping Operation referred to at page xxxix, *para* 20.

FROM A REPORT ON THE CAOUTCHOUC OF COMMERCE

BY JAMES COLLINS, F.R.S., EDIN.

Improvement in the Collection and Preparation of the Caoutchouc.

Improvements should be effected in the collection and preparation of the Caoutchouc of the *Ficus elastica.* The time of year at which the milk sap ascends to the flowers has an effect on the quantity of Caoutchouc yielded. At the time of flowering of the Heveas scarcely any milk can be obtained from the trunk, whereas the panicles if cut, yield it in large drops. If a tree be tapped too often, without a sufficient period of rest being allowed to intervene between each successive operation, each successive yield is less rich in Caoutchouc and more watery and the tree itself becomes permanently injured. In the wet season there is a larger percentage of water in the milk than in the dry season, and therefore the collection is not so profitable. The time best suited in Assam, Mr. Mann finds to be February, March and April. After tapping, a period of at least three years should elapse before the operation is repeated in order to allow the tree to recover its strength. Judicious tapping does not injure a tree nor check its growth, but the danger lies in over-tapping or bleeding to death. Natives always resort to over-tapping if left to themselves. This impoverishes the tree, and predisposes it to succumb to atmospheric changes, and to the attacks of insects, for healthy trees are not so liable to these latter destructive agents, and very seldom does a tree so injured long survive these united influences.

Mode of Tapping.—In temperate climates, the only tree which is tapped for its juice is the sugar maple (*Acer saccharinum*, L.). This is tapped with an auger $\frac{3}{4}$ inch in diameter. The trees are perforated with two holes, four or five inches apart, in an oblique ascending direction, 18 or 20 inches from the ground, care being taken that the perforation does not enter too deep. The sap is allowed to run down small channels consisting of split elder stems, &c. When these precautions are taken the tree is uninjured, the wood alone being somewhat softer and less durable, as is the case in the wood of all "tapped" trees.

From the Manna Ash of Calabria and Sicily (*Fraxinus oruns*, L.) the sweet concrete exudation known as Manna is obtained by incisions in the bark of the tree. The tree is not tapped till it has ceased to produce new leaves. Cross or transverse cuts about 2 inches long, are made with a hooked or curved knife. This is only done on one side in the season. The following year the incisions are made further round the tree so that in three or four years the first line of cuts is returned to.

In Nicaragua the Ule tree (*Castilloa elastica, &c.*) is tapped in the form of a spiral, surrounding the tree at an inclination of about 45°. A single tree often requires 2,000 cuts to complete the surrounding. If the tree be large, two such spirals are made, either cutting each other or running parallel to each other. This is however a very injurious manner.

In Pará, Guiana, &c., in tapping the Seringa (*Heveae* sps.) a long perpendicular incision is made from near the base and extending high up the trunk. On each side of this line and meeting it are numerous small oblique cuts. Sometimes a basal cut is made extending some distance round the trunk on each side of the vertical cut. This mode of tapping, especially if made without the basal cut and with slight modifications to suit particular cases, has much to recommend it as it is equally applicable to large and small trees, and in the case of the *Ficus elastica,* which is a congregation of stems, and where all sides are not equally accessible, it can be adopted with ease, whereas the spiral incision can only be used where the whole of the circumference of the trunk is accessible. In the tapping of the stems of *Ficus*, where deeply furrowed, the vertical line alone could be used or diagonal cuts only on the side best suited, and in tapping roots one long cut could be made so inclined as to form a natural channel with smaller ones about it.

Implements used.— In South America and other countries machetes (small axes) or long knives are used. All these are very bad, as in their slovenly use the tree is gashed in a frightful manner. The huleros in Nicaragua, for instance, before withdrawing the axe after a cut is made, press heavily on the handle in order to open the wound as much as possible, thus extending the injury to a considerable distance.

In tapping, the greatest care should be taken not to injure the *Cambium layer.* This *Cambium layer* is situated on the outside of each annual zone, and is a layer of vitally active cells, in which the new layers of bark and wood are elaborated and given off. If injured, the wood and bark suffer and no new bark consequently cicatrises over the wound. Mr. McIvor's very successful and interesting physiologycal operation in removing bark from living *Cinchonæ* owes its success to the care taken in order to ensure this *Cambium layer* from injury.

The only effect to provide in such an implement is that it should just remove or cut through sufficient bark to rupture the lactiferous vessels, situated principally in the middle or *Mesophlœum* layer of the bark, and thus allow the milk to escape. The very formation of such a tool should prevent the possibility of "hacking or chopping through the bark. The Manna knives are good for their purpose, and Mr. Mann has sent me a knife which had before suggested itself to me and which is used in the forests of Hanover for marking standing timber, and in this country also for marking timber, and which I have found, when I had occasion to use it for some little time, exceedingly well adapted to the purpose. A similar knife is also used by farriers. The blade which when open forms an obtuse angle with the handle, has its end bent round in a U shape, the lower of it being the only cutting edge. If a few such blades of a larger size, fixed or fixable to long handles for reaching up the trunks of trees, were tried, I believe they would prove a good kind of tool to use. Certain modifications might be made, as possibly to make the point more of a V shape, and a guard running through it such as oyster or preserved meat tin knives are provided with might be added.

After fully considering the various requisite points in order to produce the best form of cutting instrument, I have constructed a small model which I send herewith, and of which a drawing is given. In using it, it is drawn towards the operator, against the bark. The first part of the blade is sharp so as to cut through the bark. This blade gradually widens at its base till at its termination it is wedge-shaped. Above the blade a shoulder projects. The wedge-shaped cutting edge opens the bark just sufficient to allow of the escape of the milk. The shoulder prevents the knife penetrating too deeply, thus preserving the wood from injury. The relative distance between the knife edge and the shoulders can be made according to the thickness of the bark in different species, as all that is necessary is to rupture the milk vessels (*lactiferous tissue* or *Cinenchyma*). The advantages of this instrument I take to be that of removing no portion of bark, and thus not hindering cicatrization ; doing away with the possibility of "hacking ;" and also I believe if tried would prove itself a simple and effectual instrument. The handle can be made long or short, or both, as experience may dictate. It may also be made in clasp knife form, the blade when opened forming a more or less obtuse angle with the back of the handle.

Collecting Vessels.—The general collection vessels are leaves folded up in funnel fashion, clay plastered to the trunk of the tree, or calabashes. Clay contaminates the milk in a very objectionable manner. Iron vessels large enough to hold the product of a single tree might be provided. One side of them might be slightly concave in order to accommodate its side to the tree. Large vessels of the same material would be necessary for the different gatherings.

Preparation of the Caoutchouc.—In reviewing the different methods by which the particles of Caoutchouc are caused to coalesce, from the whey-like liquid in which it is suspended in its recent state, we find they are various. We may however classify them thus :—

Group i.—Coalescence brought about by heat—Examples :

(1.) Artificial heat (dry) - Pará, Madagascar.
(2.) ,, (hot water) - Assam.
(3.) Natural heat - - Assam Ceará.

Group ii.—Coalescence brought about by the addition of various substances;

(4.)	Alum - - -	Pará.
(5.)	Liq. Ammoniæ fort ? -	Pará African (best kinds.)
(6.)	An acid ? (acetic acid ?)	Pará.
(7.)	Certain plants - -	Nicaragua.
(8.)	Fresh water - -	Nicaragua.
(9.)	Salt water - -	Borneo, Madagascar.
(10.)	Sulphur - - -	Pará.

Of these various methods that by cautious application of dry heat is generally accounted the best and the Pará Caoutchouc of the best description is prepared in this manner. The action of the Urucuri and other nuts (*Attalea excelsa*, Mart. &c.) I cannot altogether understand; I am inclined to look upon it as only a ready means which has suggested itself of drying the Caoutchouc without injuring or affecting its quality. The heat of a naked fire would if great care were not taken burn the Caoutchouc; and because it is a convenient and safe method, and fulfills the desired conditions, it may have at last come to be looked upon as essential. Certain I am that it has no blackening action as is so frequently stated. That this blackening is due to atmospheric influences can be easily verified by any one taking a piece of thick Pará Caoutchouc, cutting it through so as to expose the white or yellowish white centre, and notice how soon the white will be changed to black by the influence of light and air.* The cautious application of heat especially if supplemented by the fumes of melted sulphur, which I believe is used in Pará, would and does furnish the best *prepared* Caoutchouc. Of natural heat, or allowing the Caoutchouc to coalesce and the water to evaporate spontaneously, through the Caoutchouc is in as good a condition as the tree can yield it, yet it always has masses of bark adhering to it, and necessitates a a second visit being paid to the tree, and this alone is objectionable as the scene of operation has constantly to be shifted.

Of the addition of various substances such as alum and certain plants the action seems to be similar to that of rennet on casein, but I have had no opportunity afforded me of testing the precise action of these substances. The chief plant used in Nicaragua is the common *Ipomœa-nox*, L. = *Calonyction speciosum*, Choisy, a convolvulaceous plant. This was identified with the "achete" by Dr. Seemann at my instigation. The use of alum as before stated is very much used in Pará. The treatment with an acid (Acetic)? can only be put down as a conjecture at present. The action too of Liquor Ammonia is generally said to retard coalescence; whether its action be to stay this coalescence in order first to get rid of as much aqueous liquid by the difference of density I do not know. In the wet processes as distinguished from the dry methods of preparation, viz., by the addition of hot, cold, or salt water &c., they are open to the objection of retaining moisture in Caoutchouc, by the outer portions of the coalescing milk becoming first acted upon and inclosing water inside it.

Next to *purity*, *dryness* stands as the foremost desiderata in well prepared Caoutchouc. The wet processes, particularly that with alum, is very easy of application, but the precaution should be taken to prepare the Caoutchouc in thin sheets, and subjecting them to hydraulic, screw, or other pressure.

Purity and freedom from false packing, adulteration, and admixture of all kinds should be attended to in order to produce a good marketable Caoutchouc. Frequently one sees a parcel of Caoutchouc in which possibly are patches of sand, stone, bark, &c., and as a necessary consequence it is valued at a low price. The Caoutchouc *itself* may be very good, and if free from these foreign substances, which add weight, would fetch a much higher price. Not only has an allowance or deduction to be made for the foreign matter, for a manufacturer cares not to pay 1*s*. 6*d*. to 2*s*, for stones and sand, (even though they have the recommendation of coming from a distance, a great recommendation now-a-days,) but also for loss of time, wear and tear of machinery in cleansing it. There is beside this the loss of freight value to be thought of.

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*Caoutchouc, like other hydrocarbons, absorbs oxygen readily, and thus undergoes the change indicated. The resins (*albine* and *fluavile*) found in gutta-percha appear but to be gutta-percha plus oxygen.

The admixture and adulteration arises from careless collection in allowing bark, &c., to fall in the milk, or fraudulently introducing it for the sake of increasing the weight; the first can be obviated by passing the milk through sieves before subjecting the milk to any further process and while it is yet fresh. The second by refusing to receive any such adulterated Caoutchouc, if the power of refusal be possessed. The second cause of adulteration is by the admixture of the milk (very often resinous) of the trunk, or of other trees, with the Caoutchouc, and which not only as adulteration, but frequently destroys the goodness of the Caoutchouc altogether, causing it to become "heated" and spoiled. This should be guarded against, and after a little experience such admixture can be detected in the milk or prepared Caoutchouc. To guard against careless or fraudulent adulteration it is important that the best *form* in which the Caoutchouc can be prepared should be considered. Large masses of even good Caoutchouc *never* will fetch so high a price as small pieces as in the latter case the chance or *facility* of adulteration is reduced to a minimum. The Caoutchouc should be prepared in thin separate sheets or cakes not more than one or two inches thick, and if moulds are used, wooden ones of the shape of a child's battledore would be the best form.

These remarks will apply equally to the case of any introduced species.

NOTES ON THE VARIETIES OF GUTTAPERCHA.

BY JAMES COLLINS.

In a previous article* I reserved a more complete enumeration of the varieties of guttapercha for a future occasion. In the present instance, I only give those which I have been able to examine personally; other lists which I have by me require yet further examination and comparison, and fuller materials than at present at my command. Many, too, of these names may prove synonymous, and the really valuable varieties may prove to be but few in number.

1. *Dichopsis gutta.*—Bentley and Trimen's "Medicinal Plants," plate 167. Synonym—*Isonandra gutta*, Hooker, "London Journal of Botany," vi. 463, t. 16, &c. Vernacular names—Gutta Taban: Guttapercha; Gutta Niato (Sarawak); Guttapercha Durian (Sumatra); Nyatoe Balam, or Balam Timbaga (Bleekrode) Gutta Balam Durian (Borneo); Dadauw (Banka); Mazerwood tree (English). Geographical distribution—Formerly in Singapore in abundance, but only one or two preserved as curiosities; Malacca and Malay Peninsula, as far north as Perak; Sumatra, Borneo and other adjacent islands. In Helfer's collection of Andaman and Tenasserim plants at Kew, there is a specimen of this plant. Remarks—Gutta, or as it is variously written, gutah, gatta, gitta, gatta, is the Malayan term for gum or juice; percha (pronounced soft as in peach, not hard as perka) accentuated variously as parcha, perja, percha, is the name of the tree, hence the term may be translated "gum of the percha tree." Recently, it has been suggested that percha means strips or fragments, so called from the way the gutta hangs from the incised trees, but this seems too far-fetched. The old name of Sumatra was Pulo or Pulau Percha, meaning "Island (Pulau) of the Percha tree." Tuban, taban is also the name of a tree, and according to Logan a new word has been added to the Malay language, viz.—Menaban (Men[t]aban), signifying collected gutta taban. The greater number of Malay nouns admit of conversion into verbs by the addition of a prefix. The tree is often compared to the Durian tree, *Durio zibethinus*, in its general appearance, and I have classed the Dutch varieties of Gutta Durian under it, as both specimens and accounts agree. Whilst in Singapore, I was fortunate enough to procure a fruiting branch, and also to prepare a little gutta from the same identical tree as the specimens from which Sir W. J. Hooker drew up his description were obtained. These specimens are now at Kew.

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* Jan. 18th, 1881.

2. *Dichopsis gutta*, var. *oblongifolia*. Synonym—*Isonandra gutta*, var. *oblongifolia*, De Vriese, Pl. Ned. Bat. Orient; *ib.* De Handel in Getah-Pertja. Leyden, 1856 with coloured figure. Remarks—This variety found in Borneo differs chiefly in having oblong instead of obovate oblong leaves.

3 *Dichopsis Macrophylla.*—Synonym—*Isonandra macrophylla*, De Vriese, Vernacular name—Ngiato putih (white gutta). Remarks—Mr. Motley, who collected a specimen of this at Bangermassing, Borneo, describes it as a large tree, with white and soft wood, and with whitish green flowers. The flowers had so strong an alliaceous smell, that he could hardly support the smell whilst drawing the plant. It yielded a second-rate guttapercha.

4. *Dichopsis Mottleyana.*—Synonym—*Isonandra mottleyana*, De Vriese. Vernacular name—Kotian. Remarks—Mottley, who found this tree also in Borneo, remarks, "A very tall and straight tree, with smooth reddish-grey bark, reddish within, yielding when wounded a copious flow of milky juice, which hardens to a white waxy resin, brittle when old, but readily softened by heat. Wood, reddish-white, wooly in texture, soon decaying in the weather, but good for housework. The gum is said to be used to adulterate the inferior kinds of guttapercha; it is certainly unsaleable alone. From the seed is expressed an oil used for lamps, and when fresh, for cooking. Grows in deep bogs, where its roots are under water for five months in the year."

5. *Dichopsis obovata.*—Synonym—*Bassia obovata*, Griffiths. Remarks—This guttapercha yielding plant is found in the Tenasserim provinces, and in Borneo.

6. *Payena puberula.*—Synonym—*Isonandra pubcrula*, Miquel. Remarks—Is found in Sumatra, and attains a height of 60 feet to 80 feet.

7. *Payena dasyphylla*—Synonym—*Isonandra dasyphylla*, Miquel. Remarks—Known under the name of Gutta Benton, and is found in Borneo and Sumatra. According to Motley, it yields a second rate gutta, and is chiefly used for purposes of mixing with finer qualities. The tree grows in dry woods, having hard, white, and heavy timber, black, hard, and smooth bark, and abundant foliage.

8. *Payenc Wightii.*—Synonyms—*Ceratephorus Wightii*, Hassk.; *Isonandra polyandra*, Wight. Remarks—A Sumatra tree.

9. *Payena Lecri.*—Synonyms—*Ceratephorus Lecri*, Hassk.; *Azaola Leeri*, T. & B. Vernacular names—Balen-tjabeh, Balem tandoek, Koelan, Getah Seundek. Remarks—This tree, found in Palembeng (Sumatra), Java, and Banka, is said to yield a very fair gu ta.

10. ? *Paycna macrophyllus.*—Synonym—*Cacosmanthus macrophyllus*, Hasskl. Remarks—This tree, known under the names of Karel Mundieng and Getah Pertja, is found in Java, and grows to a height of 60 feet to 70 feet.

11. *Chrysophyllum lanccolatum.* D. C. Synonyms—*C. Favanicum*, Steudel; *Nycteristition lanceolatum*, Blume. Remarks—Known as the Kilakkatang, in Java, and grows to a height of 60 to 80 feet.

12. *Chrysophyllum rhodoneuron*, Hassk.

13. *Sideroxylon nitidum*, Blume the Kinjatoe of Banka and Njatoe of Banka.

14. *Sideroxylon attenuatum*, D. C., known as the Taroentoong and Binasie, and found in Singapore. Java, Banka, and Phillippines.

15. ? *Sideroxylon chrysophyllum*, De Vriese, found in Java.

16. *Bassia cuneata*, Blume, a tree of 60 to 80 feet heigh, found in the Bantam district in Java.

17. *Bassia sericea*, Blume, known as Djengkot in Java.

18. *Bassia argentea*, De Vriese, growing in Java.

19. *Bassia Funghuhniana*, De Vriese, growing in Java.

20. *Mimusops Manilkara*, G. Don, the *Manilkara* of Rheede, and the *Metrosidoros Macassariensis* of Rumphius, growing in Java.

21. *Mimusops acuminata*, Blume, known as Genkot; grows in Sumatra and Java to a height of 80 to 120 feet. Remarks—Nos. 12 to 21 are all said to yield a guttapercha which is more or less utilized; frequently, however, for mixing with better sorts. There are numerous varieties of guttapercha which have come under my notice, to which no botanical position has been assigned. A few of these need only be mentioned here.

22. *Guttapercha Waringen.*—Under this name a Guttapercha is collected on the Kapuas river in Borneo. The tree is described as being like the Warringen tree (*Ficus sp. varia*), with white wood, and grows in the hilly country, and generally in yellow clay soil.

23. *Nettu.*—Found on the south coast of Borneo, and said by Motley to yield a second-class gutta.

24. *Ploot* is found in Borneo, and yields a third rate gutta. The tree grows in hilly districts, and its sap is brownish. The leaves and bark resemble the Champaca(*Michelia Champaca*), but the leaves are redder on the underside. The name Ploot, or P'loot, is a Dyak term, and the only one they seem to use for guttapercha.

25. *Guttapercha Papua.*—This is a fourth class gutta, and is in less demand than the two preceding ones. The tree is found on low ground in Borneo.

26. *Guttapercha Rana.* This variety, found also in Borneo, is in very little demand, as it is of low quality; it is of a white colour when boiled.

27. *Katella.*—Borneo; used only for adulteration.

28. *Fankar*—Same as 27.

30. *Guttapercha Kladi.*—Same as 27.

31. *Guttapercha Daging.*—This comes nearer in character to the Balata of commerce than any other Eastern product I have met with, and should most assuredly receive attention. "Daging" is the Malay term for "flesh," and aptly describes the toughness and gristly character of the generality of beef one meets with in the East.

32. *Gutta Muntah.*—This is unprepared gutta, "Muntah" being the Malay for "raw" or "uncooked." Hence the term is equally applicable, and, indeed, is applied to every variety of unprepared guttapercha. Some years since, this name was known and used in the English market, but now is apparently supplanted by that of "White Borneo." It may be of the best quality of guttapercha, or the very lowest; whichever it may be, if not boiled up quickly, it loses all its value, and becomes a mere resinous mass.

The following names and remarks on varieties of guttapercha were kindly furnished me by Captain Lingard, who, as a trade and rajah, has had many years' experience of the question in the Brow and Boolongan districts on the east coast of Borneo:—

33. *Getah Kalapeich Lanyut* (Brow).—Lola Lanyut, of Boolongan, is the first and best quality, and is known in the English market as Lingard's "Nina" brand. "Lanyut" means "tough."

34. *Getah Kalapeich Mookas* (Brow).—Lola Mookas (Boolongan), is a second quality. The tree yields about 10 per cent less than the first quality, and is more difficult to cut down. "Mookas" means "spongy."

35. *Getah Kalapeich Kapur* (Brow).—Lola Kapur (Boolongan), is a third variety, and yields 10 per cent less than the preceding; in the wet season even 20 per cent less. The wood is much harder, and requires a stronger and heavier billiong to cut the tree down.—*Journal of the Society of Arts.*

ACCLIMATION OF TREES YIELDING INDIARUBBER AND GUTTAPERCHA.

BY JAMES COLLINS.

The care and oversight of forests is now generally recognised and accepted as a State duty, beyond the limits and capabilities of private individuals. Such duties consist in the protection of trees from reckless destruction, replanting denuded portions, and introducing useful plants from their natural habitats to other localities having isomeric conditions of heat and moisture, and where such introduced plants are likely to prove of general utility. This latter operation is known as acclimation. The constitution of plants is a subject of general interest, and has to be considered with great judgment and abundance of information; plants have certain limited ranges, and such ranges of heat and moisture have to be clearly defined, for by no process of acclimation can a plant be made to tolerate a degree more or less than its proper limit, except to its detriment. If they be subjected to conditions other than their natural ones, they either die or become so modified as to fail to develop those special features of structure, habit or constituents, which are their characterstics in their native habitat. A single instance may be quoted here, by way of example, to show how a plant may be altered by different climatic influences. In Europe for ages the common hemp (*Cannabis sativa*, L.), has been cultivated for its fibre and oily seeds,* whilst in India the same plant shows a wide dissimilarity, especially in its medicinal characteristics, its leaves flowering and fruiting stalks yielding a resin volatile oil, known under various names as bhang, dhurrus, ganga, &c., having powerful narcotic properties the resin being apparently formed at the expense of the fibre, as the stalks are usually burnt as useless.†

The ascertainment of the extremes and mean annual temperature and moisture which best suit certain plants is the result of experiment, and is sometimes surrounded with so much difficulty that frequently trials should be made simultaneously, in two or more localities judged to possess similar climate conditions.

All these experiments entail expense, especially in the case of those trees the utilisable portion of which consists of timber, milky juices, &c., which require a period of ten to thirty years or more to elapse after planting, before they come to maturity, or any return can be expected on the initial expenditure and upkeep. This outlay, together with the long delayed returns, even if the experiment be finally crowned with success, naturally will and must fail in procuring the accomplishment of such trials by private enterprise. Government must at least give its aid in the initiation of such schemes.

In the case of the cinchonas the Indian Government did, with rare forethought, listen to such men as Pereira, Howard and Markham, and undertook the initiative : and as soon as the experiment proved successful, private planters at once showed their willingness to expend their money in the same undertaking. So has it proved in a minor degree in the present instance.

Another fact is also worthy of remembrance, namely that acclimated trees invariably improve, and their products, from the care and attention paid in their preparation, acquire a much higher value than spontaneous or uncared for produce. As instances, mention may be made of the much higher percentage of quinine yielded in India from cultivated trees than from those of South America ; and also that a specimen of Assam rubber, prepared according to my suggestions (I think by the late Mr. Leeds) was valued by one of the highest authorities in London, Mr. Edward Till, of the firm of Messrs. Jackson and Till, at from 8d to 10d per pound more than ordinary Assam rubber.‡

Fortunately, with respect to the special question of guttapercha trees, some of these difficulties do not exist. There, in their natural habitats, and in territory, too, under imperial rule and influence, are numbers of these trees ready for conservancy and cultivation, and where nurseries of plants can be started for acclimation elsewhere. Although some twenty-five years will have to elapse after planting before the trees are ready for tapping or the axe, yet, in the interim, a revenue could be secured, to

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* The great dissimilarity between the European species led Lamarck to consider the latter a distinct one, and designated it *Canabis Indica*, but it is now agreed that no specific difference exists between them.

† Why burn the stalks of the Indian hemp? Why not utilize them? I have suggested to several planters that they might make capital paper material, especially if sent over here as "half-stuff."

‡ In a paper on Indiarubber, delivered at the Society of Arts (*Journal of the Society of Arts*, December 17th, 1869), and again in my report on the same subject to the Indian Government in 1872, I strongly recommended the cultivation of the native *Ficus elastica*, and the acclimation of the *Hevea Brasiliensis*, yielding Para rubber, and also other species from which are obtained valuable commercial varieties. Backed as I was by Mr. Clements R. Markham, C.B., and Mr. Gustav Mann, of the Indian Forest Department, the Indian Government took the matter in hand.

pay working expenses at least, from the trees already existing, by "farming" them, or by royalties on the outturn. A stringent rule in all such contracts should be that four to six trees should be planted in place of every one cut down.

As to what species should be cultivated on the spot, or to be introduced, gutta-taban, gutta-durian, gutta-waringan, gutta-kalapeieh, and gutta-mukas stand in the front. Many others, although passing under other designations, may prove equally valuable.

Amongst pseudo-guttaperchas, or substitutes recommended as supplementary to the true gutta, I would certainly single out the balata gum (*Mimusops balata*, Gaertner), as it would prove a most valuable addition to our trade supplies. As to the Indian varieties of this group, I would strongly recommend that the panchontee should receive careful attention, and its products collected and prepared in proper manner. Such specimens so prepared would then allow of the question being probably set at rest. I have not much hopes of cattimandoo, mudah, and some other substances, but other uses might be found for them if good samples and guaranteed qualities were available.

As to the climatic conditions necessary for the cultivation of guttapercha trees, Borneo, Labuan, Sarawak, Singapore, and more especially the Southern States of the Malayan Peninsula, being the natural home of these trees, present the first localities in which cultivation should be essayed. Ceylon, like some localities in Assam, and, possibly, the Nicobar Islands; would form a congenial home for these plants.

On the whole question of Indiarubber, guttapercha, and pseudo-gutta, there is much still to be learned. There may be yet many improvements to be made in the collection and preparation, but these facts can only be gleaned by one somewhat conversant with market and manufacturing requirements, added to some amount of botanical and chemical knowledge. Such a task undertaken on the spot, if well executed, would clear up many a doubtful point, and render great and lasting service to commerce and science.—*Journal of the Society of Arts.*

INDIARUBBER.

The substance sold under the name of indiarubber is the stiffened milky juice of at least six different genera of trees, belonging to three widely different natural orders—Landolphia and Willughbeia in Apocynaceæ, Castilloa and Ficus in Artocarpeæ, and Hevea and Manihot in Euphorbiaceæ. Part of it comes from South America (shipped principally from Para and Carthagena), part of it from Sierra Leone, Mozambique, and Madagascar, and the remainder from tropical Asia. Besides these two genera of Apocynaceæ there are at least six others which yield a similar milky juice not at present utilized to any considerable extent. In the United States in 1883 there were 120 indiarubber factories, employing 15,000 hands. The total importation of raw material into the States in that year was 3,000 tons, worth about £6,000,000 sterling. The value of the manufactured goods made in a single year was estimated at £50,000,000. The quantity of unwashed rubber imported into the United Kingdom in 1883 was more than 10,000 tons, worth about £3,500,000, but in 1885 it had sunk to less than £2,000,000. None of the trees which yield indiarubber have yet been brought into cultivation on a large scale, and the time will soon come when either this will have to be done or the supply will gradually lessen. There are about sixty distinct species of these rubber-yielding genera, and the botanists and foresters will have to settle between them which of these are best worth cultivating and where it will pay to grow them. Unfortunately, at the present time the price of indiarubber of all kinds is exceptionally low, the best Para rubber being now only worth about 2*s* 6*d* per pound in London against 4*s*. in 1884, and the best of the African and Asiatic kinds about 2*s*. per pound.

List of the Indiarubber-producing Genera, their native Countries, with the Number of Species in each and annual Import:—

Order	Genus	Number of species.	Native country	Tons imported into England in 1880.
Apocynaceæ	...Willughbeia ...	9	Tropical Asia ...	530
,,	...Landolphia, including vahea	16	Africa and Madagascar ...	2,200
,,	...Hancornia	1	Brazil	—
,,	...Urceola	7	Malaya Peninsula and Archipelago ...	—
,,	...Dyera	3	Malaya Peninsula ...	...
,,	...Couma Collophora	4	Guiana and Brazil ...	—
,,	...Alstonia	3	Malaya and Fiji ...	—
,,	...Cameraria ...	2	West Indies	—
Artocarpaceæ	...Castilloa	3	Central America & Cuba	100
,,	...Ficus	2	Africa & Tropical Asia	370
Euphorbiaceæ	Hevea	9	Amazon region ...	5,768
,,	...Manihot	1	Brazil	35
		60		7,003

GUTTA-PERCHA.—Gutta-Percha of the best quality is the product of Dichopsis Gutta, a tree belonging to the natural order Sapotaceæ, inhabiting the Malayan Peninsula. In order to obtain it the Malays follow the wasteful plan of cutting down the tree. The bark is first stripped off, and the milky juice which then exudes is collected in the shell of a Coconut, or the spathe of a Palm. The juice quickly stiffens on exposure to the air and forms gutta-percha. The average quantity obtained from one tree is 20 lb. In 1875, 10,000,000 lb. in weight were imported into this country from Singapore, and this would involve the destruction of, perhaps, 50,000 trees. It was first brought into notice in 1842, and at that time the tree was plentiful in the forests of the island of Singapore; but during the next five or six years it was totally destroyed in the island except a few trees that were kept as curiosities. In 1847 it was plentiful in the forests of Penang, but a similar fate soon befell it there, and now the time has come when, unless it be systematically cultivated somewhere, the supply will decrease. According to the latest authority there are six distinct species of Dichopsis growing wild in the Malayan peninsula, and in Java and Sumatra, and several species of the neighbouring genera, Chrysophyllum Sideroxylon, Bassia, Mimusops, Payena, and Imbricaria, yield a similar milky juice; but it still remains to be settled which species are best worth cultivating, and where they can be most profitably grown. The annual value of the gutta-percha imported into England is between £300,000 and £500,000 per annum. J. G. BAKER.—*Gardener's Chronicle.*

THE AFRICAN RUBBER TREES.

In the West of Africa Indiarubber is collected from several species of *Landolphia*, of which the best known are *L. Owariensis and L. florida.* According to Speke and Grant *L. florida* is stated by the natives to yield the best rubber of any of the species. This plant is a woody climber, growing well in places where little else could be profitably grown, *i.e.*, in damp rocky ravines. Its trunk often travels along the ground, looking like a large boa-constrictor, until it meets with a trunk to climb up. The stem attains a diameter from six to eight inches at a few feet from the ground, and then soon divides into more slender branches, which ascend to the top of the tree, and throw down long pendulous branches and clusters of large snowy-white flowers, scented like Jessamine. The fruit has a sweet acidulous pulp, which is eaten by the natives. The leaves are opposite, and their colourless midribs are sharply angular underneath. The young shoots are deep green and spotted, jointed every ten inches, and about one-third of an inch in diameter; they are brittle, and a cord of pith may be pulled out of them. The plant climbs by means of tendrils which arise from the joints, and which consists, in some species—as in *L. owariensis*—of the hardened flower-stalks after the ripe fruit has fallen off.

The natives make playing balls of the juice of the *L. florida*, and con sider its rubber to be the most adhesive known. The milk if rubbed upon the skin adheres like birdlime, and can scarcely be rubbed off.

Vogel's African Rubber tree, or *Urostigma Vogelwii*, is stated by Mr. Neyle to yield one of the best kinds of Indiarubber in West Africa; it was first collected by Vogel, at Grand Bassa, but was afterwards discovered in Liberia, from whence the first specimens of living plants were sent to Messrs. Christy by Mr. D J. Dennis.

The tree grows from 20 to 30 feet high, and has large leathery stalked leaves, from 6 to 8 inches long by 3 to 5 inches broad, furnished with four or five lateral veins on either half of the leaf. The small fruits, which are about the size of beans, are found on the terminal leafy branches, usually in pairs, on the stem near the base of the leaf-stalks.

The trees are tapped when about five years old by making slashes or incisions in the trunk, the juice is collected in vessels and the gum is separated from the sap by the use of acids; it is then made up into balls about the size of a large orange. Although the quality is at present remarkably good, it could be geatly improved by care in the collection and preparation for the market. If the trees are tapped before they are five years old the juice is watery, and does not yield such good or strong rubber. The natives, in order to get as large a yield of juice as possible, pollard the trees at a height of 10 to 12 feet and cut back the branches to prevent the strength of the plant being used up in growth; this causes a free and regular flow of sap. The cuttings which are removed are easily propagated and will grow vigorously.

The tree will grow near the sea at an elevation of 50 to 60 feet above sea level, but does not flourish well in marshy ground. The ease with which the plant is propagated, its hardiness in sea air, with the excellent quality of the rubber which it yields, renders this a desirable species for cultivation in the lowlands of Southern India and Ceylon; also in Java, Sumatra, Penang and Siam.

Amongst other African sources of supply are the *Vaheæ* species found chiefly in Madagascar, and the Mauritius. M. Coignet mentions that on the north-east coast of Madagascar caoutchouc is obtained from three varieties of climbing plants, and a shrub sixteen to nineteen feet high. Of the climbers one variety gives the best product, though the natives use all together. The caoutchouc is prepared either with salt water or artificial heat. Madagascar rubber, formerly called Mauritius rubber, has long been largely used in France, and is now highly appreciated in England. In ranks next to Pará in price.

The *Villughbeia edulis*, also found in Madagascar, is a climbing plant which when wounded yields a pure viscid juice, that soon changes to caoutchouc on exposure. This is also an Asiatic plant, and is cultivated in Java.—*Indiarubber and Guttapercha Journal.*

PSEUDO-GUTTA-PERCHAS, OR SUBSTANCES SUPPLEMENTARY TO GUTTA-PERCHA.

From time to time numerous substances have been recommended as substitutes for, or supplementary to guttapercha. That a substance answering these purposes has not yet been introduced lies, I think, more in the fact that these substances have not yet been properly treated, or such a substance has yet to be discovered, than that such substance or substances do not exist. As to the method of preparation of these proposed substances, I have pointed out, in an article on guttapercha,* the rapid oxidation of that substance if it be not prepared immediately after collection. This applies even more strongly to subjects of the present article. Balata gum has an assured value of its own, and with regard to the rest they may yet be utilised if their rapid resinification can be arrested.

In the following remarks but a brief *resume* is given, and the subject geographically treated. In view, too, of the various names which have been given to these plants in various botanical works, I also append the synonyms.

I.—AMERICAN SOURCES OF SUPPLY.

(1) BALATA GUM. (2) MIMUSOPS BALATA, GÆRTNER. (3) Natural Order—SAPOTACEÆ.

SYNONYMS.—*Sapota Mulleri*, Bleekrod ; *Mimusops Kauki L ; M. dissecta*, Hooker ; *M. Hookeri*. A.D.C. *M. Mamilkara*, Don ; M. *Ballota*, Blume ; *Achras balata*, Aublet ; *Lucuma mammosa* De Vriese.

VERNACULAR NAMES.—Paarden vleesh (Dutch), Horse-flesh ; Bullet tree ; Bolletrie and Boerowè by the Arrawak Indians.

GEOGRAPHICAL DISTRIBUTION.—Demerara , Berbice ; British Guiana Antilles ; Jamaica and Surinam.

One of the first writers on this substance was Professor Bleekrod, who communicated some information as to the plant and its product to the Society of Arts, in 1857.† He also described and named the plant as *Sapota Mulleri.* In 1860 Mr. Walker‡ communicated samples, &c., received by him from Dr. Van Holst, of Berbice, to the same Society ; and in 1864 Sir William Holmes also drew attention to the same subject.§

The tree is a large one, with a trunk of about 6 feet in diameter, and furnishing a wood much sought after as a building material. The Dutch name, Paardenoleesch, is given on account of the wood being of the colour and having the appearance of horse-flesh. The bark is thick and rough, and the fruit is of the size of a coffee berry, sweet, like a plum, and with a hard white kernel, which yields an oil bitter in taste. The leaves are glossy, oval, and acuminated.

The milk is drunk by the natives, and when diluted with water, used as cow's milk. The trees grow in groups, and in alluvial soil.

The "Balata" gum is of a character somewhat between caoutchouc and guttapercha, combining in some degree the elasticity of the one with the ductility of the other, freely softening and becoming plastic, and easily moulded under the influence of hot water.

What small parcels were sent to this country met with a ready sale, and were remarkably free from adulteration. But, unfortunately, through the difficulty of collection, the undertaking being so dangerous and unhealthy, the supply of this excellent and most desirable article has fallen off.

Balata is collected by making incisions in the bark about 7 feet from the ground, and a ring of clay placed round the tree to catch the milk as it exudes. The yield is said to be in profusion, especially at the time of the full moon—a statement with regard to milky juices which is adhered to by natives in all parts of the world—and the operation can be repeated every two months in the rainy season. It takes six hours to bring about coalescene by simple atmospheric influence, but very quickly by boiling in water. A large tree is said to yield as much as 45 lb. of dry gum.||

* Encyclop. Britann. : Article "Gutta-percha."
† Jour. Soc. Arts, London, Oct. 8, 1857.
‡ *Ib.* Aug. 24, 1860.
§ *Ib.* March 4th, 1864.
|| *Trinidad Chronicle*, September 2, 1873.

II.—INDIAN SOURCES OF SUPPLY.

PAUCHONTEE, OR INDIAN GUTTA TREE.

Dichopsis elliptica, BENTHAM.

Natural Order—*Sapotaceæ.*

SYNONYMS.—*Bassia elliptica*, Dalzell ; *Isonandra acuminata*, Lindley.*

VERNACULAR NAMES —Indian Gutta Tree ; Pauchontee Pauchoontee or Pasbonti ; Pauley or Pali Tree.

GEOGRAPHICAL DISTRIBUTION.—Wynaad ; Coorg ; Travancore ; Anamally and Neilgherry Hills ; Sholah Forest ; Cochin ; Sichar ; and according to General Cullen, "appears to be common in all the forest tracts at all within the influence of the south-west rains."

This tree, which is now placed in the same *genus* as the true guttapercha, is a large one, from 80 to 100 feet high, was first met with by Mr. Dalzell in North Canara, near the falls of Goirsuppah, in 1849. Since that date, General Cullen and Dr. Hugh Cleghorn have used every exertion to bring the substance prominently forward. The gum is obtained by tapping, a pound and a half being obtained from one tree by five or six incisions, a large tree yielding as much as 20 to 40 lb. of sap. Many experiments have been made with specimens of the raw milk, *i.e.*, milk simply dried after taken from the tree. The result of these experiments have shown that for telegraphic purposes it is wanting in some essential qualities, but it has been recommended as a sub-aqueous cement or glue. When dissolved in ordinary guttapercha solvents, it, after the evaporation of the solvent, remains for some time soft and viscid, and partakes somewhat of the characteristics of birdlime. When cold it is hard and brittle. Without wishing in the slightest degree to throw doubt or discredit on the many and valuable experiments made, I would suggest that good samples be collected. I have not the slightest doubt, from the scientific aspect of the case, as well as from practical experience and experiments at home and abroad, that many a parcel of what would otherwise be good guttapercha is spoilt through not being *well boiled immediately* after collection from the tree. At present, this is the only way in which I can see a possibility of ascertaining whether this product can be utilised, and I have the more hope that it can, from the fact that its structural character has led the plant to be placed in the same *genus* as the guttapercha tree ; structural affinity being a wonderfully safe index in numerous instances to chemical affinity also. There are in India various species of *Isonandræ* and other closely allied sapotaceous *genera*, but I have found no mention nor heard of their yielding any milky juices likely to prove of commercial value. It would be well if experiments were tried with the products of these trees.

CATTIMANDU AND OTHER EUPHORBIUM GUMS.

Euphorbia cattimandoo, and other species.

Natural Order—*Euphorbiaceæ.*

Euphorbia cattimandoo, of W. Elliot, is found in Vizagapatam, and is variously known under the vernacular names of Cattimandoo, Catemandoo, or Kattimandoo.

The product of this tree was first brought to notice by the Hon. W. Elliot, and a prize medal was awarded for the substance by the jurors of the Exhibition of 1851. This Euphorbia grows to the size of a shrub or small tree, and the milk flows out freely when a branch is cut. The natives use the milk as a cement to fasten knives in handles, &c. Under the influence of heat it becomes soft and viscid, and when dry it becomes very brittle. The same remarks as to the probable utility of "Pauchontee," apply also to this and following substances, although in a somewhat limited degree.

Euphorbia tirucalli, of Linnæus, known vernacularly as the Milk hedge or Indian tree spurge, tirucalli and the Lunka sij, is found in the Coromandel, Malabar, Bengal and is, in fact, a very common plant in various parts of India.

* Under this name, Dr. Hugh Cleghorn wrote a very valuable report in 1858.

This succulent unarmed plant often attains a height of 20 feet, and its inspissated milk is used for various purposes chiefly medicinal, in India, and has been recommended as a substitute for gutta-percha; but like Gum Euphorbium, it has a very acrid character, and the collection of it is a very dangerous operation to the eyes. When dry it becomes very brittle, but when warmed in water has a certain amount of plasticity.

Alstonia or Pala Gum.

Alstonia scholaris, Robert Brown.

Natural Order—*Apocynaceæ*.

Synonyms.—*Alstonia oleanrifolia*; *Loddidge*; *Echites scholaris*, Linnæus.

Vernacular Names.—Mookum pala; Pala; Chatinu; Eerellay-play; Ezhilaip-palai; Edakulapala; Edakulatariti; Edakula-ponna.

Geographical Distribution.—Travancore, Coromandel, Assam, and Ceylon.

This tree attains a height of 50 feet, and its wood and bark are much valued in India for their medicinal qualities. The tree yields an abundant milky juice, which was recommended as a substitute for gutta-percha, amongst others, by Mr. Ondaatjee, who brought the substance before the notice of the Society of Arts in 1864.* It is stated to readily soften in hot water, take impressions readily, and to retain these impressions when cold. I have only had very small specimens in my possession, so am unable to form any decided opinion. Good specimens of this and other like substances would be acceptable.

Mudar Gum.

Calatropis gigantea, Robert Brown.

Natural Order.—*Asclepiadaceæ*.

This plant known also under the name of *Asclepias gigantea*, of Willdenow, was very early described by Rheede in his Malabar Plants, under the name of Ericu.

Vernacular Names.—Gigantic swallow-wort; Yercum; Yerica; Nella-jilledoo; Akund; Mudah; Ark.

Geographical Distribution.—Throughout the peninsula and Southern Provinces of India.

This shrub is found in waste places, and grows to a height from six to ten feet. Ten average shrubs are said to yield one pound of a gutta-like substance, which becomes plastic in hot water and other ways behaves like gutta-percha. There is also another species said to yield the same characteristic milk, viz., *G. procera*, but I have not been able to procure specimens.

III.—CEYLON SOURCES OF SUPPLY.

In Ceylon there are species of *Dichopsis*, *Isonandra*, and other allied *genera* belonging to the natural order: *Sapotaceæ*. Specimens of their inspissated juices I have not seen. When I passed through Point de Galle, in 1874, I wrote to the late Dr. Thwaites, the talented Director of the Government Gardens at Peradeniya, with regard to the question of gutta-percha, and received a quick and courteous reply, by which it appears that the natives do not collect any of the gutta, even if the trees yield it in appreciable quantities. This agrees, too, with information I have received from native and other sources of information. Dr. Thwaites also remarked that some ysars ago he sent the inspissated juice of one species to Sir W. J. Hooker, but that the report on it was unfavourable.

Certain parts of Ceylon having a climate,† so similar to that of the Malayan Peninsula and Archipelago, it seems probable that here would be found the best localities for the acclimation and cultivation of the true gutta-percha tree. I have recommended the adoption of this course, and sincerely trust that efforts will be made in that direction. It is also probable that the island contains many indigenous pseudo-guttas, which might be made use of.

* Jour. Soc. Arts, London, vol. xii. xii. 39., Feb., 1864.

† *Vide* Thwaites' *Flora Zeylanica* (Preface).

IV.—AFRICAN SOURCES OF SUPPLY.

At the Cape of Good Hope there are many species of Euphorbias which are said to yield a substance very similar to Cattimandoo, but hitherto I have only been able to see fragments, and thus have been precluded from making any experiments. Like the *Euphorbia officinalis* the juice is so acrid as to give intense pain and irritation to any part of the body with which it may come in contact, especially the eyes and nostrils. Dr. J. Cormbie Brown, whilst holding the post of Government Botanist at the Cape, paid much attention to the subject, and favoured me with much correspondence upon it. Our united efforts bore no fruit. The substance has been well spoken of as an anti-fouling dressing for ship's bottoms.

Mr. Baxter, whilst on the Niger Expedition, collected a pecimen of *Chriysophyllum* (Sapotaceæ) yielding a substance like gutta-percha, but no specimen seems to exist. Tropical Africa should indeed be rich in such substances, and doubtless such will prove to be the case when careful search and enquiry is made.

With regard to the whole question of the Pseudo-Guttas, Balata should most certainly receive attention, and efforts should be made by the Government to introduce it into Ceylon and elsewhere. Panchontee, too, should receive attention, and the possibility of the utilization of the rest of the group not denied till further trial has been made.—J, C.—*Indiarubber and Guttapercha Journal*.

CAOUTCHOUC.

By Prof. C. F. Chandler, Ph. D., M.D., Prof. Anal. Chem. School of Mines, Columbia College.

Caouthouc may be roughly defined as a peculiar substance composed of carbon and hydrogen, found in suspension in the milky juice of a great many different families of plants. It has been stated that all milky vegetable juices contain it; but this is not the case, many of these juices yield gum resins free from caoutchouc.

Properties and Composition of the Juice.—Caoutchouc juice or sap has been imported from time to time into England in considerable quantities, but it is found more economical to prepare the crude rubber where the juice is collected. It resembles ordinary cow's milk in colour and consistence. Its specific gravity varies from 1·012 to 1·041. Several circumstances may conduce to give the commercial juice a grayish brown, milky gray, or pale yellow colour, but the pure juice as it issues from the tree is white. Dr. Adriani (*Chem. News* II. 277, 289), who made some valuable experiments upon the fresh juice of the *Ficus elastica*, tapped by himself, says that, as the general result of his experiments, the quantity of solid matter contained in the milky juice decreases according to its being collected from incisions made in the higher, and consequently younger, parts of the plant. The tree which yielded the juice for his experiments was a young plant 2·25 metres in height.

Amount of juice evaporated.	Height at which it was taken.	Total residue.	Per cent.
0·183 grms.	0·30 metres	0·046 grms.	25·15
0·395 ,,	1·74	0·095 ,,	24·05
0·143 ,,	2·10	0·030 ,,	20·98
0·825 ,,	Top.	0·145 ,,	17·70

These figures prove, as stated above, that the juice in the older parts of the plant does contain more solid matter than in the younger parts. Old trees, then, furnish the richest juice, and Mr. Griffiths states that the juice of the reflex roots, which lie exposed, is richer in gum than any which is subsequently drawn off.

The following analyses have been published :—

JUICE OF FICUS ELASTICA (ADRIANI).

Water	82·30
Caoutchouc	9·57
Resin soluble in alcohol, but not in ether	1·58
Magnesia, combined with peculiar organic acid ...	4·49
A substance soluble in water and alcohol, but not in ether (sugar ?)	0·36
An organic substance soluble in water, takes a yellow tinge with alkalies (dextrine), and traces of salts of lime and soda	2·18
	100·48

JUICE OF SIPHONIA CACHUCU (FARADAY),

Water, acid, &c.	56·37
Caoutchouc	31·70
Substances soluble in water, not in alcohol	2·90
Albuminous precipitate	1·90
Peculiar bitter colouring matter, a highly azotised body; Wax	7·13
	100·0

An apparent paradox has been announced in the fact that India-rubber when stretched and exposed to the heat contracts instead of expending—a fact very contrary to common experience as the result of the application of heat. This is explained, however, by the fact that the rubber is very porous and filled with air-cells, which, when the rubber is stretched, assume an elongated shape. When heat is applied it of course expands the rubber to a certain degree, but, at the same time, it expands the air-cells, which, by shortening their longitudinal axes, produce a virtual contraction of the rubber.—*Indiarubber and Gutta-percha Journal.*

CELLULOID.

Celluloid is certainly not rubber, but in certain industries it is to some extent associated with, or substituted for, rubber ; therefore some account of its composition and the methods of producing it may not be unacceptable to our readers.

Celluloid may be briefly defined as a species of solidified collodion, produced by dissolving gun-cotton (pyroxylin) in camphor with the aid of heat and pressure. The nature of this product, and the methods of procedure employed in its manufacture, will be found described in what follows. First let us devote a few lines to an account of the materials employed ; and here, as of prime importance, we must begin with gun-cotton.

When cellulose or wood fibre (under which term are included common cotton-paper or paper-pulp, the refuse of cotton mills, and vegetable fibre of every description) is immersed for a few minutes in a bath composed of a mixture of strong nitric and sulphuric acids, then removed and washed and dried, it will be found to have acquired new and remarkable qualities. In external appearance there is nothing to indicate that any change has taken place, but when the test is made it will be found to have become highly inflammable and (if the action of the bath has been sufficiently prolonged and intense) even highly explosive. Wood fibre, or, to give it its proper chemical name, cellulose thus treated is said to have been nitrated, and the resulting product is termed nitro-cellulose, pyroxylin or gun-cotton. It has received the latter appellation because, when properly prepared, it can be used as a substitute for gunpowder, which indeed, it considerably excels as regards it explosive qualities. There are many other substances besides cellulose which, when treated in the manner above described, acquire similar inflammable or explosive qualities. Sugar, starch, and glycerine may be mentioned as examples ; of the last-named substance the nitro-compound is nothing else than that terrible explosive agent nitro-glycerine, the basis of dynamite.

But the cotton (supposing, for illustration, that we are using this common form of cellulose), besides becoming highly inflammable and explosive after the treatment we have above described, also acquires another quality. It is found now to be readily soluble in certain *menstrua* which are utterly without action on common cotton. For example, it will gelatinize and quickly disappear in a mixture of alcohol and ether, forming a thick, transparent liquid. This is the same material used by photographers, who, in taking a picture first spread a thin film of this solution, called collodion, upon a glass plate. The ether and alcohol, being volatile, quickly evaporate, leaving behind a thin, smooth, and tenacious membrane or film of gun-cotton, which serves as the medium of holding the sensitive silver compound used in taking the photographic image. It is upon this property of ready solubility of gun-cotton that the manufacture of celluloid depends. Professor Seeley was the first to observe that gun-cotton would dissolve in an alcoholic solution of camphor, and after many experiments, the brothers Hyatt succeeded in perfecting and patenting a procedure whereby camphor with finely pulped gun-cotton is made to exert its solvent effect upon this substance, with the aid of heat (fusion) and pressure, in a close chamber, to prevent the volatilization of the camphor.

The following is an abstract of their method :—

" A machine similar to that used in grinding paper-pulp is first employed to grind the gun-cotton in water to a fine pulp. This pulp is then subjected to powerful pressure in a perforated vessel to extract the bulk of the moisture, but still leaving it slightly moist for the next operation. It is now thoroughly incorporated with finely comminuted gum-camphor in the proportion of one part by weight of the camphor to two parts by weight of the pulp. With the camphor and pulp," the patentees further state, "they can also incorporate any pigments, colouring matter, or other materials that may be adapted to the requirements of the articles into which the product is to be manufactured."

Having obtained the desired mixture of pulp, camphor, and pigments, the next step in the process is to subject the mass to powerful pressure, in order to expel from it the remaining traces of moisture, and incidentally to effect also the more intimate contact of the camphor with the pulp. The dried and compressed mass is then put into a mould open at the top, into which fits a solid plunger. The vessel is next placed in a hydraulic (or other) press, and heavy pressure applied to the plunger is brought to bear upon the mixture. Whilst thus under pressure it is heated by means of a steam jacket surrounding the chamber, or by other means to a temperature of about 300° Fahrenheit. At this temperature the camphor fuses, and its volatilization being impossible, the melted gum dissolves the gun-cotton pulp, or, to use the words of the patentees, "converts" it. It is further stated by the patentees that the process of transformation is rapidly effected when the right temperature is reached and the product which results is the homogeneous solidified collodion known as celluloid. After the mass is taken from the press it hardens and acquires that extraordinary toughness and elasticity which are the distinguishing characteristics of the product. And it is a noteworthy fact that a large portion of the camphor it contains appears to be permanently held or combined with it (to use a convenient, though not strictly correct, term), so that the tendency of the camphor to volatilize is practically arrested.

There are numerous varieties and modifications of the abovenamed procedure, which it would take too much space to enumerate. Upwards of ninety patents have been taken out in connection with the process and the machinery employed.

The applications of celluloid are legion, and only the more prominent can now be mentioned. It is best known as a substitute for ivory. In this capacity it has been very successfully employed So perfect is the resemblance that a close inspection is required to distinguish the counterfeit from the genuine. The absence of " grain " is perhaps, the readiest peculiarity by which celluloid goods may be detected, but for all practical purposes it is not only as good as ivory, but, in some respects, better than that material. It possesses the strength and elasticity of ivory, but it does not warp or discolor with age.

On these accounts it is now largely used instead of ivory in making piano and organ keys, and billiard balls, combs, backs of brushes and hand mirrors, frames, handles, &c. Not the least of its advantages is the fact that it can be moulded so that the most delicate and elaborate decoration can be produced at a fraction of the cost of the same ornamentation executed in ivory.

For most purposes hard rubber, on account of its cheapness, can hold its own against celluloid very well; but tortoise shell, malachite, amber, pink coral and other costly and elegant materials are so successfully imitated that an expert must look sharply to tell the original from the copy. In imitation of tortoise-shell it is made in such articles as combs, card cases, cigar cases, match boxes, napkin rings, &c. The pink coral, so popular for jewellery, is admirably imitated and sold at low prices, as are also the imitations of malachite and amber. It is a very common substitute for the last-named material in the mouthpieces of pipes, cigar-holders, &c.

As a substitute for porcelain in dolls' heads, celluloid stands any amount of hard usage. It is used instead of hard rubber in many spectacle and eye-glass frames; and also for shoe tips, emery wheels, knife sharpeners, &c. In combination with linen, cotton, or paper, it is manufactured into shirt bosoms, cuffs, and collars, which are at once elastic, strong and durable, and when soiled only need to be wiped over with a damp sponge to restore them to their original lustre.—*Indiarubber and Guttapercha Journal.*

COLLECTION OF THE JUICE OF THE INDIA-RUBBER TREE IN PARA.

(From the *Journal of the Society of Arts*, July 30th, 1880.)

In the operation of collecting the juice of the tree, either shells or clay vessels are attached to receive the exuding milky sap; and when sufficient of this has been collected, the operation of drying it is performed as follows:—A kind of wooden bat thinly covered over with clay, is dipped into a pail filled with juice, and the bat, thus coated, is held over a fire, fed with certain wild nuts, which, in burning, give off abundance of aromatic smoke. A kind of short chimney is fixed over the fire to lead the smoke compactly upwards. As soon as the first layer of juice has become indurated, the bat is again dipped, and the drying operation is repeated; layer after layer being thus dried on the bat, until a thickness of nearly an inch is attained. A knife cut is now made in the bottle or biscuit of caoutchouc thus obtained, so that it can be removed from the wooden bat, and exposed to the air to become still further indurated. Pará caoutchouc, prepared in this manner, has a fragrant aromatic odour, which you can study for yourselves in the samples now before you.

The residues of juice left in the various vessels employed, the scrapings of the incisions, together with other materials, which the ingenious native thinks he can shuffle off on the unsuspecting merchant as caoutchouc, are made into balls, and sold as "negro head." The negro head-rubber is frequently made into crude representations of animals, and there are several such works of native art on the table—as, for example, this specimen, which will pass about equally well for a horse, a pig or a crocodile.

The milky juice of the Pará rubber trees, of which you see a specimen before you, has approximately the following composition:—

Caoutchouc	32
Albuminous, extractive, and saline matters ..	12
Water	56
	100

As a rubber producing tree, the *Ficus elastica* stands next in importance to the Heveas. The *Ficus elastica* grows abundantly in India and the East Indian Islands, one district in Assam, thirty miles long by eight miles wide, being said to contain 43,000 trees, many of them attaining a height of a hundred feet. This tree also grows freely in Madagascar, and it is well known to us as a green house plant. The slide now projected on the screen represents the *Ficus elastica* in its native regions; and I will next show you one illustrating a *Ficus elastica* now growing out of the doors in the Parc Monceau at Paris.

The juice of the *Ficus elastica* contains notably less caoutchouc than that of the American trees, the proportion very often falling as low as 10 per cent of the juice.

A vine-like, plant the *Urceola elastica*, which grows abundantly in Madagascar, Borneo, Singapore, Sumatra, Penang, and other places, yields a considerable amount of caoutchouc of very good quality, and you will find specimens of the substance from these districts on the table.

Africa yields a considerable quantity of caoutchouc, but generally soft and of inferior quality. It is believed to be yielded by various species of landolphia, ficus and toxicophlea. Here are some specimens of African rubber. This specimen, representing the quality known as African ball, being tolerably firm in consistency, while the African flake, which you see here, and the African tongue represent the lowest and most viscous qualities of commercial rubber. In order that you may compare the two extremes of quality, I will hand round specimen of fine Pará together with a piece of African tongue.

NOTES ON GUMS, RESINS, AND WAXES.

BY C. G. WARNFORD LOCK.

(From the *Journal of the Society of Arts.*)

India-rubber (from *Ficus elastica*).—The collection of the rubber in Assam is conducted under rigid restrictions in the case of all trees growing in the timber reserves, but cannot be enforced on scattered trees. The Chardwar rubber plantation has an area of 80 square miles. The exports from Lakhimpur in 1871 were 260¾ tons, value £8,340. Immense forests of these trees existed on both banks of the Subansiri river, and on other streams ; but the reckless treatment they received from native lessees of the forest caused their ruin. In 1876, the leasing of these forests ceased, but there is now little or no rubber left in the plains of the Lakhimpur district. The tree grows to heights of 15 to 35 feet, and its girth, when fit to be tapped, is 18 inches to 6 feet. A high yield for the first tapping of a tree is 35 to 40 lb. of rubber. It is then allowed to remain untouched for three or four years, when another collection is made, but the yield is then much less. It is estimated that the forests of Cachar could yield upwards of 2,000 cwt. of rubber annually. It is stated that the trees yield most during the rains.

Of India-rubber, 20,000,000 lb. are annually exported from Para (Brazil), chiefly derived *Siphonia elastica*, but a few other species are admitted. The utmost yield from each tree is one gill. In the wet season, from February to July, the gum is week, and the tapping is stopped. The trees will grow on the *terra firma* when planted, but their seeds naturally lodge in lowland swamps. Trees properly planted, and cared-for, yield well in fifteen years. Brazil is being gradually cleared of its rubber ; gatherers now go to the Tocantins, Madeira, Purus, and Rio Negro, and will soon clear there also. Straus's method of preparing rubber, instead of smoking is to drop the milk into alum solution ; it is stated to be superior, but it is not adopted.

India-rubber plants grow on the slopes of the Cameroons mountains (West Africa), but the people do not yet know their value. India-rubber trees abound on the River Djour, in the province of Bahrel Ghazal. The natives of the Marutse-Mabunda empire, on the Upper Zambesi, trade in India-rubber with the tribes to the west.

The *Landolphia* vine is known from Pangani inland all the way to Handei (in Usambara, East Africa), and at Magila the rubber is made into balls for export.

The giant creeper, *Landolphia*, grows chiefly on trees near rivers and streams in Angola and the Congo. Every part exudes a milky juice when cut or wounded ; but this will not run into a vessel placed to catch it, as it dries so quickly as to form a ridge on the wound, which stops its further flow. The blacks collect it by making long cuts in the bark with a knife; and as the milky juice gushes out, it is wiped off continually with the fingers, and smeared on their arms, shoulders, and breast, till a thick covering is formed. This is peeled off their bodies and cut into small squares, which are then said to be boiled in water. From Ambriz the trade in this rubber quickly spread south to the River Quanza, where considerable quantities are exported.

Within 20 miles of the coast from Liawa and the Lindi estuary (Masasi and Rovuma, East Africa) the forest becomes almost entirely formed of India-rubber vines, affording an abundant supply of fine India-rubber, at present gathered only in a very desultory manner by the natives, who gash the plants, and collect the rubber as it issues in a liquid form, and dries hard after short exposure to the air. Rolled into orange-like balls, it is taken to Lindi, where what is worth 7 to 8 dol. fetches 2 dol. The width of the belt is 15 to 20 miles. On the Victoria Lake (Central Africa) are one or two kinds of tree which produce caoutchouc of good quality.

Dr. Kirk has just determined, with accuracy, the plant which yields the best East African India-rubber, and has obtained seeds of the species for introduction into India. It occurs in great abundance along the newly-made road from Dar-es-Salaam, in a west-south-westerly direction, for about 100 miles towards the interior of East Africa, through the Wezamaro country; it is apparently but little affected, except in the immediate neighbourhood of the villages, by the reckless mode of tapping employed. In many parts, a native can still collect 3 lb. of rubber daily. There are five species, but only one is considered worth tapping.

Rubbers and Guttas of Borneo and Sulu.—The Kadyans and their Murut neighbours collect a quantity of gutta-percha and India-rubber in the surrounding forests. The gums are afterwards manufactured into lumps or balls, and conveyed to Labuan for sale. The gutta is obtained from four or five species of the genus *Isonandra*, all large forest trees. The trees are felled and their bark is girdled or ringed at intervals of two feet, the milky juice or sap being caught in vessels formed of leaves or coconut shells. The crude juice is hardened into slabs or bricks by boiling, and is generally adulterated with 20 per cent of scraped bark. Indeed, it is said that the Chinese traders, who buy up the gutta from the gatherers, would refuse the pure article in preference for that containing bark, to which the red colour is mainly due.

India-rubber in the north-west districts of Borneo is the produce of three species of climbers, known to the natives as *manoongan manoongan putih*, and *manoongan manga*. Their stems have a length of from 52 to 100 feet, and a diameter rarely exceeding 6 in; the bark is corrugated, and coloured grey or reddish-brown. The leaves are oblong, green, and glossy; the flowers are borne in axillary clusters, and are succeeded by yellow fruits, of the size of oranges, and containing seeds as large as beans, each enclosed in a section of apricot-coloured fruit. These fruits have a delicious flavour, and are much prized by the natives. The stems of the India-rubber creepers are also cut down to facilitate the collection of a creamy sap, which is afterwards coagulated into rough balls by the addition of nipa salt.

The fallen gutta trees lie about in all directions in the forest, and the rubber-yielding *Willughbeias* are also gradually, but none the less surely, being exterminated by the collectors in Borneo, as throughout the other islands, and on the Peninsula, where they likewise abound.

It was formerly thought that gutta percha was the produce of only one species of tree (*Isonandra Gutta*), but that obtained from the Lawas district is formed of the mingled saps of at least five species, the juices of a *Ficus* and and of one or two species of *Artocarpea*, being not unfrequently added as adulterants The Bornean *gutta soosoo*, or India-rubber, again is the mixed saps of three species of *Willughbeia*, with the milks of two or three other plants surreptitiously introduced to increase the quantity.

The gutta trees are slow to attain maturity, and are difficult to propagate, except from seed. The *Willughbeias*, on the other hand, grow rapidly, and readily lend themselves to both vegetative and seminal methods of propagation; hence these are especially deserving of the attention of the Government of India, where they may reasonably be expected to thrive.

There are, doubtless, yet many thousand tons of rubber and gutta in the Bornean woods, but as the trees are killed by the collectors without any thought of replacing them, the source of supply must recede constantly further from the markets, and prices will rise in consequence. The demand for India-rubber from Borneo is of quite recent growth ; yet in many districts the supply is already practically exhausted.

In Assam, Java, and Australia, rubber is afforded by *Ficus elastica*, which is cultivated for the purpose. There are many milk-yielding species of *Ficus* in the Bornean forests which, with careful experiment, may possibly be made to contribute remunerative quantities. The Malayan representatives of the breadfruit family also deserve examination, as an excellent India-rubber is derived from *Castilloa elastica*, a South American plant of this order.

INDIA-RUBBER IN THE UNITED STATES OF COLOMBIA.

(From the *Journal of the Society of Arts*, Dec. 2, 1881.)

A very considerable trade is carried on in Colombia in gathering india-rubber, and the trade accounts of that country show a large increase in the export of this article for 1880 over the previous year, the greater part of it being consigned to the United States. Consul Smith, of Carthagena, in his recent report, gives an interesting account of the system pursued by the rubber hunters in collecting this article, and at the same time, calls attention to the wasteful custom they have of cutting down every tree from which they extract the rubber instead of tapping them; in this way all the trees near the rivers have been long since destroyed, and the hunters have now to go several days journey into the forests, crossing swamps and mountains before they can find the rubber and bring it out on their backs over these rough trails. Each succeeding year the quantity gathered is less, and it is a matter of surprise that the Colombian government has not enforced its regulations against the systematic destruction of one of the most valuable forest trees. The trees which yield the largest supply flourish along the banks of the Sinu and Aslalo Rivers. The hunters before entering the woods provide themselves with guns, ammunition, flour, salt, and tobacco. The flour is made from plantains which are cut into slices, dried and ground, and is generally mixed with corn meal; this will keep sweet for months. For meat the hunters depend upon the game they can kill. Each man starts out with his gun and machetè alone, hunting for rubber and game. As soon as a rubber tree is found he cleans a space round the trunk, cutting away all vines, under-bush, &c , and again marches off in search of more rubber trees, not returning to camp till nightfall. Accoring to immemorial custom, a tree belongs to him who has cut round it. The hunt is continued until all the trees in the vicinity of the camp are thus secured, and then begins the work of gathering the rubber. A hole is dug in the ground near the rubber trees, unless another party is encamped near, in that case the holes are dug near the camp. The bark of the tree is first hacked with a "macheté" as high as a man can reach, the cuts being in the form of a V, and the milk, or sap, collected as it exudes, and put into the hole which has been dug for it. After the sap ceases to flow from the cuts, a pile of wood or brush is made at the foot of the tree, and the tree itself is chopped down the branches keeping one end of the tree off the ground, and the piles of wood at the foot of the tree doing the same at the other end, thus the tree is suspended. The hunter, after carefully placing large leaves on the ground under the tree, proceeds to cut gashes in the bark throughout its whole length. The sap is collected from the tree and from the leaves placed under it, and added to the milk first collected. The sap when it first exudes from the tree is as white as milk and as thick as cream, but it soon turns black on exposure to air and light, if not properly watched and cared for. The quantity of milk which is put into one hole, depends not only in the size of the trees and their distance apart, but also on the strength of the man who is to carry the rubber from camp to the rivers,and the track and trail he must carry it over. As soon as the milk is placed in the hole, the rubber is coagulated by the addition of some substance, such as the root of " mechvacan," hard soap, or other substance, and these cause the milk to coagulate so fast as to prevent escape of the water, which is always present in the fresh sap, and as the rubber and water will not mix, a piece of rubber coagulated in this manner is full of small cells containing water. It costs no more to make the rubber perfectly clear and transparent as amber, in which case it is infinitely more valuable, than to make it full of holes, water and dirt. As soon as all the rubber trees are cut down, and the rubber coagulated, the pieces are strapped on the backs of the hunters by thongs of bark, and carried by them out to the bank of the river, and brought to market by canoe or raft. Consul Smith says, in concluding his report, that the importance of the india-rubber tree, in connection with the many and useful purposes to which it is now applied, can hardly be estimated ; and the attention of the planters of Colombia has never been turned to its cultivation, and he expresses an opinion that a good field for investment lies in this direction, as a plantation of india-rubber trees would prove a most valuable source of profit. There are places on the Sinu river where the trees will grow from eight to ten inches in diameter in three or four years from the planting of the seed ; the trees require but little attention, and begin to give returns as soon, if not sooner, than other trees.

RUBBER IN BORNEO AND PERAK.

On the subject of Bornean caoutchouc, the Kew report says :—" The most authentic information on the caoutchouc-yielding species of North-West Borneo is apparently that contributed by Mr. Treacher to the Journal of the Straits Branch of the Royal Asiatic Society for July, 1879 (p. 58). He enumerates no less than eight, with the following names :—

" 1. Manungan pulau (*i.e.*, Manugan proper).

" 2. Manungan bujok.

" 3. Manungan manga (light coloured bark).

" 4. Manungan manga (dark coloured bark).

" From the above is obtained the gutta lechak or gutta susu of commerce. (*Gutta* in Malayan means gum ; *lechak*, elastic ; *susu*, milk).

" 5. Serapit larat.

" 6. Serapit pulau.

" The produce of these is only used to increase the weight of the manungans, the milk not hardening sufficiently of itself.

" 7. Bertabu or Petabo pulau.

" 8. Bertabu or Petabo laut.

" The produce of these is no longer marketable. The different plants would appear to be accurately distinguished by the native collectors ; and, if the best of them are to be sought and brought into cultivation, their precise botanical identification becomes important.

" No. 1 of the foregoing list is referred to as a new species of *Willughbeia*, the name proposed for it being *Willughbeia Burbidgei.*

" No. 2 is *Leucenotis eugenifolius.*

Nos. 3 and 4 are supposed to be species of *Willughbeia* and *W. Treacheri* is proposed for No. 5.

" The remainder would at present seem to be undeterminable. All the above species belong to one natural order, namely, *Apocynaceæ*. Other caoutchouc yielding plants are referred to in the report, which are, however, of minor importance as compared with those just enumerated.

" Regarding the collection in Perak of *Gutta singgarip*, the produce of *Willughbeia Burbidgei*, the following description is given :—'The stem is generally ringed at intervals of 10 to 12 inches, and the milk allowed to run into vessels made of palm or other leaves, coconut shells, or anything available for the purpose ; it continues to flow for sometime, but after flowing for some minutes, it gets very watery and thin. One flow will yield from five to ten catties of the coagulated caoutchouc. When raw, it has the appearance of sour milk, and, to coagulate it, the natives add salt, or salt water. When freshly coagulated, it is quite white, which gradually changes to a darker colour. It keeps white inside, and, on cutting, it presents a foveated appearance, the cells containing water and salt which have become enclosed during cogulation. In texture it is soft, very spongy, and very wet."

INDIA-RUBBER AND GUTTA-PERCHA IN SAIGON, &c.

(From the *Colonies and India*, 12th May, 1882.)

Dr. L. Pierre, Director of the Botanical Garden at Saigon, in French Cochin China (about the same latitude as Tenasserim), has recently made some interesting observations on the rubber and gutta yielding trees of Cochin China and Cambodia, in No. 2 of "Cochin Chine Francaise: Excursions et Recon naissances," an official work published at Saigon.

Siphonia elastica, introduced *via* Java, is apparently certain of establishment, though not yet seriously cultivated; *Ficus elastica* has also been introduced. It is, however, to the indigenous plants that Dr. Pierre's attention has chiefly been directed. He speaks of three native species of *Euphorbia*, not worked by the inhabitants of the country, though easily cultivable, and growing on the driest and most unlikely soil, which afford a medium or inferior product, and are considered to be worth the attention of the Government; and he also mentions an allied plant of very wide distribution and rapid growth, *Excœcaria oppositifolia*, which furnishes a most abundant milk. But the most remarkable plant in Cochin China, from the caoutchouc-producing point of view, is one of the *Apocyneæ*, *Parameria* (or *Ecdysanthera*) *glandulifera*, on which positive and entirely conclusive experiments have been made. This plant is a liana or creeper, which grows to the tops of even the highest trees, and is found abundantly in all the forests of Cochin China, chiefly at Cam-xay. Phuquoc, Poulo-Condore, and in the environs of Tayninh, Baria, and Bienhoa, being excessively common near Xong-luu (we retain the original spelling): nevertheless, the natives do not know how to extract the rubber from it.

The diameter of this creeper when full grown (say in ten years) is nearly two inches. The juice that flows from it presents exactly the appearance of milk, and can be used like it, having a slightly nutty flavour. In its liquid state it is often employed as a medicine by the Annamites and Cambodians. The bark, after being dried (usually by fumigation) is sold at the rate of from 20 to 25 frs. the picul (133 lb.) and sent to China, where its medicinal properties are much appreciated. It is to be had in all the markets of Cochin China under the name of "dau" or "do tam" in the Annamite, and of "wahrr angkot" or "whole angkot" in the Khmer, language.

The method employed for the procuring caoutchouc is of the very simplest nature; it is only necessary to pour the juice drawn from the creeper (either by incisions or cutting it up into small lengths, if a larger quantity is wanted at once) into a basin of water of the temperature of 40° or 50° (presumably centigrade, equivalent to 104° or 122° Fahr.), when, on being stirred with a rod, the milky mass is instantly converted into an excessively pure rubber of unrivalled quality.

This plant is propagated by cuttings with astonishing rapidity. Introduced into the botanical garden at Saigon in 1874, it had, by climbing up trees, reached in 1877 a height of from 26 feet to 33 feet. It could be planted so as to economise space without harm under any forest tree not less than ten years old, when the now devastated forests of Cochin China are regularly taken in hand; or it could be trained at the foot of fruit trees grown as hedges. In this way the almost entire want of any neccessity for cultivation, and the double utilisation of land generally considered worthless, would combine to render the plant the source of a very paying revenue.

As to the now possible working of the creeper as it grows in a natural state in the forest, the only way would be to apply to the Chinese and the native traders (especially the Cambodians), who for an adequate offer would collect the juice. It is solely a want of care and the present state of infancy of French commerce which have caused the product of so valuable a plant to be hitherto neglected, says Dr. Pierre, who mentions among other *Apocyneæ* in the Botanical Garden a species of *Willughbeia*, very vigorous and a rapid spreader, and yielding a very abundant juice, though its rubber is possessed of but slight elasticity.

As Indiarubber is apparently now increasing in market value, it may be worth the while of our settlers in British Burma and the Straits Settlements to pay careful attention to the rubber-yielding Apocyneous plants, growing wild in those countries, which are in about the same latitude as Saigon, and present similar climatic and geographical conditions, being also parts of the Indo-Chinese peninsula. Economic botany has not been neglected in them, it is true ; *Ficus elastica* has been introduced into British Burma and thrives as far as mere growth goes, though it is yet too early to judge whether it will retain its quality out of its natural limits. *Chevanesta esculenta*, a caoutchouc-yielding creeper, has also been planted in the Ma-ga-ree Forest (British Burma) and grows vigorously ; but it is to the native plants that attention could apparently be profitably turned, and of these, *Ficus laccifera* (in Burmese "Guyoung"), which grows in the evergreen tropical forests of Pegu and Tenasserim, is stated to yield a very good rubber, equal to that of *Ficus elastica ;* and there are many other native species of *Ficus* and *Artocarpus* yielding caoutchouc of different qualities. Another plant, *Isonandra polyantha*, found in the forests of Arakan, yields gutta percha probably not inferior to that of Singapore (according to Spearman's *British Burma Gazetteer*, 1880) ; but it is evidently to the resinous gums that most attention has been paid by Colonial botanists here.

As regards gutta-percha, Dr. Pierre points out the present state of uncertainty as to the exact trees which furnish the very varied qualities of that commodity coming into the market under the names "Macassars," "Borneos" "Sumatras," "Banjermassins," and "Singapores"—purely commercial designations, which afford no indication of the local origin of the species. "Borneos" are known to be inferior, but the others are subject to great variation ; and it is a curious thing that no collectors, Chinese, Malays, Dyaks, or others, can be induced to supply specimens of the trees which furnish the gutta they bring. Hooker's original gutta-tree, brought by Lobbe from Singapore, and described as an *Isonandra*, is now known with certainty to be a *Dichophis ;* but it is still not known whether this is the tree that supplied the best commercial gutta, for which the southern part of the Malayan peninsula, Borneo, Bantam, and the neighbouring isles, must probably be searched. The only commercial gutta really traced to a tree is that obtained in Larut by Messrs. Brau de St. Paul Lias and De la Croix, through Mr. Low, our Resident at Kuala-Kangsar. The tree from which this came is figured by Dr. Beauvisage under the name of "Gueutta, seundek," and is supposed by him to be the *Keratephorus Leerii* of Hasskarl, which is now known to belong to the genus *Payena*, a sapotaceous plant. Dr. Pierre notices another species of this genus *Payena alabasterana*, from the right banks of Mekong; also a *Bassia* (called "Sang dao"), a *Mimusops* (probably *M. Rauki*), *Chrysophyllum Roxburgii*, two species of *Sideroxylon*, and *Dichopsis krantziana*, as indigenous plants worthy of investigation as yielders of gutta-percha, and he concludes with pointing out the great commercial and economic importance of scientific observations in this direction, in language equally applicable to British Colonies in the Far East.

FICUS ELASTICA.

(From the *Gardeners' Chronicle*, December 31st, 1881.)

The way in which this remarkable tree, Ficus Elastica, became known to botanists and horticulturists was very singular, as related by Roxburgh in his *Flora Indica* iii., p. 543. Towards the close of 1810 a Mr. Matthew Richard Smith, of Silhet, sent Roxburgh a vessel, there called a "turong," filled with honey in the very state in which it had been brought from the Pundua or Juntipoor mountains north of Silhet. The vessel was a common, or, rather, coarse basket, in the shape of a four-cornered, wide-mouthed bottle made of split rattans, several species of which grow in abundance in the abovenamed mountains, and contained about two gallons. Mr. Smith observed that the inside of the vessel was smeared over with the juice of a tree which grows on the mountains. Roxburgh was therefore more anxious to examine the nature of this lining than the quality of the honey. The turong was accordingly emptied and washed out, and Roxburgh then found that it was very perfectly lined with a thin coat of caoutchouc. Young trees were speedily procured through Mr. Smith, and cultivated in the Botanic Garden at Calcutta, where they throve with the greatest luxuriance. The name only was first published in Roxburgh's *Hortus Bengalensis* (1814), p. 65. When we say name only we mean without description,although Roxburgh indicated that it was a large tree,and gave the season of flowering and fruiting. Recently Dr. Brandis (*Forest Flora*, p. 418 in a footnote) has stated that Blume must stand as authority for Ficus elastica, "because Roxburgh did not include it in his *Hortus Bangalensis*, and his *Flora* did not appear till 1832, whereas Blume published it in his *Bijdragen tot de Flora van Nederlandsch Indie* (1825), p. 446." But this objection fails inasmuch as the name is included in the *Hortus Bengalensis* in the place quoted. Blume received the plant from the Calcutta garden, and published the name as his own. We sometimes find Linnæus cited as the authority for the name, but, as we have shown, it could not have been known to him.

In 1815 five years after its discovery, as we learn from Sweet's *Horus Britannicus*, 2d ed., p. 461, it was in cultivation in this country. Its hardy nature enabling it to bear smoke, dust, gas, wet and drought better than most other plants, it soon became a common and favourite ornament in sitting-rooms, and other parts of dwelling-houses, as well in this country as on the Continent. Although it will bear a great deal of rough treatment it repays a little care by producing leaves as much as two feet in length ; but for indoor (dwelling-house) decoration it should be kept in small pots, in moderately rich soil, or it will soon outgrow its space. Indeed, it is remarkable how long this tree, which attains gigantic dimensions in a wild state, may be kept healthy and ornamental in a mere handful of earth. With regard to the size of this tree in its native country, we find some interesting particulars in William Griffith's "Report on the Caoutchouc Tree of Assam," in the *Journal of the Asiatic Society of Bengal*, vii., part 1, p. 132. In the district where it grows it overtops the other vegetation, not only growing tall, but forming colossal trunks. The dimensions of one tree measured by Griffith were :— Circumference of main trunk, 74 feet : ditto of main trunk and supports, 120 feet ; estimated height, 100 feet. The nature of the trunk is very extraordinary, and is thus described by Griffith :—It differs in the first place from the ordinary trunk by its sculptural appearance, and it is from this that its extremely picturesque appearance arises. The appearance arises entirely from the tendency of these trees to throw out roots, both from the main trunk as well as from the branches, and from the extreme tendency these have to cohere with the trunk or with each other. If the roots are thrown out from or very near the main trunk, they ordinarily run down its surface, and cohere with it firmly, and hence the sculptured appearance. If, as happens in some, they are thrown from the branches at such a distance from the trunk that they do not come in contact with it, they pass down to the earth and form what I call supports. These supports never appear to produce leaf-bearing branches, so long at least, as they remain attached to the tree. They are generally perfectly straight at first, becoming conical only by divisions at the apex when nea the earth, and by the mutual adhesion of these divisions. Very generally it would appear this species, as well as some others, vegetates in other trees ; its first process of growth being probably similar to those of other dicotyledonous trees. The roots, however, in obeying the laws regulating their descent, soon come into contact, and wherever they do so a mutual and firm adhesion is the result. A network is soon formed round the tree ; the size of its reticulations soon diminishes with the increase in the number of roots ; and at last a nearly solid and excessively firm cylinder is formed, which encloses, as it were, in a case, the tree which originally protected the young seedling. To such an extent is this carried that the death of the tree is sure to occur sooner or later. In such a case as this the fig tree has, it may be said, no trunk at all comparable to ordinary trunks, which result from growths in an ascending direction. In these they originate from the aggregation and cohesion of roots, or from growth in a descending direction." From Griffith's observation it appears that this tree rarely fruits in a wild state, and still more rarely does it fruit under cultivation in this country. An instance occurred in the garden of Mr. Boyce, of Clapham, in 1874, and the fruit was figured in this journal, n.s., ii., p. 359.

THE INDIARUBBER AND GUTTAPERCHA TREES OF BRITISH GUIANA.

At a meeting of the Royal Agricultural and Commercial Society of British Guiana, the Secretary handed in a communication he had received from Mr. Jenman with regard to the India-rubber trees in Demerara. The letter is as follows:—

My Dear Sir,—I enclose herewith for the Museum of the Royal Agricultural and Commercial Society, samples [vulcanised] of india-rubber, produced respectively by the Hatie and Cumatraballie of this colony. The raw rubber from which these samples were manufactured, I collected on the Pomeroon River, and sent to Kew, to be tested a few months ago; which resulted [with other correspondence] in the following report, communicated through the Secretary of State for the Colonies and published in the *Official Gazette* :—

" The india-rubber made on the Pomeroon River, British Guiana, from the *Hevea Spruceana* contains caoutchouc, but is impregnated with other principles which destroy its properties for any manufacturing purposes involving the process of vulcanizing. Since most of the species of *Hevea* have been described as yielding good india-rubber, including the *Hevea Spruceana* growing several miles north of the Amazon, it would be important to determine whether in this case the deteriorating principles are foreign [? belonging] to the tree, or whether they arise from injudicious incision. The rubber smells very strongly of the oily matter which goes off in the smoke from the burning of the nuts of the Uracapi palm, which also has the effect of softening and rendering the rubber dark.

The loss on washing and drying is 11·75 %. The soft and sticky character would appear to be due to a volatile, or perhaps easily carbonised substance. When mixed with sulphur and submitted to the vulcanizing processes, it vulcanizes, but becomes spongy. The caoutchouc vulcanizes so completely, that it would be worth while to try whether by any chemical treatment its sponginess can be prevented. Such treatment, however, prevents its being used extensively.

" The [Cumatraballi] india-rubber on washing and drying yields a loss of 14·96 %, and when mixed with the suitable proportions of sulphur, vulcanizes perfectly. Its firmness and freedom from stickness are in favour of its manipulation.

The passage in the report,—" it would be important to determine whether in this case the deteriorating principles are *foreign* to the tree, or whether they arise from *injudicious incision* " is not very clear in its meaning. Injudicious incision, so far as it affected the character of the milk, would be " foreign" to the tree ; but I do not see how any method of tapping could be injudicious in this sense. In collecting this rubber, the incisions were made with a cutlass ; and an axe or this instrument must necessarily be used in the operation. It is true the juice was dried in the smoke of burning palm nuts, but this system is very largely practised in coagulating Para india-rubber. It hastens the process, but is not essential, and need not be pursued if disadvantage pertains to it.

It is disappointing, however, that as *Hevea Spruceana* is so abundant in the colony, and such a near ally botanically of the valuable *Hevea brasilensis*, its rubber should be, apparently, of such inferior quality. I say apparently advisedly, for I think this cannot be regarded as determined till the nature of the deleterious principle, which prevents its perfect induration when vulcanized, is ascertained, and whether it was accidental in this sample or is inherent in the juice of the species of *Hevea*. It is possible, too, that if the sponginess cannot be prevented in its manufacture, considering the multiplicity of the applications which are being found for india-rubber, certain uses may be discovered for which this character will specially recommend it, which seems not improbable, for it is certainly a very peculiar and characteristic substance.

As I anticipated in my report of the discovery of the Cumatraballi,* its

* Report of the Government Botanist and Superintendent of the Botanic Gardens on some of the India-rubber and Gutta-percha trees of British Guiana.—*Gazette* Office, 1883.

rubber has proved to be an excellent material; and considering the great size of the tree, its thickness of bark and prolificness in milk, the price [2/3-2/6 per lb.] it is estimated as worth in the market is very satisfactory and encouraging; and I have no doubt that in the future both the trees and the rubber which it yields will be in considerable demand. I hope in the interval steps may be taken to prevent collectors from felling and destroying a tree so valuable, and of much interest for its grand proportions as a woodland feature, and thus ensure its abundant perpetuity in the colony.—Very faithfully yours,—G. S. JENMAN.

W. H. Campbell, Esq., Secy., Royal Agricultural and Commercial Society.

INDIARUBBER AND GUTTAPERCHA IN THE DUTCH EAST INDIES.

We have received a separate reprint of a paper from the February number of the *Tijdschrift van Nijverheid en Landbouw* (Journal of Industry and Agriculture) published in Batavia, the title of the paper being "Over de Toekomst der Caoutchouc-culture in Oost-Indie." (On the Future of Caoutchouc Culture in [Dutch] East India), being a notice of a "report on planting experiments with caoutchouc-yielding trees during the first quarter of 1884, carried out by the forester of the forest district of East Preanger, A. H. Berkhout." The review is dated "Batavia, 19th December 1884," but there is no signature, so that we cannot tell who the writer is. He commences by briefly sketching the history of indiarubber and detaling the uses to which it is put, and then deals separately with the three commercial varieties of East Indian, Sumatran, and American. Under the first, he speaks of *Urostigma elasticum* and *Urostigma karet*, both belonging to the family of the Artocarpaceæ. It seems that Java has the oldest plantation in the world of karet trees, Messrs. Hofland having in 1866 formed an extensive plantation in the neighbourhood of Soebang. The writer goes on to refer to the wasteful method of gathering the rubber, and quotes from the *Tropical Agriculturist* for November 1884, p. 361, an extract on this subject the statements in which, he says, are borne out by experience in Java, and he quotes from Mr. Berkhout's report an instance of this, and then mentions the regulations which are being enforced in Assam for the protection of rubber trees. Details are given of experiments by Mr. Berkhout with karet trees, which seem to promise success. The usual method of propagating this tree is by cuttings, but the writer thinks that the use of seed would be cheaper and more efficacious. Proceeding to speak of Ceara rubber (*Manihot glaziovii*), the writer quotes from Mr. Berkhout's report detail of experiments with seeds obtained from Ceylon in December 1883, through Messrs. John Pryce & Co. Two different methods were employed. A portion was simply put out in the open air between gunny bags and kept constantly moist. To guard against the attacks of ants, which are very fond of the kernels, the bags were placed on rough trestles, the legs of which were put into tins of earth and these into kerosene tins filled with water. Three days afterwards some of the seeds had sprouted, but a large portion after the expiry of a month showed no signs of germination: recourse was therefore had to filing, and seeds were once more placed between the gunny bags. Many then showed that they possessed the power of germination, but, Mr. Berkhout adds, filing is a difficult operation and it not done carefully causes harm instead of good: if the germ is injured the cotyledons swell but soon rot and no roots are produced. Mr. Berkhout adds that as soon as the seeds begin to germinate they should be planted with the root downwards 1 centimeter (say ½ inch) deep. Seedlings should not be planted out directly in nursery beds, as many would fall a prey to ants, but should be put into pots filled with sand and placed on trestles. When the plumule begins to develop the plant can be placed with the ball of earth in the nursery bed, and for the first few days shaded. The differences in the growth of the plants Mr. Berkhout thinks are to be explained by a portion of the seed being from young trees. Figures are then given of the growth made by plants at different elevations. Experiments were to be tried with cuttings, but Mr. Berkhout considers these doubtful of success, judging by experience with cassava, which is closely allied to Ceará. The writer of the review then quotes from the *T. A.* for last November, p. 354, an extract from the report of the Agricultural Society of Madras, giving part of a letter from Messrs. J. P. William & Bros. of Henaratgoda on Cerá cultivation, and directions for the germination of the seed, which he compares with those given by Mr. Berkhout. Passing on to speak of *Castilloa elastica* the reviewer gives an extract from Mr. Berkhout's Report relating to the planting of seeds from a tree in Java all of which germinated, the plants growing well. Mr. Berkhout adds :—"The statement of Dr. Trimen, that the *Castilloa elastica* is destined under careful culture, to be a source of revenue, appears to me, in view of what I have stated, perfectly correct." Information on the subject is again quoted from the *T. A.*, and then the reviewer proceeds to notice certain indigenous caoutchouc-yielding trees, viz. *Leuconites eugenifolia*, *Beaumontia grandiflora* Wall., *B. multiflora*, F. & B., *B. spec. jav.*, and *Vahea gummifera*, and finally Para rubber. Figures for rainfall at various places in Java are then given, and a table showing the growth of the various varieties of caoutchouc planted. The last plant referred to in the report is a tree called by the Malays *hambarang* (*Ficus fulva*), which yields a vegetable wax, used in the colouring of cloth. The report concludes by pointing out the importance of an extended cultivation of caoutchouc-yielding plants, now that the price of cinchona-bark has so decreased and the coffee crops have fallen off to such an extent. The writer points out that there is no fear of over-production, as in the case of quinine, the uses to which caoutchouc can be put being almost endless. He calls upon the Government to send a botanist to South America to procure plants and seeds of the best varieties; while at the same time there should be a thorough investigation into the varieties growing in the Dutch East Indies, especially Borneo. So far Mr. Berkhout's report, and the reviewer concludes his remarks by pointing out the difference between caoutchouc and guttapercha, which two substances are popularly confounded together, though entirely distinct in origin, chemical composition and uses. His final words are :—"If, however, the reader wishes to get further information on this subject he should buy the following"—and then come the entire title and list of contents of the book on indiarubber and guttapercha compiled and published by us. For this gratis advertisement and testimonial to the value of our publication we tender our thanks to the anonymous writer.

RAW PARA INDIARUBBER: ITS COLLECTION AND PREPARATION.

BY THOMAS T. P. BRUCE WARREN.

A few years ago I was engaged as an electrician in laying a submarine telegraph cable between Pernambuco and Para. After the cable was laid I was stationed at Para for a few weeks, during which time I availed myself of every opportunity for seeing what was to be seen, so long as it did not interfere with my duties or inclination to be idle. It is no use disguising the fact that at midday within a few miles of the equator even an active Englishman is likely to seek the cool retreat of a hammock, in preference to any form of outdoor amusement. Bates, in his "Voyage on the Amazons," says that the Brazilians have a proverb that only Englishmen and dogs are to be found in the streets in the day, so that, at any rate in the eye of a Brazilian, it is no great sin to shirk one's work a little.

During our stay at Para we found the acquaintance of many Brazilians, Americans, and Englishmen, so that at no time had we any reason for being particularly dull or feel our time hanging heavily on our hands. To Captain Bloem, a gentleman in the service of the Amazon Steam Navigation Company, we were particularly indebted for several interesting little trips into the forests. In these excursions, Captain Talisman, a gentleman belonging to the same Company, and formerly of the Brazilian navy, acted as pilot. This same gentleman accompanied Professor Agassiz in his journey through Brazil, and was consequently well able to point out and explain to us the marvels around us. I have frequently thought that the immensity and grandeur of these forests would tempt almost any weak-minded man to go off into poetry. We were bent on sterner things, amongst them being monkey-shooting, botanizing, and curiosity-hunting. A strange sensation creeps over one when quietly walking along in these forests; snakes of the most formidable kind may be lurking about ready to pounce upon one, whilst ants, mosquitoes, and other small insects are not very particular, if you interfere with them, of illustrating in a practical way their objection to being studied. Then, too, one perspires so freely that one's garments become so saturated as to make locomotion uncomfortable. After two or three visits to the forests one appears to get hardened against strange and poetical fancies.

I have met with no description of these forests which adequately represents a picture of what they really are. The vegetation is no doubt superlatively wild; the mingled chorus of the birds and monkeys, although in striking harmony with the vegetation, would lead you to believe that you were near the Antipodes to Paradise. The crowded state of the vegetation keeps the trees pretty much on a par as regards girth; the wrangling for survival is probably kept under by the richness of the soil. I had no opportunity of seeing Indiarubber trees in their native wildness. These trees are valuable on an estate, and the ground is kept cleared for some distance from the butt; this gives them a chance of developing into good-sized trees. I am not aware of any account being published of the amount of rubber produced by these trees under different ages; this fact, however, is certain, that the owners of these trees will not tap them until they have attained a good size, which will of course depend on the facilities given for their development. An owner has no interest in weakening his plants by drawing too freely at one time. The incisions, instead of being carried around the tree, are more frequently made at intervals on the stem, one above the other, in a zigzag fashion. Little cups made of clay, and dried in the sun, are cemented to the tree with a little soft clay, directly under one of these incisions, so that the sap flows freely into them.

I have frequently noticed the exaggerated ideas which are evidently current with regard to the collecting of the sap. Only a short time ago I saw an illustration in which the sap is represented as gushing out in a perfect torrent. At different periods of the year the sap has different degrees of inspissation flowing more copiously when the elaporation of sap is most active, and becoming slower as evaporation from the plant and dryness of the season set in. These conditions would indicate the necessity for repose, and growers who have an interest in their plants act accordingly. I must not, however, be supposed that to tap a tree at this time involves any serious peril, for the sap flows very slowly, and in a day or so heals up. When sufficient sap or juice is collected it is poured into a large earthenware pan, and the liquid is dried in successive layers on a mould formed of clay until the desired thickness is obtained, or until the juice is all used up.

The mould is thus made:—A piece of wood of a convenient length for a handle, about one inch or more in diameter, is coated with a layer of clay about 6 or 8 inches long, and from 3 to 5 inches diameter tapering at top and bottom. After drying in the sun it is ready for use. The clay-covered part of the handle is dipped into the juice and moved about so as to facilitate the removal of adherent air-bubbles, and then lifted out, and the handle carefully turned round and round, so as to keep an even thickness or coating all round. When this coating is set, another dip is made, the additional coating dried, and the operation repeated for as many coatings as may be necessary. When finished the whole is held over a fire made by burning the nuts of the Urucari palm fruit until it becomes of a dark rich brown colour. In this state it rapidly darkens. It is becoming more and more rare to find this smoked Para rubber;

this may be due to the scarcity of the palm nuts and the want of a suitable substitute.

Whatever may be exhalations from the roasting nuts it is evident that the Para rubber so treated may be kept for years without deteriorating. At one time, each coating was dried or coagulated by the heat from these fires. The statements made by some writers on this smoking process are absolutely ludicrous, and suggest the acceptance second-hand of a description which has been borrowed from a writer who has embellished a description by someone else, and which was probably correct until it received the adornment. The peculiar cooked-like odour of the Para rubber is due to the oil which rises from the burning nuts, and the curious-shaped nuts sometimes found in packages of Para or Negrohead rubber are those which are used in this smoking.

It may be a troublesome thing to prepare Indiarubber in a climate like India, so as to ship it in a condition likely to compete favourably with the rubbers from Brazil and elsewhere, and I would therefore suggest that it may be worth while to try the effect of smoking the prepared masses of Indiarubber directly they are finished. At any rate, the danger from handling might be avoided, as Indiarubber in contact with perspiration soon becomes soft and sticky. After the bottle is finished it is cut open by a longitudinal slit, so as to remove the mould; the clay is broken up, and the handle drawn through the neck of the bottles. It is then placed under pressure, when it takes the form of the well-known Para bottle-rubber. It is a very common thing to find a small hole through the flattened bottles. These holes are made so as to string them together in piles, in which form they are sent by the collectors to Para or to the merchants.

Bates says that the thongs used in threading up the bottle is an air root of an epiphytous plant. On our visits to the forests just outside Para we saw an immense number of these thong-like roots hanging down from the highest branches of the tallest trees, and reaching to the ground. One of our party hung on to one of them without its breaking. I do not remember seeing any of these thongs in a package of Indiarubber. The strength of these thongs must be very great, as one about a quarter of an inch in diameter is quite sufficient to support about one hundred and fifty pounds of rubber.

The rubber thus prepared is conveyed by canoes to the ports from which it is exported. The merchants who ship the article obtain it from the natives in exchange or barter for other commodities. The rubber accumulates in the warehouses of these merchants until sufficient is collected to make a consignment to a shipper or broker, whence it find its way in this country to the ports of Liverpool and London. This rubber is eagerly sought after by the Americans, and there is no doubt that its price is kept up by competition between the English and American markets. A great deal of rubber is now shipped direct from Maranham which was formerly sent to Para. The purity of this rubber commands for it a good price.—*Indiarubber and Guttapercha Journal.*

RUBBER TREES IN CEARA.

The following information has been received from Mr. George Holdern, the acting British Vice-Consul at Ceara, in reply to questions sent out by the authority of the British Government, with reference to cultivation of the Indiarubber tree in that province:—

Query—What are the names and productive qualities of the different kinds of rubber trees grown within your district?

Answer.—There are two kinds of rubber trees known in this province: first, the "Manicoba" plant from which the Sernamby rubber is extracted, and secondly, the Mangabeira" from which, with the application of alum, the "Mangaberia" rubber is produced.

Q.—What is the extent of land under cultivation by said trees?

A.—The Manicoba trees are only cultivated to a very small extent on the mountains of the "Serra Grande" and Serra da Uruburitama, the greater part of the trees growing wild are over the mountains, at an estimated area of 20 leagues. On the Serras of Maranguape and Pacatuba many trees are to be found, but in this district they have not been cultivated. The Mangabeira tree grows wild in nearly every wooded district where there is sandy soil.

Q.—What is the nature of the soil most favourable for the cultivation of the Indiarubber tree?

A.—The soil most suitable for the cultivation of the "Manicoba" plant is the clay soil of the mountains. For the "Mangabeira" the sandy soil of the low lands, especially towards the coast. The planting of the "Manicoba" is very simple either from the seeds or from slips of trees. The cultivation of this plant has not been much extended in this province, the people limiting their efforts to substituting any tree that may die by another from seeds or slips. Most of the planting has been done by nature; every year when the Manicoba fruit or seed is ripe it drops off the tree, and falling into suitable ground springs up without any care whatever being given to it.—*Indiarubber and Guttapercha Journal.*

COLLECTION AND PREPARATION OF GUTTAPERCHA.

The collection of guttapercha generally takes place directly after the rainy season is over, as in the dry season the gutta does not flow so readily, and during the rainy season the collectors are more liable to attacks of ague and jungle fever, and often, after cutting down a tree, a heavy rain washes away the gutta as it flows out. At times the collectors go in companies, often receiving advances in money, clothes, food, and tools, to be afterwards deducted from the proceeds of their expedition, although cases are not unknown where the trader who makes the advances loses principal and interest from the non-success, death, or knavery of the collectors. Sometimes the natives who live in the vicinity of the trees collect the gutta and exchange it at the trading stations for goods of which they are in want. There is a curious belief amongst the natives that if a tree be cut down at the time of the full moon, the result is better than at any other time, as the juice flows more readily, although, on the other hand, other natives affirm that the seasons make little or no difference.

Yield.—The yield of a well-grown tree of the first or best variety is from 2 to 3 lb. of guttapercha, such a tree being about 30 years old, 30 to 40 feet high, and 30 inches to 3 feet in circumference. A full-grown tree sometimes measures 100 to 140 feet to its first branches, and with a girth of 20 feet at a distance of 14 feet from the base. Such a tree will sometimes yield 50 to 60 lb. of guttapercha, which quantity loses about 35 per cent of its weight in six months from drying. There is also a great difference in the relative yield of different varieties, sometimes amounting to 20 per cent.

Method of Extracting.—Guttapercha is extracted in much the same way amongst Malays, Chinese and Dyaks. The trees are cut down just above the buttresses or banees, as they are called; and for this purpose a staging about 14 to 16 feet high is erected. The tools used in felling are either "beliongs" or "parangs." A beliong" is a chisel-like axe, used by the Malays in cutting down trees, building houses, &c. The blade, as will be seen, is of chisel-like form, and is secured to the handle by a lashing of "ratan" or cane. The Chinese often use an axe perfectly wedge-shaped. The "parang" with its short sword-like blade, is used to cut the rings round the trunk; it is a box of tools in itself in the hands of a good Malay, as with it he can cut up his food, fell a tree, or build a house. They are made of various sizes, the one figured was given me as a keepsake by a Hadji from Palembang, on his as way to Mecca, and is drawn quarter size. All these tools are forged by the natives themselves, and are used with considerable dexterity.

As soon as the tree is felled, the greatest haste is made to lop off all the branches, the natives asserting that if this is not done all the gutta would ascend to the leaves. Captain Lingard relates one instance where, it being late in the evening, one tree was left with the branches on, and the result was that in the morning, instead of obtaining 40 to 60 lb. of gutta, only, 10 lb. was obtained. The next operation is to cut and remove narrow strips of bark about 1 in. broad and about 6 in. apart. These cuts do not extend all round the tree, the under part of the tree being buried in the soft earth as it falls, and thus much gutta is wasted. Some natives also strike the bark with mallets, in order to accelerate the flow of milk. The milk or gutta flows slowly (changing colour as it flows) and rapidly concretes, and is of a different colour in different varieties, varying from a yellowish white to a reddish or even brownish tinge. The gutta as it flows, is received in hollow bamboos, doubled-up leaves, spathes of palms, pieces of bark, coconut shells, or even in holes scraped in the ground. Only two-thirds of the gutta is thus extracted, as one-third is buried in the ground. Captain Lingard told me that once he induced a native "pungula," or head man, to roll over a tree which had been felled four years, and even then a large quantity was extracted. If the quantity collected is small, it is prepared on the spot by pressing it together in the hands into a mass, and making a hole in the one end of the mass and passing a ratan through to carry it by. Often it is sent into the market in this state, and is then known as "raw gutta" or "getah muntah," the latter word in Malay meaning "raw." If water gets into the juice, the gutta becomes stringy and is considered deteriorated, but after being boiled appears quite as good. Sometimes the gutta is kept in a raw state for a month or two, and then undergoes the next step in preparation, that is, of boiling, but this should, I believe, take place *immediately* after collection. The boiling is generally conducted in an iron pan or "kwali." These are cast or stamped pans; 15 inches in diameter and 6 inches deep, with two handles rivetted on. Those made in Siam are generally preferred. The boiling is either made with simple water or with the addition of lime-fruit juice, salt, or coconut oil. Lime-fruit juice and salt are added to hasten coagulation. If one pint of the former be added to three gallons of gutta milk, the gutta coagulates or coagulates immediately on ebullition, and this addition expedites the preparation very materially. Coconut oil is added to give a better appearance to the product.

When the gutta arrives at the port of shipment, before it is exported it generally undergoes an examination with a view to classification in suitable classes. As it is received it presents great diversities as to appearance, shape, size, and colour; from crumbling, hardly coherent, whitish or greyish "raw" or getah muntah fragments, to reddish brownish blocks as hard as wood. Sometimes it is made up into all manner of grotesque shapes, and nearly always adulterated with sago, flour, sawdust, bark, clay, stones, &c. The Chinese are great adepts in assorting and classifying gutta, and frequently "reboil" the guttapercha by making small parcels of different varieties up to a certain "standard sample." This is done by cutting or chopping the gutta into thin slices and boiling with water in large, shallow iron pans, keeping the contents constantly stirred with poles, and adding good gutta and even coconut oil to give gutta a better appearance. When sufficiently boiled, the gutta is taken out of the pans, pressed into large moulds, and packed for shipment.—*Indiarubber and Guttapercha Journal.*

THE INDIARUBBER GATHERERS OF THE AMAZON.

For the most part the juice of the seringa has been hitherto collected on the islands and swampy portions of the mainland which lie within a distance of a hundred miles of the port of Para, and for that reason the produce is known as Para Indiarubber. In the great delta, away from the channels that have now become the highway for steamers between Para and the main Amazon, the explorer may paddle about in his palm-decked canoe through hundreds of miles of sequestered creeks, lakes, and streams, under the shade of huge overhanging trees of the richest variety and luxuriance, and for weeks together he will not find the slightest trace of man's existence in the dense solitudes, but here and there the hut of an Indiarubber gatherer. Although the industry is largely confined to this limited district, the tree flourishes with equal vigour in all the swampy districts, bordering the Amazon, and there are groves of untapped, serinagas growing by the Tapajos, Maderia, and other vast tributaries of the central river. Indeed, the traveller by the steamboats (of English make, by the way) that ply on the Amazon from Tabatinga—the first fortress in Brazil on the Peruvian border—to Para, which is quite two thousand miles distant will observe that Indiarubber is an article of export from nearly all the places at which the vessel calls. At the remote Tabatinga itself, rubber and salt fish are taken on board, the contributions to the civilised world from the numerous Indians who dwell in the adjacent forest. Five hundred miles further down the river stands Ega, on the tributary Teffe, half-way across the continent. Bates, who lived there exploring to the interest of science for four years and a half (Agassiz fished there for six months), exclaims, "What a future is in store for the sleepy little village!" At present, that distant population of 1,200 composed of pure Indians, half-castes, negroes, mulattoes, and whites, exports Indiarubber along with cacao, sarsaparilla, Brazil nuts, capaiba balsam, salt fish, turtle oil, and other products of the district. At Manaos, a thousand miles from Para, there is "enough Indiarubber to coat the civilised world." The same article—although cacao is the favourite product from this point—is taken on board at the mud village of Villa Nova, and so also at the town of Santarem, to which it is brought down from the river Tapajos. Still, as we have said, the greatest portion of the supply is obtained in the swampy districts nearer Para and the mouth of the Amazon.

The caoutchouc-gatherer reaches the swampy regions on which alone the Para rubber tree grows towards the close of August, when the floods that have prevailed for four months and kept the trees under water to their crowns, have gone down. A spot is chosen where a good supply of rubber trees is at hand, and in selecting it the gatherer has to take care that too dense an undergrowth does not hinder a ready passage between the hut and the trees. The caution is highly necessary, for the juice is rapidly spoiled by contact with the air, and every one must be familiar with the difficulty of threading a Brazilian forest because of its marvellous mazes of creepers and shrubs.

A piece of ground, of a size proportioned to the number of the household or group, is cleared leisurely, about a yard of the stumps being left standing. At intervals the mestizo, with a genius for saving himself trouble, allows some of the harder trees to remain, in order to serve as supports for the roof. The floor of the projected dwelling must be raised above the reach of the water, and accordingly the felled trees are placed upon the stumps for that purpose. Small strips of the bark of the muruti palm are laid down as flooring. To form the framework of the roof thin trunks are fixed to the stems that have been left standing, and over this are placed immense palm leaves, sheltering a space probably sufficient to accommodate a company of twenty persons. To serve as walls—there is no need in the tropics of any protection against cold—bass-mats are hung all round the structure on a horizontal pole. Partition of the building into apartments is not regarded as an indispensable feature among these semi-savages, and the highest conception of refinement among them is satisfied by the construction of a ladies' chamber in the centre by hanging up a few mats. The staircase is not an invention that requires much toil or genius; some blocks are laid above each other, or a tree stem, with rough steps cut into it, is placed obliquely against the hut floor.

Look now at the pantry. A space at the foot of some neighbouring tree is cleared of earth to a depth of two or three feet and fenced round. The adjacent stream fills the pond with water, and to this reservoir are consigned the fish and turtles that are caught. Less care is bestowed on the food obtained by the Indian's gun; what remains over the necessity of the day is simply dried in the sun, or salted and preserved in well-shaded spots.

The last few days before the caoutchouc harvest actually begins are spent assiduously in increasing the stock of shells and clay vessels necessary for collecting the juice, in gathering a store of tenacious clay for attaching these receiving vessels to the tapped trees, and also in laying in a supply of a certain kind of palm-nuts, which, as we shall see, play an important part in the preparation of the milky juice of the *Hevea Brasiliensis* into the India-rubber of commerce.

The tree, which is the object of so determined an attack from September till January or February, cannot, indeed, be spoken of as at all remarkable in appearance in the giant forests of the Amazon, but it is certainly an imposing tree, often towering to a height of sixty or eighty feet; its round, straight, pale-grey trunk is devoid of branches till far up, as is the habit of all forest trees; the trunk has a circumference of two or three yards, and bears a stately but not widely spreading crown. The foliage is beautiful, the long thin leaves growing in clusters of three, the central one being more than a foot long. The fruit is of about the size of a large peach, and is divided into three lobes, each of which contains a small black nut, not only edible but eagerly sought by the wild animals of the forest. In fine, the bark and foliage of the Para rubber tree have a strong resemblance to those of our own ash.

In the early morning, between the hours of five and six, the mestizo, in his light cotton vest and pantaloons, sets out from the rude hut, bearing with him a small axe, the edge of which is about an inch long. With this he makes twenty incisions or so into the bark of every third seringa at a convenient height, and with a little soft clay sticks one of his small shallow earthen cups just beneath the incision, to receive the milky sap that now oozes out drop by drop. In a few hours he has thus tapped thirty or forty trees with the assistance of his wife and children.

It is now time that he should make a second round, in order to collect the juice; for, although the tiny cups are not yet filled, the wounds are already closed up with dried juice, and the sap itself now requires to be looked after if it is to be a good marketable article. Instead of the hatchet, the seringueiro this time takes with him a small wooden bucket, into which his wife and children empty the contents of the cups, each of these holding, perhaps, half a gill of juice. The emulsion, while still fresh, has an agreeable taste, not unlike that of sweetened cream. The skin of sap that has attached itself to the bark under the incisions, or to the edge of the cups is also stripped off and stuck on the outside of the bucket. The husband clears the wound and sticks on another cup for the second crop of the day. The sap that has been obtained is immediately conveyed to the hut and subjected to the following important process.

A fire of brushwood is kindled, and on this a narrow funnel-shaped pot of clay is placed, in or underneath which the palm-nuts already referred to are heated. The seringueiro, with the bucket of juice by his side, seats himself before the fire, dips a club shaped piece of wood with a flattened clay mould at one end into the milk, and turns the juicy end round and round in the white vapour issuing from the pot. In half-a-minute the milk is changed into a skin of a reddish tint. When this is firm the stick is again dipped into the milk; and so the process goes on, layer being added to layer, until a sufficient thickness has been obtained. Another stick is then taken up, and the work goes on until the juice has been exhausted. The benefit of the nut smoke is alleged to consist in its absorption of the oxidised resin of the juice, and it is smallness of the quantity of this resinous body in Para rubber that gives it the highest value in the market of the world. A good hand will make five or six pounds in an hour. When the cakes are completed they are slit up with a sharp, wetted knife, and after being hung in the open air to dry for a few days, they are ready for sale. The flat, rounded Para rubber cakes, made in the way we have described, are known in London at "biscuits," and command a higher price than any other kind of caoutchouc.

On the same day the trees are exhausted once more, and even twice if they are rich in milk—a quality that reaches its maximum when they are about twenty-five years old. On the second day the second portion of the tree is attacked and dealt with; the third portion on the third day; and on the fourth the first portion may again be tapped with impunity.

How does the gatherer secure the sale of his caoutchouc? Boats ply up the rivers and creeks during the season with wine, trinkets of all sorts, and an endless variety of wares, and the rubber is exchanged for these articles. The chief delight of the half-savage Indian is in procuring fireworks, and days of toil are sacrificed for one evening of festive illumination.—(Abridged from *The Welcome.*)—*Indiarubber and Guttapercha Journal.*

NEW PROCESS OF PREPARING RUBBER: "MANGABEIRA" RUBBER SUITED TO CEYLON.

To the Editor of the "*Tropical Agriculturist.*"

BAHIA, 16th August, 1885.

SIR,—We have perused with a great deal of pleasure your valuable book on "Indiarubber," and seeing that you are much interested in the "article," we wish to inform you that we are the owners of a new process of preparing rubber direct from the milk doing away entirely with the tedious method of evaporating or smoking. We can at a trifling cost and in a few hours convert into marketable rubber any amount of milk, producing a rubber equal, we say even superior, to the finest Para, out of the "Mangaberia" milk, which is the rubber-tree we have here in abundance; but, unfortunately, all the trees have been so badly cut by the natives that they do not yield any milk at present, whilst, if properly bled, they should give milk every month. We enclose a sample of *Mangabeira rubber* made by our process. As you will notice, it is perfectly dry and differs totally from the spongy stuff known as commercial Mangabeira rubber. We came here a short time ago hoping to get large quantities of milk, as we had been informed that there are here immense tracts of trees, which is true, but we were not aware that they had been so badly damaged. We shall therefore have to move very far into the interior where there are still thousands of trees intact, before we can apply our process on a large scale. We had some thoughts of going up the Amazon, but health considerations have deterred us from doing so, one of us here having already being carried away by yellow fever. We should be very glad to make an arrangement with some of your planters to sell them our process for Ceylon; if there is sufficient interest evinced, one of us might go out to Colombo to demonstrate by *facts* the value of the invention. We should state that samples have been submitted to manufacturers in Europe and America, and after trial declared to be excellent and applicable to all the different requirements of the rubber manufacture.

Mangabeira.—As your book contains very little information about this tree, it may interest you to know that the plateau on which it grows is not 4,000 or 5,000 ft. above the level of the sea, but only about 500 or 600 ft. It grows *only* in sandy soil, and where it grows there are only one or two other trees to be seen.

MARVAL IRMAOS.

[We are obliged to our correspondents for this investing letter. Ceylon is rather too young as yet as a rubber-producing country, to make much of the patent process, although we shall be glad to put any of our readers interested, in communication with the writer of the above. The sample of rubber, vastly superior to anything as yet gathered in Ceylon, can be seen at our office. We should be glad certainly to see "Mangabeira" rubber introduced, and, if our correspondents send us some seed, they will confer an obligation.—ED.]

INDIARUBBER GATHERING.

During a twelve months' stay on the river Purus, a tributary rising in the Bolivian Andes and falling into the Amazon on its right bank about 1,050 miles west of Para, I saw a deal of Indiarubber gatherers, and the way this important article of commerce is collected, and prepared for exportation.

The *siphonia elastica*, or tree from which rubber is extracted, is found throughout the Valley of the Amazon, though the tributaries on the south shore of the great river between the Madeira in Brazil, and the Ucayali in Peru, yield the greatest supply. It grows upon the *vargems*, or lowlands annually submerged by rising streams, then called *ygapos* or swamps. A full grown tree usually attains a height of seven feet, with a stem a little over two feet in diameter. Rubber trees found on lands one hundred feet above high-water mark are of no practical value, the yield of milk not conpensating for cutting.

Let me introduce the reader to a rubber station called Terruhan, on the left bank of the Purus, about 900 miles from its mouth, and consequently nearly 2,000 miles from the Atlantic. Facing the stream is an open shed built upon piles of hard wood capable of resisting the white ant and the steaming humidity of the climate. The floor, about 6 feet from the ground, is composed of the half rounds of split *pashiuba* palms, laid an inch apart, and held down with vegetable twine. This gives plenty of ventilation from below, and considering the establishment has no walls and that rain sometimes inconveniently percolates through the palm-leaf roof, no complaints can be lodged against the the architect on the score of shutting out fresh air. Happily I had brought out the frame of a large square room which I soon rigged up. A sheet of stout canvas was laid on the floor. and a strong kind of butter cloth stretched on the walls and roof enabled me to see everything outside, and enjoy comparative immunity from myriads of *pihums* by day, and mosquitoes by night, besides the importunities of vampire bats, tarantulas, and snakes, *et hoc genera*, which sometimes persist upon making the personal acquaintance of visitors and natives.

My host was a thin, sickly Brazilian from Ceara. He called himself a *branco*, or white, and would have felt mightily indignant had any one ventured to doubt his right to the title, but he was more Indian than white. He had left his sterile sandy province for the verdant forests of Amazonia, and in the hope of making a fortune, had invested about £150 in prints, calicos, cutlery, beads, *farinha*, rum, guns, ammunition, and "notions" for barter. On his way up he enlisted a number of needy adventurers of every shade between ebony and copper, first of all priming them with glowing representations and promises, and firy *cashaca*, or rum. Once on board he kept all hands half-intoxicated until too far on the journey for them to think of venturing back alone. The party numbered fifty all told, including several Indian women called *Tapuyas.* Having reached a suitable spot named Terruhan, after an Indian village on the high land about a mile distant, a clearing was made facing the river, and a huge open hut erected for head quarters, whither all might resort during the rainy season with the produce of their labour. The party then broke up into twos and threes, to all of whom were apportioned an area of *vargem* land where rubber trees exist. Here rude shanties were constructed for shelter and once a month the rubber cutters would paddle down to head-quarters with the rubber collected, receiving on account a supply of rum, tobacco, rice, sugar, coffee, and *farinha*—the common substitute for bread throughout Amazonia. Every man had a Birmingham trade gun, and as the "location" was some hundreds of miles from the nearest town, no fresh animal food could be obtained beyond what was killed in the forests. Game was plentiful during the dry season, when it was nothing extraordinary for us to bag half a dozen pigs, besides a tapir, or so, in a single day's shooting. At such times we indulged in tremendous feeds, because it might be days before getting another. Fresh meat rots in twenty-four hours, so we cooked as much as our vessels would hold, the dogs and alligators making short work of whatever remained. Sometimes we manged to bring down a deer, and more than once I have been glad to dine off the arm or leg of a big black monkey called the *coaita*. I confess, however, to always having had qualms of conscience and stomach when devouring Mr. Darwin's friends. The *coaita* travels in bands of sixty or seventy. When they look down and chatter to each other, and monkey mothers cuddle puling babes in their arms, it requires downright hunger to knock one over. I remember upon one occasion, while dressing a big fellow for cooking, his appearance seemed to bear such a striking resemblance to Hamitic humanity that I could hardly bring my mind to further act as *chef.* But I was very hungry, and am prepared to say that I had no nightmare after supper. Small monkeys taste like hare. We found *jabuti*, a sort of land tortoise, passable food. Fish was plentiful when the river was low, and at such times we had *surubim piraruсu*—nearly as big as a good sized sturgeon—*tambaqui, piranhas*, and small flat fish—capital eating. Now and then we hunted turtle on sandy reaches, and obtained baskets full of eggs, the yolks of which were not bad when mixed with *farinha.* Turtle not required for immediate use were kept in a fenced pond. Sometimes we bagged wild turkeys, geese, *magoarys, ynambus, cujubim*, parrots, and macaws. The two latter require a deal of boiling, and unless decapitated when shot, retain a *catinga*, or unpleasant flavour. We had no vegetables, but forest fruits abound, and their judicious use is an admirable corrective, they prevent many ailments from which new-comers apparently cannot otherwise escape.

I will now describe, from notes in my journal, a day's rubber cutting, and the method of preparing milk. Rose about 5·30, just before sunrise. Supped basin of coffee mixed with *farinha*, carefully loaded our guns and in company with Feliz, a brother of my host, started for a day's rubber cutting. Feliz carrying a small steel tomahawk and a two gallon tin-can strapped upon the shoulders. My guide was a wiry youth of eighteen, a keen hunter, a dead shot, a swift runner, and full of fun and humour. In the distance we heard a band of *guaribas*, or howling monkeys, giving a final chorus. They usually commence at sunset, and amuse themselves by utter blood-curdling shrieks at intervals till daybreak. Feliz says he believes they howl because of toothache. Countless birds now began to whistle, pipe, coo, and scream; *cicadas* kept up a deafening stridulation, and the rise and fall of insect hum and twitter resembled the distant roar of ocean surf. A gentle breeze rustling among tree tops brought down a smart shower of dew deposited during the night. Though drenched with perspiration and water—one always freely perspires asleep and awake in equatorial latitudes—we were sheltered from the already blistering rays which would soon impart to the forests the temperature of a Turkish bath.

The run was nearly two miles in length. When the Purus rises fifty feet, the land submerged on both banks will vary from a few yards to ten miles. I reckoned one rubber tree to about eighty others, and of these not half a dozen would belong to the same kind. Some, such as the *massaranduba*, or cow tree, were of stupendous dimensions, the lowest branches being as much as a hundred feet from the ground. These huge boles resembled vegetable towers, their gnarled, twisted roots stretching along the soil in serpentine convolutions. This tree yields a milk resembling the finest produce of the dairy; mixed with coffee it is both nutritious and agreeable. The *samauma*, or silk cotton tree, often attains a prodigious growth. *Assacus*, the upas of Amazonia, are frequently met with of vast size. Their thorny stems are usually covered with moss, and the milk exuding from an incision is said to be as deadly as strychnine. *Curuas*, a ground palm, with long narrow leaves drooping round the central spathe, resemble an emerald fountain. Millions of bush ropes hang from giddy heights: rare orchids flourish on lower branches: curious air plants dangle overhead: delicious scents indicate unseen flowers; foul exhalations rise from stagnant pools, and great blocks of woody fungus adhere to tree trunks. There is an almost infinite variety of palms. Some flourish best on the margins of stagnant lagoons, too foul even for alligators to live in; others prefer the edge of lakes and banks of rivers, while some are always found in openings where a monarch of the forest has tumbled to the earth, crushing down smaller trees in its fall. Here are the Hebes of these bosky solitudes, the *assai*, with bunches of purple fruit which make a delicious drink.

On *vargem* lands, I was struck with the number of young trees of about a foot in diameter which had been attacked by a vegetable parasite that strangles its victim by squeezing the stem so tightly that sap cannot ascend above its ruthless embraces. The parasite first runs up the trunk in the form of an almost transparent tendril. On attaining light and air above, it rapidly increases in girth, and then throws out tendrils at irregular intervals, which meet, entwine, and form solid rings, that in time contract with such terrific force as to make its victim bulge out above and below the embraces. As a rule, this is unavailing to burst the deadly grip, and by-and-by the tree threatens to fall. Apparently conscious of impending disaster, the parasite throws out tendrils which droop to the earth, take root, and form on elaborate system of struts by way of support. Long after the tree itself is dead and withered, its naked boughs are decked with a brilliant canopy of flowers and foliage. In time the roots give way, and then a sudden puff of wind hurls the parasite and its victim to the ground, where both decay to enrich the soil.

Insect life abounds in these regions. Almost every leaf is covered with ants, and thousands of air shafts spring up from *formicaria*, some of which latter are hundreds of yards across. It is hardly possible to put one's foot down without crushing some kind of insect. *Morpho* butterflies a span long float on azure wings about eight feet from the ground ; huge beetles burrow in the soil ; and here and there are snails, slowly dragging their length with shells on the back capable of holding a pint of water.

A rubber tree is first tapped six feet from the ground. The number of incisions made depends upon the diameter of the trunk; but one a foot thick will bear six. The first two rows of cuts are practically of no account, the yield being very watery ; the lower the cuts the richer the milk. The incision is made by striking the edge of a small steel tomahawk deeply into the bark. After this operation, my companion stuck a tin cup on to the bark with clay, into which milk immediately began to trickle. By the time our journey was finished one way, every tree had from three to eight cups adhering to the stem. This work would not be fatiguing in a temperate climate, but we were glad to sit down and rest awhile previous to hunting something for dinner.

We crossed a number of tapir tracks, the impressions on the soft soil showing the beasts must have weighed as much as an ox. We also saw *rastros* of deer and pigs, but for some time caught sight of nothing. Suddenly Feliz motioned me to stand still, and gliding away with a swift, stealthy step, he was soon lost to view. On a tree close by I observed a number of lines where a big jaguar had scratched like a cat to sharpen his claws ; the bark was deeply indented. On this I peered among the branches overhead, for I had found jaguars to be nasty customers upon more than one occasion previously, and had no ambition to be caught napping. Unless killed or disabled by the first shot, they show determined fight, and the way they make for you indicates mischief. Presently I heard a sharp report, and then another, and then a "cooey," by which I knew something had been bagged. Hurrying up, I found a goodsized porker in his last gasps. We immediately cut off the gland on the back just above the tail, which contains a secretion of sickening odour, and severing the fore and hind quarters, left the rest, and retraced our steps homewards, Feliz emptying the cups of milk into the can on his back. The incisions were already closed up with coagulated milk, but this was cleared off and stopped with clay.

It was past noon when we returned to the hut, and after a welcome meal, we were glad to tumble into our hammocks and have a couple of hours' snooze before resuming work. The rubber milk had now to be smoked, and this is how it was done. First of all a few dry sticks were set on fire, and on these were piled *urucari* palm nuts, the whole being covered with a bell-shaped earthenware dome or oven, with a narrow opening at the top, from which curled a dense white smoke of pungent smell. A saucer-shaped calabash was now dipped into the can of milk and poured over a canoe paddle blade, which was then slowly turned round in the smoke until the milk had coagulated. This operation was continued until every drop of milk had been used, and day after day the same process resumed, until the ball became too heavy to turn, when one end of it was cut and the paddle withdrawn. In three months' time the ball shrinks to a little over half its original size.

A diligent workman—no skilled labour is required—on a good run, can easly earn 20s per diem during six months of the year. The ignorant negroes and half Indians, however, who are engaged in this labour, are obliged to hand over their rubber to the trader who supplies them with goods. These are fixed at a most exorbitant price, and as the rubber cutter is rarely able to read or write, the books are usually against him, and he is kept in semi-slavery to an unscrupulous trader who soon grows rich and retires, selling his book debts to another, who gives unlimited rum and feasting for a week, when he continues the devices of his predecessor.

Some traders send down to Para thirty or forty tons of rubber in a single season. Gangs of sharpers are always on the look-out for successful traders, and it not unfrequently happens that gains amassed by cruel employers are in turn lost at card. Indeed, steam-boats plying on the Amazon are notorious gambling dens, and a voyage rarely takes place up and down the river between Para and Manaos on the Rio Negro, a distance of 1,000 miles, without one or more traders coming to grief.

During the wet season, heavy thunderstorms take place every day when the warm rain descends in torrents and renders rubber cutting impracticable. This is the hotter season of the two, clouded skies, shutting out cool air, and rendering the afternoon and evening little short of stifling. As the great tributaries of the Amazon rise, fish wander from them to feed on flooded lands, and are difficult to catch. Game, too, leave for high lands, and fewer birds are seen. During this season, even the alligators have a hard time of it, and the scaly monsters skulk about human dwellings to pick up what can be had. Like tigers, they certainly prefer dog's flesh to any other, but women and children are sometimes carried off. Insect pests increase in number and voracity, and what with heat, hunger, malaria, and mosquitoes, life is hardly endurable. The poor rubber cutters are often put to great straits for fresh food, and all hail with delight the fall of the river, which means abundance of food and renewed opportunity for work.

R. STEWART CLOUGH.

[The foregoing article is reprinted from *The Welcome* by kind permission of S. W. Partridge & Co.]—*Indiarubber and Guttapercha Journal.*

MANGABEIRA RUBBER.

This rubber is likely to attract considerable notice in consequence of a recent favourable development in the manipulation of the raw material. When first imported, owing to the careless way in which it was collected and prepared, it only fetched about sixpence a pound. But it has recently been imported by a Brazilian merchant in very fine condition, and the article when submitted to some of the best London firms, has been declared to be worth three and four-pence a pound. The rubber is especially suited for springs of railway and tram cars, and for similar purposes.

Through the kindness of Messrs. Christy, we are enabled to present our readers with some information concerning this rubber, as well as with a picture of the plant from which it is produced. The Mangabiba, Mangaba, or Mangabeira Tree, as it is called in Brazil, is a small tree belonging to the *Apocynacæ* —with an elegant mode of growth, like a weeping birch, having drooping branches and small oblong leaves, sharp at the base, but with a short rounded point at the apex. The tree yields an excellent rubber, but is more frequently grown for its fruit, which has most delicious taste, and is a great favourite with the Brazilians. It is about the size of a plum, of a yellow colour, and marked with red spots or streaks. It is only fit to eat when perfectly ripe, or after being kept for a short time. Hence the tree has the double advantage of bearing fruit which will bear exportation, and of yielding a valuable rubber. The tree is now attracting attention in its native country, having been undeservedly neglected as may be seen from the following note, taken from the *Journal of the Society of Arts*, June 4th, 1880, p. 634 :—

"The inhabitants of Pernambuco are beginning to realize the vast stores of undeveloped wealth existing in their virgin forests, and rubber is being exported from that Province, which may soon rival Para in the extent of its exports of the article. Recently Senhor Jose Fernandez Lopes issued a circular, April 20th, 1880, calling attention to this important source of wealth, and giving practical instructions for the collection and preparation of the rubber, from which the following is extracted :—'The process of extracting the milk from the Mangabeira is very simple and easy. Each person must be supplied with fifty or more small tin basins and a small axe. He should make oblique cuts sloping downwards at a little distance from each other, all round the trunk of the Mangabeira. cutting only the bark, and placing immediately below each cut one of the basins, securing these either with adhesive clay or nails. These small basins will collect the milk that exudes from the cuts, and when full they must be emptied into larger vessels. This process should be continued during the whole day, and thus three or four bottles of milk may be collected, according to the fertility of the trees. The cuts should not be deep and a great number of incisions should not be made on each tree, as these may weaken or kill the trees, which has been the case in some instances with the Seringueira, the tree from which the Para rubber is obtained.'

"The rubber is prepared from the juice as follows :—Put a little powdered alum into a teacupful of water, mixing it well, then put a few spoonfuls of this solution into a vessel in which three bottles of the milk have been placed, properly strained to clear it from any extraneous matter. Immediately the milk coagulates, which will be in two or three minutes, the rubber must be exposed to the air on sticks, and allowed to drain for eight days. After thirty days it is ready to send to market in cases or barrels."

To the above it may be added that in incising the trees it would be better to use a guarded axe, *i.e.*, one thickened in the upper part of the blade to prevent its penetrating the bark beyond a certain distance, so as not to injure the cambium or juicy layer, for if this be pierced the tree is likely to decay.

The use of alum or salt, or any such substance, to coagulate the rubber, is liable to render it wet and spongy, unless it be prepared in sheets and subjected to strong pressure. The best plan is to evaporate the milk in thin layers, over smoke (as is done in Para), or in shallow pans in a current of hot air.—*Indiarubber and Guttapercha Journal.*

THE MEXICAN RUBBER.

The Rubber tree (*Castilloa elastica* of Cervantes, olquaquitl of the Aztecs, hule of the Spaniards) is indigenous in Mexico, and is found growing wild along both coasts, below 22 degrees North latitude, from sea-level to altitudes running from 1,200 to 1,500 feet, and principally by the river meadows. The region most favourable for the growth of this important yet rarely cultivated tree are : the plains of Pochutla, Oaxaca, between the Pacific Ocean and the base of the Sierra Madre Cordillera, and also along the banks of the Copalita River ; in Soconusco, Chiapas, below the coffee belt, and in Pichucalco and Mezcalapa along the great Grijalva River clear down to Tabasco ; in the Papalopana and Tuxtepec Valleys clear up to the Rivers Tonto and Quiotepec, and the lands on the Gulf side of the Isthmus, covering an extension of 1,100 square miles, where the tree is found in astonishing numbers throughout the forests that skirt the Coatzacoalcos, Uspanapa, Coachapa, Chalchijapa, Del Corte, Chichihua, Malatengo, Sarabia, Jumuapa, Jaltepec, San Juan, Trinidad and Colorado Rivers.

Few are the plantations of rubber existing in the Republic, the principal one is "La Esmeralda," in Juquila, Oaxaca, which has over 200,000 trees 8 years old, and the next is a plantation in the hacienda "Dona Felipa Ortiz," in Pichucalco, Chiapas, consisting of 10,000 trees 7 years old.

The hule tree belongs to the Urticaceæ, grows from 45 to 50 feet high, and has branches only at its upper section ; has smooth yellow bark, its leaves are 6 to 10 inches long, oval, oblong, entire, thick, smooth, bright green, and glossy above. The umbrella-like form of the tree, which covers 10 feet square, is often seen among the mamey-zapote, striving to free itself, and rising majestically over the neighbouring trees. The tree is a hardy one, nothing affects it, not even parasites or animals. There are eight kinds of rubber tree that grow wild in the country, but the kind known under the name of (*Castilloa elastica*) is the most important and the best, as it is very much sought for its sap and for propagation; an example may be seen in the botanical garden of the preparatory school in this city.

The best soil for rubber cultivation is a deep, rich loam, such as is found along the alluvial banks of the above-mentioned rivers, and in the plains between the sea and the foot of the hills of the coast ranges.

Rubber is essentially a tropical tree: hence it requires a hot and moist climate. The temperature most adapted for its vigorous growth is about 86° Fahr., and the rainfall should be at least 60 to 70 inches per annum; however, salt air does not hurt it. A plot in the vicinity where natural trees are in abundance should be preferred for starting a plantation. Generally under favourable conditions the tree will there grow faster, thicker, and consequently produce quicker results and a larger amount of juice.

In most cases the trees are found in the above places in sizes from seedlings to 18 and 36 inches in diameter. The tree propagates itself from the seed which drops from the tree, in the months of May and June, to the ground, and there watered and nurtured by the warm rains, which soon follow, the young plant some time after comes up to take its place, amongst the varied tropical life.

If the land set aside for the plantation is covered with trees, these must be felled and the undergrowth cleared only where the young trees are to be planted, providing no side planting is to be made. This work must be performed in the months of March and April, and immediately after, corn should be sown in the open spaces 15 inches apart. This operation is simply done by making a hole in the ground, dropping in a few grains, and covering over with the foot. Should the planter wish to adopt the most economic system, and thereby obtain the greatest return for the money invested, it would be advisable for him to plant besides corn, cotton, bananas, and coffee. But the attempt to plant Mocha coffee must not be made in elevations less than 1,000 feet above sea-level, neither on plains, nor where the temperature exceeds 85° Fahr.

In the latter case the acreage to be planted must be stubbed and the under brush forked in, or burnt before sowing the corn; then line and stake the plot in rows 15 feet apart. Peons who are posted in this kind of work, especially in coffee planting, have a long cord of rope (24 to 36 varas in length) on which they mark the divisions with inks made from dye-woods of the forests in these sections; the cord is held by two men, and another one marks the holes with his garrocha, leaving a stake in the excavated place every 15 feet in the row. This rule of setting the trees at such distance would ensure larger size and a greater flow of rubber-making fluid. As to shade, if the young plants have been taken from woods under shelter, then natural trees must be left on the plot before clearing to protect them from the strong rays of the sun until they are 10 or 12 feet high and have a prosperous appearance.

This must not be overlooked, as the plant will suffer a great deal from transplanting, even when that operation is done under the best circumstances. But if the young plants are obtained from unsheltered places, or from a nursery established in an open space, they having grown stronger and stouter will require no shelter, and will flourish more rapidly and vigorously than if they had shade.

If the seedlings or cuttings can be obtained within a few miles from a plot, it is advisable even to pay 2 dol. 50c. per 100 rather than to wait 12 months for the seed to grow in the nursery. When the place, where the supply of young plants or cuttings is to be had is too distant, the expense of transportation would be enormous, and they would suffer to such an extent as to render them unfit and risky for transplanting; the only practical method in that case is to start a nursery. For this purpose a rich sandy loam should be selected. Beds are made 6 feet wide by 15 to 20 feet in length, leaving a walk 2 or 3 feet wide. The seeds are sown 8 inches apart in rows 10 inches distant one from another. This operation is done in the beginning of June or a few days after the rains have started, and by merely marking the ground, about an inch deep, with a stick, dropping the seed in and covering it with vegetable mould.

In 12 months the seedlings are about 24 inches high and ready for transplanting. All weeds and grass must be carefully removed with the hand from the bed as they appear and the earth watered when it seems dry, which is best done in the afternoon.

In the latter part of May or in the first days of June, when the rainy season commences, the seedlings, young plants, or cuttings are transplanted in the cleared plot between the corn and cotton, 15 feet each way. In removing the seedling or young plant as much of the original soil should be left attached to it, in accordance with the system known as "pilon." The earth must be opened sufficiently to place the plant at the same depth as in the seed bed, and then press down the earth with a spade so as not to leave any hollows around the tree. The plot planted with rubber trees should be inspected every now and then in order to know how they are progressing, and to replace the plants that have withered and died. In July or August it will be necessary to clean the corn, weed the plot, and after harvesting the corn, banana suckers (hijos) can be planted 7 feet apart between the rubber rows.

In Chiapas and Tabasco, cacao trees are set a few feet from the 2 or 3 year old rubber trees, the latter acting as shade for the former in lieu of the regular madre protector or shade tree. Vanilla trees can be attached to the cacao tree, and by that means, after the lapse of 6 or 7 years, the planter has three or four different crops to harvest. Furthermore, bees could be raised on the place which would act as a medium to fertilise the vanilla flowers and give a handsome profit from honey and beeswax. Again, should the proprietor not want any side planting, cattle, which bring a good income in those sections, may be permitted to graze on the land as soon as the young trees are well rooted and have grown over 20 feet high. After going through the work of transplanting, the only care in the cultivation of the tree, thereafter, is that of keeping the ground free from all weeds and the rank vegetation of the tropics.

As to the expense and cost, the preparation and cultivation of an acre for 5 years, when a tree is ready for production, will require the services of a labourer working 51 days, or its equivalent of 51 labourers each working one day. The work consists of clearing the ground, so as to render it fit for general crops requiring 26 days; collecting the seedlings or cutting 193 trees, 1¾ day; planting same, 2½ days; hoeing and staking 2 days; sowing corn, 1½ day; harvesting same 1¾ day; planting banana suckers, 2½ days establishing nursery, 1 day; and 5 years' cultivation, weeding, &c., 12 days. Estimating each day's labour at 50c., it is seen that 193 trees on an acre of ground will have cost the planter at the time they are ready for planting less than 12c. a piece. If a plantation of 100,000 trees is wanted, 517 to 529 acres or 5 caballerias of land will be required, and the total cost at the end of 5 years, exclusive of the first cost of the land, will be 12,000 dol. The wild land will cost from 1 dol. 50c. to 2 dol. per acre in small tracts; supposing that the 5 caballerias of land cost 1,200 dol., including the expense of drawing up documents, stamps, and recording; administration for 5 years, 5,000 dol.; gathering of the crop will be about 5c. per tree or 5,000 dol. for 100,000 trees; gathering of banana bunches from ¾ to 1c. per piece; collecting, drying, and sacking the cacao, 8½c per lb.; collecting and curing vanilla beans 5 dol. per 1,000 pods: hence the total expense for the rubber plantation of 100,000 trees will not exceed 25,000 dol. Mexican currency.

Regarding the work of extracting the rubber, one man will tap from 20 to 25 trees per day if the operation is performed carefully and methodically. In most places the tapping is done in the month of May and sometimes again in October, but it is not advisable to repeat the operation as often as that. The process generally consists of making two or three incisions in the lower part of the trunk of the tree and collecting the sap that flows from them in clay vessels placed next to the trunk. Others make a spiral cup from 6 feet above the ground down the trunk of the tree, collect a portion of the juice at the bottom and the rest is allowed to dry in the concavity of the incision and later on is taken off. The best and most advisable system is to make low incisions.

The process can be repeated every year for 25 years or more, especially if the wound is covered with wax or clay after the flow of the sap has ceased. When there is a large quantity of milk gathered, it is dumped into a barrel having a faucet, and a solution of 5 oz. of chloride or sub-carbonate of sodium in sufficient water to cover the whole mass, which is agitated with a stick every now and then. After the lapse of 24 to 36 hours the water is allowed to run out through the faucet, this operation of washing is done until the rubber becomes white.

About 44 per cent. of rubber remains, from the original amount of milk, after the water and other matters have been eliminated by evaporation.

Trees planted on lands having the soil, climate, and elevation adapted for the culture will produce from 5 to 6 lbs. of juice on the first year that they are tapped, which amount is equivalent to 2·4 lbs. of pure rubber.

This product will be gradually increased every year for the next 4 or 5 years, and sell for 50c., per lb. on the plantation. Thus 240,000 lb., the yield of 100,000 trees at the first year's harvest, will bring the planter 120,000 dol. besides the product obtained from the corn, vanilla, bees, cacao, and bananas raised from side planting. The net profit on the investment, after deducting the entire cost of the land and all expenses up to the first year of harvesting, will be 95,000 dol., and each of the succeeding harvests for 25 or 30 years will bring a steady income of over 100,000 dol.

CEARA RUBBER.

(*Manihot Glaziovii*, Muell. Arg.)

The plant yielding what is known in commerce as Ceara rubber or Manicoba, and shipped from the Brazilian ports of Ceara, Bahia and Pernambuco, was identified at Kew eleven years ago. The following note on the subject appeared in the *Kew Report*, 1877, p. 17 :—

"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 moderately-sized tree, 30 to 50 feet high, with an erect stem, 8 to 20 inches in diameter, branching di- or tri-chotomously, 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 tranversely 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 wooly 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 Sao 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 climte 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, Museum No. I, 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 4s 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 *debris*, 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 distircts 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 gárdens 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 Society 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 arried 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. Trimen 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 ruppee) 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 *Iadia-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 diffiulty 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 lb. of dry rubber is at that age obtained from each t,ree."

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 (*Havea 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."

The following is the most recent information (*Annual Report of the Forest Department, Madras Presidency*, 1895-96, pp. 29-30) :—

In Ganjãm 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 Godávari 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, Museum No. 1, 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 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 Nilambûr. 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 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 artifical 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 earely 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 Cerea 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 propagate 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 seconded 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 ; tney keep their power of germination well. The tree is apparently very liable to a dryrot, for rotten branches are continually falling."

"Growth is very rapid ; in Baturite 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, ¼ 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 lb.) 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 15-20 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.

CEARA RUBBER.

The Madras Government has recently issued a resolution on the experimental cultivation of Ceara rubber in the Malabar district. The experiments have not been very encouraging, but the Government is of opinion that the matter should be kept in mind and that it should be considered whether the cultivation cannot be improved. The following are the reports which form the subject of the Resolution :—

Report by M. R. Ry. V. S. Gurunatha Pillai, Acting District Forest Officer, South Malabar, dated Nilambur, 6th February, 1897.

'In January 1895 one hundred Ceara rubber trees were tapped in Iravallikavu both morning and evening, each tree was tapped six times, *i.e.*, twice a day for three days and 10 lb. of rubber was collected which was valued at 1 shilling 6 pence to 1*s* 9*d* per lb. in England.'

'In the latter end of December 1896, 309 trees were tapped and 24 lb. of rubber collected ; the largest tree tapped, *i.e.*, 3 feet 9 inches in girth gave 8 oz. of solid rubber and the smallest *i.e.*, 3½ inches in girth gave ⅛ of an oz. ; on an average 1 oz. per tree was collected.'

'*Method of Tapping.*—A few trees were tapped by making incisions on the trunk of various shapes and little cups made from leaves were pinned underneath to receive the milk, but it was found that no milk could be collected in this way. The milk trickling down the stem from the incision was after three days peeled off in long strips which gave a few grains of rubber per tree, but the rubber was of good quality, *i.e.*, clean and very elastic and free from disagreeable odour.'

'The other trees were tapped as follows ; the large roots near the surface were laid bare, and incisions 1½ to 1 inch long and ½ an inch apart were made on the exposed roots with a bill-hook and the milk collected in little pits dug in the ground under the roots to receive the milk. The trees were tapped twice a day for three days, *i.e.*, between 6 to 10 a.m. in the morning and between 4 and 6 p.m. in the evening and on the next morning the milk was found to be coagulated in hard tongues. These were removed and the tree tapped again as before.'

'It was noticed that the trees bled more freely in the early morning than late in the day ; *i.e.*, a tree tapped at 6 a.m. would bleed for 10 to 15 minutes, while those tapped later would only bleed for 5 or 6 minutes, as the heat caused the milk to set much quicker and clog the milk ducts. Again trees growing on moist alluvial soil bled more freely than those growing on dry soil ; a small sized tree with a girth of 21 inches standing on good moist soil and little distant from the surrounding teak gave 4¼ oz. of rubber, while a tree growing on dry soil and surrounded by teak though 37 inches in girth gave only ¾ oz. of rubber. Particular notice was taken of the trees tapped in January 1895, the incisions made then were completely healed and those that bled well then bled freely even this year. From this it is plain that soil and surroundings have a good deal to do with rubber-producing qualities of the Ceara.'

'In March and April 1896 attempts were made to tap, but with little success, the trees bled but little ; the weather being too dry and hot and the trees leafless ; the best season to tap is between December and February.'

'From the experiment tried it has been noticed that trees planted 20 yards apart, *i.e.*, 100 trees per acre (the soil being favourable *i.e.*, deep moist alluvial soil) will produce on an average 4 oz. of solid rubber per tree per annum when 3 feet in girth in about 18 years.'

Report by Mr. H. Tireman, District Forest Officer, North Malabar, dated Manantoddy, 29th August, 1897.

'Twenty-three Ceara rubber trees were tapped at the end of May this year. The average girth of these trees was 21 inches. The yield was 8 oz. of rubber. These trees were tapped three times on three consecutive days. They had never been tapped before. In July, during a break in the rains, 67 trees, all of which had been tapped last September, were again tapped once. Their average girth was 27 inches and the yield was 20 oz. I will do some further tapping after the rains are over. I do not, however, think that the Ceara rubber is of any use as a rubber producer, compared with Ficus elastica and Hevea Braziliensis.'

(By H. N. Ridley in *Agricultural Bulletin of Malay Peninsula.*)

Except in the case of Ramie, no cultivation has been so long practically neglected, and all at once sprung into notice as that of rubber within the past few years. Though rubber was first found in South America in the second voyage of Columbus, it was not recognized as of any value till Dr. Priestly, in 1770, pointed out that it was useful for erasing pencil-marks, and it was sold in cubes of half an inch for three shillings. The rubber industry really commenced about the beginning of the present century, and in 1830, 464 cwt. were imported into, Europe; since then there has been a rapid rise to 948,404 lb., valued at over £51,000.

It has long been pointed out that rubber cultivation was well worthy of the notice of planters, but in no part of the world does any great interest seem to have been taken in it except in Ceylon, where, from 1873, when seeds were introduced from Kew till 1886, when the cultivation was abandoned, the planters were very enthusiastic about it. The plants then under cultivation were Ceara and Para rubber. In Assam also, the Indian Government protected and formed plantations of Indiarubber, (*Ficus elastica*). But the greater part at least of the rubber of commerce has always been derived from wild trees or vines, and as these were largely worked out from careless cutting, the supply decreased in quantity and increased in price. Later the African rubbers came into notice, and the market became overstocked. Following on that, however, came an enormously increased demand for rubber, partly due to the great development of the bicycle-trade, and the increasing use of rubber tyres for carriages. To meet this demand now, we have Africa only as a large source of supply, for it is stated that the South American supplies, from want of a policy of consideration of the trees producing rubber, has fallen to such an extent that they can only meet a small part of the demand.

The African supply, though without doubt very large, is at present derived from wild plants of *Landolphia*, a climber and *Kickxia africana* and *Ficus Vogelii* trees, and the large amount now produced must diminish as the forests are ransacked wherever accessible. Meanwhile there is but little doubt that the demand will increase yet more, and in the future the demand will have to be supplied from cultivated trees.

KINDS OF RUBBER.

The number of rubber-producing trees and shrubs throughout the world is very large, and they may be divided for economic purposes into trees and climbers. Of the latter, the chief are the Landolphias of Africa and Madagascar, and the Willughbeias, Melodinus, Leuconotis, and Urceolas, known here as *Getah Grip* of the Malay Peninsula and island. These climbers produce considerable quantities of the rubber of commerce, but are not at all satisfactory to cultivate. They grow, it is true, easily enough from seed or cuttings, but produce under cultivation thin, slender stems not at all easy to get the rubber out of, and even if they did attain the thickness of stem that they do in the jungle, which is about as thick as the leg, they would be difficult to work economically.

For cultivation purposes, it is, therefore, necessary to turn the attention to the trees, and of these the following are the kinds which have attracted most notice :—

India rubber,	...	"Ficus elastica,"	...	Assam to Perak.
Lagos rubber.	...	"Ficus Vogelii,"	...	West Africa.
,,	...	"Kickxia africana,"	...	,,
Jelutong,	...	"Dyera costulata,"	...	Malay Peninsula.
Pulei,	...	"Alstonia scholaris."	...	
Ceara scrap rubber,	...	"Manihot Glaziovii,"	...	Brazil.
Para rubber,	...	"Hevea braziliensis,"	...	,,
Central America,	...	"Castilloa elastica,"	...	
Mangabeira,	...	"Hancornia speciosa,"	...	Pernambuco.

Ficus elastica supplies a very fair rubber, but the tree seems to be of slow growth, and rather expensive to cultivate even in Assam. It does not grow at all well in Singapore, though it perhaps might do better in the hills of Perak and Selangor, but I should very much doubt its being at all suitable for cultivation by planters.

Ficus Vogelii and Kickxia africana are but little known as yet in cultivation. Seeds of the latter were received recently at the Gardens, but only a few germinated, and all soon perished.

Dyera costulata is a large tree common in our jungles. The rubber is abundant, but usually contains much water. It is considered of a low quality and seems chiefly to be used for adulterating other kinds. There is however a fairly large trade in it in Singapore.

Alstonia Scholaris is also a common large tree, but the rubber is thought but little of and is seldom collected even in the Malay Peninsula.

Central American rubber, *Castilloa elastica,* the biggest of all the rubber trees, is a native of Panama, where it grows in damp wooded ravines, along the edges of streams. It grows very feebly here, and never looks healthy. It seems to thrive better in Southern India, but there is as much difficulty in extracting the rubber as there is in Ceara scrap.

Mangabeira, *Hancornia speciosa,* is a small birchlike tree, which grows on the dry sandy heaths in Pernambuco, where I have seen it. It is a poor class rubber, and is I think, not worth cultivation, here at least. I doubt if it has ever been introduced into this country.

Para rubber, *Hevea braziliensis,* on the other hand, has the advantages of being exceedingly easily grown, and a very suitable plant for wet low ground, for which we have no use except for sago or rice, and of which class of land there is a very considerable amount in the Peninsula. It also gives a quick return, at a very trivial cost, and requires no expensive machinery or elaborate cultivation, and finally holds, as it has always done, the first rank in value among the rubbers.

It has been tried in Ceylon and India, but I can find but little published as to its cultivation in the former country. It seemed, under Dr. Trimen's management, to have done almost if not quite as well in Ceylon as it does here, but, in spite of his recommendations, the planters seem to have condemned it with Ceara rubber, and abandoned it. In Tennasserim it seems to have done well, but I know nothing as to practical cultivation there on a large scale.

Manihot Glaziovii, Ceara scrap rubber, has attracted a great deal of attention in past years, and many trees were planted in Ceylon and elsewhere. The amount of rubber produced under cultivation was so small, and the profit so slight the Ceylon planters destroyed their trees and abandoned the cultivation. In the Peninsula, trees were planted in many places, and though isolated trees are to be found as fine as could be wished the greater part utterly failed. The failure in Ceylon gave the whole of rubber cultivation a bad name, because planters, decribing their want of success, did not say, in many cases, what rubber they had been growing, and sometimes confused the two plants.

The Ceara rubber is easily known by its silvery bark, like that of a birch, while Para rubber has a brown rough bark. There is a great difference also in habit, the former tree having a straight stem with leafy branches only at the top, giving it a flat umbrella-like appearance, the latter having a tendency to branch at about six or ten feet from the base, and forming a magnificent large crown of foliage. The habitat of Ceara rubber trees is one of the driest of the Brazilian provinces, where the soil is sandy or gravelly or even rocky, where even tapioca requires to be watered, and there are occasionally years when no rain falls. In fact, the tree is a regular desert plant. What wonder then that it should not be successful in a wet climate like ours?

PARA RUBBER.

Hevea braziliensis (*Euphorbiaceæ*), a very large tree inhabiting the swampy islands and banks of the river Amazon.—In suitable soil it grows very fast and attains the height of about sixty feet, with a diameter of about two feet through the stem.

The leaves are trified, dull green above and whitish beneath. The flowers are produced in panicles on the ends of the branches. They are small and green, very sweetly scented, so that when a tree is in flower, it can be detected by the scent of the blossoms. The flowers seem only to be produced when the tree has attained a considerable size, and usually before flowering the tree sheds a proportion of its leaves, sometimes becoming quite bare during the flowering season. The trees here flower somewhat irregularly. The fruit is produced some months later. It consists of a large three-lobed capsule about an inch and a-half long containing a single large seed in each lobe. When ripe the capsule splits explosively, throwing the seeds thirty or forty yards from the tree. This usually takes place in the hotter part of the day. The seed is about an inch long, rounded on the back and flattened in front, silvery marbled with brown in colour, much resembling a castor oil bean on a large scale. They are very light and float on water. They germinate usually very soon after planting, and, do not require to be filed or otherwise specially treated as Ceara rubber seed usually does, but do not retain their germinating powers very long, and should be planted soon after they are ripe.

Cultivation.—Para rubber can be raised from seed or cuttings. The former is the most to be preferred. The seed is planted in nurseries and lightly covered with soil, and when about six inches high can be planted out.

Cuttings are recommended for use in inundated spots where the seed might float away. They are taken from lateral twigs and planted in the mud so that their tops are above water, but they can also be grown in dryer spots shaded at first from the sun.

They should be made from well grown wood, and not from the softer tops of the branches. It is sometimes stated that trees from cuttings do not last, and perish in a few years :—Fallen trees, however, throw up strong stems, which eventually develop into healthy large trees, and, as it is stated that in South America trees are habitually grown from cuttings, there seems no reason why they should not be successful here.

The soil most suited for the plant is rich and very wet, such land as s commonly used for sago is very suitable, and wet ricefields or any damp low-lying ground will do. The tree will grow on dryer soil, but more slowly and in a less satisfactory manner. Where the ground is liable to shift from underground currents or streams cutting the soil away, the trees, owing to their having no tap root, are rather liable to fall, and though they continue to grow even when prostrate, they are much more difficult to tap. However, they are very easy to raise again with the aid of ropes, and can even when pretty large be propped up again, when they will continue to grow as before.

The trees can be planted about twelve feet apart or even closer. They grow very straight and do not spread much unless planted far apart, and the closer they are planted the straighter and taller they grow. When planted they require no further care than to keep down the brush wood and grass for the first year or two, after which they will draw up above the weeds, and if planted close together will soon so shade the ground that but few weeds will appear beneath them. As they are rather sensitive to fire, care should be taken to keep down the lalang, if any should grow near the trees, to prevent risk of its taking fire.

In suitable soil the trees grow very fast. Trees planted from seed in the Botanic Gardens in 1888 have attained the height of about sixty feet and a diameter of from a foot to a foot and a-half at the base. Some other trees, thirteen years old, planted about twenty feet apart have a diameter of about two feet, but are no taller. In these the stem has branched at about six feet from the ground which the closer planting of the others has prevented.

Trees on the outside of the wood which obtain more air and light are indisputably finer than those grown very close together, but it will probably be found better to grow the plants fairly close in order to obtain a taller and straighter stem which is easier to tap and to obtain a larger amount of stems on a given area.

I have not noticed any enemy, animal or vegetable, attacking the tree.

Collecting the rubber.—Trees can be tapped at the age of three years if they are well grown, but it probably would be better to wait till they are five year old, when they are stronger, and the wounds would heal more readily. It appears from the account of Mr. Cross, who went to Para to investigate the methods of collecting the rubber and the habit of the tree, that it was the custom of the collectors there to tap the trees in the early morning, but here it appears to be best to tap in the evening after four o'clock as the milk is thicker and more free from water in the evening. I have noticed the same thing in other lactiferous trees such as the Upas (*antiaris*). It is preferable to tap in dry weather, not only on account of the greater amount of water in the milk in wet weather, but also because it is easier to prevent the rubber being spoilt by rain falling in to the cups.

The tapping is best done in the following way. A number of oblique cuts are made in the back converging to a central vertical cut, at the bottom of which a cup is placed. The rubber runs down the cuts into the central one which conducts it to the cup.

The cuts should be made through the bark, which is about a quarter of an inch thick, but so as not to injure the wood, and should not be made more than a half an inch wide. Their length, six or more inches, will depend on the thickness of the tree. These cuts may be re-opned a day or so later and more rubber will come out. It is best to make a small groove at first, cutting a thin slice off the edge of the wound each day till the groove is about half an inch wide. The wounds heal up in a few weeks if not too wide.

Any sharp knife can be used to cut the bark, but it will probably be necessary to supply the coolies with guarded knives which cannot be forced into the wood and so damage the tree. I have found a sharp chisel used with a hammer a good instrument for making the cuts.

The common method in Para seems to be to chop at the bark with a small axe with a blade an inch in length, and to put a cup under each incision. But this is a cumbrous and wastefull method and is not at all to be recommended. Another plan recommended by some is to make punctures in the tree and put cups to each puncture, but the method above described has the advantage of collecting all the rubber into one cup instead of having a lot of cups on the tree, saving time and labour. In South America, cups of clay are prepared and stuck to the tree by means of lumps of wet clay, a very clumsy method, which also has this disadvantage, that the cups being quite open at the top, dirt and rain fall in and spoil the rubber. The best cups I have used are small cigarette tins with lids. These are nailed on the base of the vertical cut with a small nail, hinge outermost. The lid is then pushed down so as to admit the rubber only. Any bits of stick moss or dirt and rain will fall on the lid and not into the cup.

The cuts having been made and the cups fixed in the evening, the rubber continues for some time to run into the cup, and in the morning is found to have partially or quite set, and in a few hours a solid cake of pure white rubber can be taken out of the cup. Little or no rubber flows during the day.

There is usually a good deal of water which exudes from the rubber as it sets and after for a few days. This should be dried off in the sun, or the rubber can be pressed to get it out. The rubber shortly after it sets has a very foul smell, which soon goes off. In a few days the rubber becomes yellow, then dark gray. In Para it seems that the rubber does not set without being smoked in the smoke of burnt nuts. The milk is taken up on a batlet; and turned over and over in the smoke till it is dry, and then peeled off. This does not seem at all necessary for improving the keeping power of the rubber. A sample cake of rubber prepared in the Botanic Gardens in 1893, on being cut across in 1897, was found to be perfectly sound and elastic and the interior even retained the white colour of the fresh rubber. This had been simply prepared in the above mentioned way without the addition of smoking or any other process.

Trees, if carefully cut, recover from their wounds very soon, and in a year or two can be cut again in the same place.

Amount of rubber produced by a tree.—The exact amount of rubber which can safely be drawn from a tree is not yet settled experimentally, but two pounds may be safely reckoned on for a year's tapping of a five or six years old tree if well grown, and it is probable that a larger quantity than this can be taken without harm. Of course much depends on the size of the tree which again depends on soil and position in which it is grown. Further experiments are being made on this point.

A tree nine years old was tapped, April 20th. It was about forty feet tall and a foot through at the base. Cuts were made in it, the edges of which were sliced again every day for a week. The first cut yielded half a pound, and the whole result gave one pound fourteen ounces. Now (June 17), the wounds are partly callused over and the callus already contains rubber.

Price.—Para rubber seems always to command the highest price of any rubber in the market, fetching from half a crown to three and seven pence a pound under ordinary circumstances. Samples sent from the trees in the Botanic Gardens to a well known firm of rubber dealers were valued at the highest price then given for rubber. But with the increased demand and failing supply, even higher prices may be obtained.

When one considers the little expense of planting, tapping and preparing the rubber, it seems clear that, though the amount given by each tree is not large there should be a large profit made on the cultivation. One may safely say that the cultivation of rubber is at present in its infancy and may reckon that as its study progresses, we shall obtain much larger results than these which, I think, I have estimated at a considerably lower valuation than they will be found to bear.

RUBBER GROWING IN PERAK.

Seeds of Para Rubber were first obtained some twenty-four years ago, and the introduction is thus described in the *Economic Products of British India*—"On the 4th June, 1873, the Director of Kew Gardens received from Mr. Markham some hundreds of seeds which had been collected by Mr. J. Collins. Of these less than a dozen germinated, and six were in that year taken out by Dr. King to Calcutta. These did not succeed well in Calcutta, and it was accordingly arranged that Ceylon should be established as the depôt for supplying young plants to the parts of India where *Hevea* cultivation was thought possible. On the 14th June, 1876, 70,000 seeds were received at Kew from Mr. Wickham (who was paid for them at the rate of £10 per 1,000) ; 4 per cent. germinated. Of these, 1,919 plants were sent to Ceylon in 38 Wardian cases, in charge of a gardener, and 90 per cent. reached in excellent condition." It must have been some of these plants which were procured by Sir Hugh Low, for in his Annual Report for the year 1883 he says that the trees at Kuala Kangsar were six years old. In the report for the previous year he says that "seeds and plants of *Hevea braziliensis* have been distributed to Java and Singapore, to Ceylon and to India." These original trees are therefore now about twenty-one years old, and the second generation of trees at Kuala Kangsar are some fourteen years old.

In 1887 some seeds were 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.

Finding that they grew so well I ventured, in 1891, to write to Sir F. A. Swettenham, the then British Resident of Perak, suggesting that they should be planted on waste lands and, as a result, Mr. O Marks, then Superintendent of Government Plantations, put out a number of trees at Kuala Kangsar, which are now about six years old, and are doing very well. It is much to be regretted that more were not planted at that time, as by now they would be valuable, not only as rubber but as seed producers.

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 nipah palm to grow well on its banks.

It has been planted at Setiawan, 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 alluvium 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 fifteen to twenty feet apart would appear to be about the correct spacing. At twenty feet it might be necessary to plant something in between to keep them from early branching, but this would not be necessary at fifteen feet. In Larut, at an estate at Kampong Dew, they are being planted at ten by ten 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 twenty by twenty 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 some 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.

A.	Total Height	77 feet.	Girth of Trunk at	3 feet,	3 feet,	8 inches
B.	,,	89 ,,	,,	,,	4 ,,	3 ,,
C.	,,	98 ,,	,,	,,	4 ,,	9 ,,
D.	,,	69 ,,	,,	,,	5 ,,	3 ,,
E.	,,	74½ ,,	,,	,,	5 ,,	5 ,,
F.	,,	75 ,,	,,	,,	5 ,,	5 ,,
G.	,,	60 ,,	,,	,,	5 ,,	2 ,,
H.	,,	64 ,,	,,	,,	3 ,,	4 ,,
I.	,,	77 ,,	,,	,,	5 ,,	6 ,,
J.	,,	69 ,,	,,	,,	3 ,,	3 ,,
K.	,,	67 ,,	,,	,,	3 ,,	11 ,,
L.	,,	83 ,,	,,	,,	4 ,,	5 ,,
M.	,,	67 ,,	,,	,,	3 ,,	11 ,,

For these thirteen 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 best grown of these trees is *A*, which has a trunk of 21 feet to the first branch, its diameter being, at 3 feet from the ground, 14 inches; at 6 feet, 12½ inches; and at 21 feet, 11½ inches. This tree is in between others which have, by shading and crowding it, induced it to grow up straight and branchless.

The greatest difficulty in planting Para is the very short time which the seed remains good after it falls from the trees. The time which elapses before they are planted should not under any circumstances be longer than a week, and if they can be planted before this so much the better. Sown at once nearly all germinate, but each day which intervenes increases the number of failures till at the expiration of ten days or so none grow.

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 been distributed, 3,000 given to the Jebong Estate and 11,000 to the Sam Sing Estate.

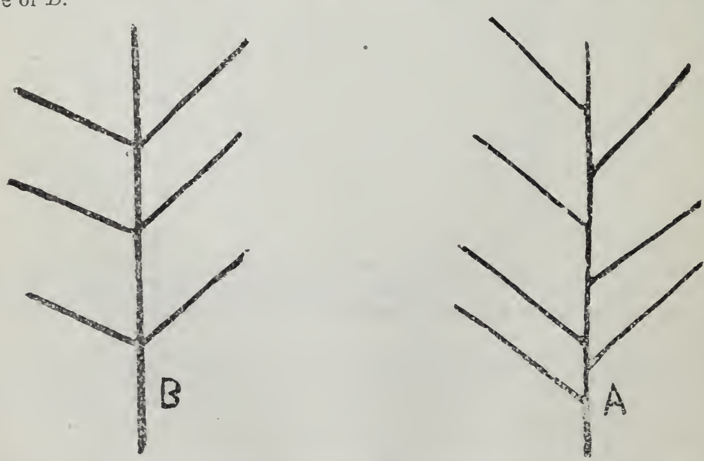
At fifteen by fifteen feet 14.000 seed would be enough to plant $72\frac{1}{2}$ acres of land where the land is ready it is certainly an advantage to plant the seed at stake, but where this cannot be done not much loss would follow planting in nurseries and then transplanting. The thing to avoid in this method is the production of double stems near the ground, caused by the original shoot dying out or or being broken off.

In the first few years a little judicious pruning would prevent this tendency to throw up more than one stem. In other respects they do not require any pruning nor after the first few years, any attention at all, except a little cleaning with a parang. The trees are vigorous growers and have such thick foliage that they would soon cover the ground and effectually keep out all weeds and scrub.

Many methods have been suggested and tried for tapping the trees, but what may be called the herring-bone method appears to have advantages over the others This is the way the Ipoh trees are tapped by the wild tribes of Perak, and it is also used by the Malays for tapping trees yielding bird-lime, etc. The American rubber collectors also adopt the same method for tapping Castilloa. In 1888-9 the trees, Para and Castilloa, at Kuala Kangsar, were tapped by herring-bone cuts by Malays.

On the 5th July, a rubber tree in the Museum grounds was tapped by a herring bone incision in the bark of the trunk about a quarter of an inch wide and reaching down to the wood. The cuts were widened several times to, ultimately, about half an inch. By the 7th October the cuts were closed up with a new growth of bark. Three months is therefore sufficient for the covering over of half inch wide cuts made right down to the wood. The last places to heal over were those where the two side cuts met the vertical one ; here, of course, the width of exposed wood was considerably more than half an inch.

I would suggest that the lateral cuts should not meet the vertical ones at the same point, but that they should be made in the way shewn at *A* in place of *B*.



The junctions in *A* would heal over in much less time than in *B*, as they would not be nearly so wide.

The best way of carrying out the herring-bone method of tapping is a matter of much importance, as on it depends the cost of the collection of the rubber. Common knives, chisels, chopping knives, pruning knives, etc., are quite unsuited to the work, so I devised an implement for scoring the bark which apparently answers the purpose in a satisfactory manner. The handles are made like a boat-builder's draw knife, but the cutting blade is shaped like the letter U, and fixed by a suitable set screw or wedge in the bar joining the handles, and at right angles to them. In cutting a herring-bone incision the knife is taken in both hands by the handles and a long vertical cut made in the bark, but not so deep as to reach the sap layer. The blade ploughs out a furrow having the same section as itself and of a depth corresponding to the inclination at which the instrument is held in relation to the surface of the bark ; the set of the handles giving complete control over the direction of the blade.

The side cuts may then be made to the same depth. Having gone so far, and having cleaned away all the loose cuttings of outer bark, the receptical for catching the sap may be fixed at the lower end of the vertical score ; and then beginning from the top of the cut it may, by a second application of the tool, be deepened to the proper extent. By following this procedure waste of rubber may be avoided to a large extent, and a cleaner product obtained.

The same instrument can, of course, be used to enlarge the scores for the subsequent tappings. The scoring knife will, I think, be found to quite halve the time taken in tapping the trees, and do the work in a much better fashion as well.

The receptacles for catching the sap can conveniently be made as follows :—A tin can is fitted with a sort of sharp straight-edged lip at one side, and a hinged lid to keep out fragments of bark, rain water, etc., and it is best and quickest hung on to the tree by a couple of attached wires furnished with sharpened hook points.

In this way there is nothing required by the Collector but his scoring knife and tins. He wants neither nails, hammers, wet clay, knives, chisels or other things now in use.

Mr. J. C. Willis, Director of the Ceylon Royal Botanical Gardens, is trying a method of tapping with small detached V-shaped incisions made with two cuts of a chisel having a wide blade of about an inch in breadth. These cuts, I find, heal up in a very short time and do little damage to the tree, but it is doubtful if they will yield as much rubber as the native herring-bone shaped cuts. Mr. Willis informs me his experiments are not yet complete.

Some years back an instrument for tapping was recommended, of the following description. A piece of wood, about an inch broad and a foot or more long, had the central portion set with sharp steel spikes like the hair of a brush. It was to be taken in both hands by the ends, which served as handles, and the spikes pressed into the bark, producing a series of punctures through to the wood. On trial, in Perak, on the Kuala Kangsar trees, it was found that although the sap flowed when it was applied in fair quantities it stopped almost at once, as the holes quickly became sealed up by the coagulation of the sap within them.

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 twenty by twenty feet, an annual crop worth £10. 6*s.*, and if planted at fifteen by fifteen feet, worth £19.6*s.* This should begin, as far as is known, at about the sixth or seventh year, and by the twelfth year should have increased to double the amount given.

The history of Ceara Rubber (*Manihot Glaziovii*) in Perak is not encouraging. The trees were first planted in Perak in 1877, at Kuala Kangsar and in 1880-1 at Lady Weld's Rest-house. They grew well for a few years, but on attaining a trunk diameter of about four to five inches all died off. Some were also planted in Taiping and other places with similar results.

A single tree of Castilloa Rubber was planted by Sir Hugh Low at Kuala Kangsar, on a low hill by the side of the Residency ; it does not seem to thrive, but this may be due to the unsuitability of the situation.

I hope to be able to give further information on the subject when some experiments which are in progress are completed. L. WRAY, Junr.,

4th December, 1897. *Curator and State Geologist.*

PROSPECTUS.

This Company is formed to purchase and work the Pará Rubber Estates of the Visconde de S. Domingos, situated, as shown in the map appended to the prospectus, in the centre of the rubber district known as the "Islands," in the Municipal District of Anajas, State of Para, Brazil, and also for the purpose of carrying on the business of Rubber Curers, Shippers, &c. The estates have yielded large revenues for a number of years, and are being sold owing to the advanced age of the Visconde.

AREA.—As will be seen by reference to the plan accompanying the prospectus, the Estates comprise eleven different properties, all adjoining, with a total area of 737,572,035 square metres, equal to about 182,254 acres, or over 284 square miles, the whole forming one of the largest rubber properties in the valley of the Amazon and its tributaries. All the lands have been surveyed, and are free of rent and taxes. The title deeds have been examined by Mr. McDowell, solicitor, of Para, who reports that they are all in order.

COMMUNICATIONS.—The Estates have a frontage of over 27 kilometres ($16\frac{3}{4}$ miles) on the River Anajas, which is navigable at all seasons of the year permitting the largest river steamboats navigating the Amazon to come alongside the wharves of which there are eight on the properties. Steamers leave the City of Para, the headquarters of the rubber trade, for the River Anajas and district every three or four days, the direct journey occupying on the average 52 hours. The Estates are therefore most advantageously situated with regard to their nearness to Para, the chief exporting rubber market in the world, and the consequent low freights and great facilities for obtaining supplies and labour. The directors believe that no rubber property in Brazil is more favorably situated.

VARIETY AND VALUES OF THE RUBBER.—The rubber trees on the estates comprise various species of Hevea (syn: Siphonia), producing Para Rubber, the varieties of which are known by different names. The rubber from the "Islands" to distinguish it from "Up river hard-cured" "Bolivian," &c. There are three qualities—viz, "Fine," quoted on the Liverpool market, March 18th, 1898, at 3s. 11d. to 3s. $11\frac{1}{4}$d, per lb.; "Entrefine" 3s. 10d. per lb.; and "Negrohead," 2s. $7\frac{1}{4}$d. to 3s. 1d. per lb. On these estates "Entrefine" is seldom produced. For the value of rubber produced on these properties, see Mr. A. Camille's report, dated London, March 18th, 1898.

NUMBER OF THE RUBBER TREES.—The impossibility of counting the trees over such a vast area will be obvious. In the appended joint report by Senhors Jose Simoes Chuva and Jose Antonio de Rezende, jnr., two well-known merchants in Para, who have resided in the district of Anajas many years, and are well acquainted with the properties, the number of rubber trees per hectare (2,471 acres) is estimated at 20 full growth producing trees, besides a much larger number of smaller ones which from year to year arrive at a state of production. The Visconde de S. Domingos estimates that each hectare contains from 18 to 20 producing trees of full growth and a much greater number of smaller ones, which year by year augment the productive or milk-giving trees.

At 18 trees (the lowest estimate in the reports) per hectare, which is equal to about $7\frac{1}{4}$ per acre, the total number of full-grown trees on the estates will be over 1,300,000, which when opened up would form more than 13,000 estradas (rubber roads of about 100 full-grown trees each, of which upwards of 3,000 roads are already opened up. This is irrespective of all trees not of full growth. The trees are indigenous to the soil, and reproduce themselves naturally from seed, therefore planting is unnecessary.

YIELD OF RUBBER PER TREE.—Very large trees of the genus Hevea are known to yield as much as 50lb. of rubber in one season. Senhors Chuva and Rezende, jnr., report that the rubber trees on these estates are in a perfect state of conservation, producing as much and as good a quality of milk as any other rubber forest in the Islands district. The Visconde de S. Domingos estimates the average yield per tree at about 4 kilos, (equal to 8,816 lb.) of "Fine Rubber," exclusive of Negrohead. The proportions of "Fine" and "Negrohead" rubbers depend on the appliances and care of the collectors. As will be seen from the reports, the proportion of "Negrohead" is variously estimated at from 25 to 30 per cent. of the "Fine," and at about one-fourth of the whole. The proportion, however on these estates during the past three years is estimated by Mr. E. Kanthack in his report to have been about 15 per cent.

Labour.—It must be understood that the excess of rubber received in any one year over another is not the result of increased productiveness of the trees, but is entirely a question of labour. In some years a larger number of men have been employed than in others. In respect to labour, however, no difficulty need be apprehended. The numerous immigrants arriving in the Amazon from the South, and seeking employment on rubber lands, prefer those estates where the necessities of life cost them less than half the rates on the Upper Amazon. The situation of the estates, so near the mouth of the Amazon and Para, is a feature of the greatest importance. The cost of placing men on some of the up-river estates is estimated by Mr. Pond to amount to £35 per man, and on these estates to only £3 per man. Owing to their situation the facilities for obtaining labour are much greater than on the "Up-river" lands; freights are very much cheaper, and the cost of procuring supplies of food, &c., is considerably less.

Demand.—The demand for India-rubber is best shown by the following figures, compiled from the "India-rubber Journal" (February-March, 1897): —Europe, together with the United States, in 1896 imported 100,804,238 lb. of India-rubber of all varieties, and of the total value of £10,395,436. Of this quantity nearly one-half, or £48,290,568 lb., was imported into the United Kingdom.

Since 1894 the value of "Fine" Para Rubber, the "Islands" variety of which is produced on these estates, has risen more than 25 per cent. The following table, compiled from the "India-rubber Journal," will show the steady increased in prices.

Year.	Lowest price.	Highest price.
1894	2s 9½d per lb.	3s 0d per lb.
1895	3s 0¼d per lb.	3s 4½d per lb.
1896	3s 0¾d per lb.	3s 9d per lb.
1897	3s 4d per lb.	3s 9½d per lb.
1898	3s 6d per lb.	4s 0d per lb.

Revenue.

The revenue derivable from these estates is based on the results of actual production. The Company will acquire properties which are yielding very larger profits and have done so for a number of years.

An investigation of the books of the Visconde de S. Domingos has been made by Mr. E. Kanthack, of Para (late manager to Messrs. R. Singlehurst & Co., of Para and Liverpool), local auditor to the British Bank of South America, and for many years acting British Consul whose report is as follows:—

"Para, 17th December, 1897.

"Gentlemen,—Having been appointed by Mr. Churchill, H.B.M. Consul, to examine the books of the Visconde de S. Domingos with reference to his rubber estates, I beg to inform you that I have ascertained the production of rubber on that portion of his estates which has been worked during the last few years, and as this information seems to be particularly wanted in London, you may transmit by cable the following details:—

"Production, 1895, from 399 roads worked by the Visconde's traders, 125 tons; by other tenants, 436 roads, estimated 137 tons. Total 262 tons. Last year; total 238 tons. Present year, estimated total 251 tons. Coarse rubber included, estimated 15 per cent.

I remain, gentlemen, yours faithfully,

(Signed) E. KANTHACK."

From the foregoing report it will be seen that taking the value of the "Fine" at an average price of 3s 6d per lb., and the "Negrohead" at 2s 4d per lb., and the proportions at 85 per cent. of "Fine" and 15 per cent. of "Negrohead," the gross value in London from 835 rubber roads only, would be as under:—

1895—262 tons =	498,848 lb. of "Fine" at 3s 6d per lb....... =	£87,298
	88,032 lb. of "Negrohead" at 2s 4d per lb. =	10,270
1896—238 tons =	453,152 lb. of "Fine" at 3s 6d per lb ...... =	79,301
	79,968 lb. of "Negrohead" at 2s 4d per lb. =	9,329
1897—251 tons =	477,904 lb. of "Fine" at 3s 6d per lb...... =	83,633
	84,336 lb. of "Negrohead" at 2s 4d per lb. =	9,839
751 tons =	1,682,240 lb.	£279,670

Equal to an average gross value per annum of £93,223.

The Visconde's net profit in Para on the production of the road worked by his own traders, has averged 39 per cent. of the value there.

From figures supplied by Mr. E. Kanthack it is estimated that had the total production of the estates during the last three years been shipped direct to London, the profit accruing from the sale, including the rubber received for rents, and for goods supplied to collectors, would have amounted to a minimum of 50 per cent. of the above gross value, equivalent to an average annual net profit of £46,611, sufficient to pay 7 per cent. on the £175,000 cumulative preference shares, and 15 per cent. on the £175,000 ordinary shares, leaving a balance of over £8,000 for administration and other expenses.

FUTURE REVENUES.

The results of the past three years were obtained from the working of an average of 835 rubber roads being less than 28 per cent. of the roads opened, and under 6½ per cent. of the estimated total number of full-grown trees.

The revenues to be derived in the future from these estates are entirely a question of capital and labour. It is proposed for the present to continue working the estates on the rental system, but under European supervision and control; to sell the rubber in the best market for gold; and during the coming season to work 1,600 roads (160,000 trees), reported by Mr. Kanthack to be practicable, and which should produce a net profit exceeding £90,000, which profit would be considerably increased by the further opening up of the estates; and it should be noted that the average price of fine Para rubber in the English market is now 3s 11d per lb., as compared with 3s 6d per lb., upon which price the above calculations are based.

WORKING CAPITAL.—The working capital, the subcription of which is guaranteed, will be £50,000. This will enable the Company to provide for the expenditure necessary to the increased business.

The statements in this prospectus are based on reports by Mr. E. Kanthack, Messrs. Jose Simoes Chuva and Jose Antonio de Rezend, junr., Mr. A. Camille and Mr. F. Pond, and upon a letter from the Visconde de S. Domingos.

The vendors have fixed the amount of the purchase consideration at £300,000, of which £120,000 is payable in cash, £100,000 in fully-paid shares, and the balance in fully-paid shares or partly in shares and partly in cash at the option of the directors. The vendors desire to have allotted to them the largest number of shares permitted by the rules of the Stock Exchange relating to quotations.

NOTES ON SOME TREES YIELDING INDIA-RUBBER.

(*By* Dr. TRIMEN *of the Royal Botanic Gardens, Peradeniya, 29th March 1880.*)

INDIA-RUBBER or CAOUTCHOUC is afforded by a considerable number of trees and shrubs, chiefly, if not entirely, members of the families *Euphorbiaceæ*, *Artocarpaceæ* and *Apocynaceæ*. It is to be distinguished from gutta percha, which is a product of trees belonging to the family *Sapotaceæ*.

In its natural condition in the plant caoutchouc is a milk-like fluid and the channels in which it occurs occupy a definite position in the structures composing the stem, it is of the highest practical importance to bear in mind that the "milk-vessels" occur wholly in the bark, externally to the chambium-layer or vitally active part of the stem where growth goes on. There are none in the wood, nor in the outer corky, papery or green layers, but only in the inner part of the bark, and either adjacent to or in its bast or liber-tissue.

The kinds of rubber trees at present exciting interest in Ceylon are:—

1. *Ceara Rubber-tree*—MANIHOT GLAZIOVII; *Mull. Arg.*
2. *Para Rubber-tree*—HEVEA BRASILIENSIS, *Mull. Arg.*
3. *Central American Rubber-tree*—CASTILLOA ELASTICA, *Cerv.*

These three are all natives of tropical America, and are in cultivation at both Peradeniya and Heneratgoda gardens. The two former are North Brazilian Euphorbiaceous trees; the last is Atrocarpaceous and extends over a wide area from Mexico as far south as Guayaquil on the west coast of South America.

None of these species has been yet subjected to systematic cultivation out of a botanic garden, but the efforts of the Indian and Home Governments, extended over many years, have at length brought us to the eve of that long-desired result. It will therefore be well to make public what is known of the nature of these plants, of their surroundings in their native localities, and of the methods by which the product is obtained and prepared. Our information is unfortunately but scanty, being mainly derived from the somewhat meagre accounts of the few travellers who have had the opportunity of seeing the trees wild, and especially of the veteran collector, Mr. R. Cross, employed by the Indian Government, by whose energy and perseverance they were brought to England.

From these extracts, and from the results of the cultivation of the trees at Peradeniya and Heneratgoda gardens, it is hoped that some answer to the numerous questions recently addressed to me by planters and others may be given, and some guidance afforded towards a successful cultivation in Ceylon.

I.—CEARA RUBBER.—*Manihot Glaziovii.*

1.—*Locality, Soil and Climate.*—Ceara is a coast town of Brazil in lat. 4° S., and the flat country which runs back to the hills is described by Mr. Cross as manifestly possessing a very dry arid climate for a considerable part of the year. This is evident from the fact that mandioca 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 Pactuba, about forty 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 grow 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. These had been broken where they lay, and were the result of a volcanic explosion. 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.

2.—*Propagation and Planting.*—Mr. Cross's directions are as follows :—"Seeds are early produced, if the tree is not shaded. They should be buried in brown sand, kept pretty moist until there are indications of growth, when they may be planted out permanently. In some situations where the ground is rough and strong they might be sown broadcast. Meantime I would suggest 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 gravely 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 *debris* 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."

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 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 appears 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.

Germination of Seed.—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 assit 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 mandioc 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 2½ years) the larger ones form branching trees about 25 feet 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.

3.—*System of Collecting the Rubber.*—I quote again from Mr. Cross's report :—"This is an operation of a very simple description. On commenc-

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* This end is to be recognized externally by possessing at its side a flat two lobed appendage technically known as the caruncle.

ing to 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.

Mr. Cross says nothing as to the age of the trees so operated upon : probably the collectors treat all indiscriminately. In the sequel of his report, however, he incidentally remarks that Ceará rubber may be tapped on attaining "a diameter of four to five inches," which is the case here in Ceylon after about two years' growth. But unless there were a very large number of trees in an extensive plantation, this would certainly be labour thrown away. The trees, however, comes so early to maturity, as shown by the production of seed, that it is improbable that it attains any very great size. The process above described must be, if thoroughly done, almost exhaustive of the milk, but in the case of a small stem it would be a work of some care and time to so conduct it as to avoid cutting into the wood, and probably some of the methods afterwards described will be preferred. But these are practical difficulties which it may be safely assumed the ingenuity of our planters will quickly master.

11.—Para Rubber.—*Hevea brasiliensis.*

1. *Locality Soil, and Climate.*—The town of Para occupies a position near the mouth of one of the vast embouchures of the Amazon's 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 this and allied spiecies are abundantly found. The climate has been often described and is remarkable for its uniformity of temperature, usually not exceeding 87° F. at midday 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 seasons 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 lowlying country near the Amazon's mouth 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 frequently be subject to be partially covered with water.

2. *Propagation and Planting.*—This valuable species as yet has been propagated from cuttings only. No fresh seeds were brought to this country, but to judge from dry ones in the herbarium of the British Museum, London, they are considerably larger than those of the Ceara rubber. Our largest trees at Henaratgoda, three years old, are thirty feet in height with a slender stem

scarcely branched, and about twelve inches in circumference near the base; but neither there nor in Peradeniya have they shown any symptoms of flowering. Cuttings may be taken from the green lateral twigs as soon as they begin to harden; they strike readily in rich firm land. Mr. Cross 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." 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.

Over 500 plants have been sent from Ceylon to Burmah and some to the Madras Presidency. An attempt to grow the tree in Assam failed.

3. *Collection of the Rubber.*—Several accounts have been given of this, the fullest and most recent being that of Mr. Cross, who saw in practice the methods employed in the neighbourhood of Para. His description 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 down 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 of rubber, and for what may adhere to the bottoms of the cups. These promiscuous gatherings are termed *sernamby*, and from 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 when with a small portion of clay they are 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 a 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 cups to the trunks; 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 table-spoonful 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 ones 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 is 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 twelve 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 seventy-two. 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 quantity 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 portion 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 be always carried on when the whether 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 to the large quantity of clay employed in the process.

"*Collection of the Milk.*—Going from tree to tree at a sort of running pace, the collector empties the contents of the cups into a large calabash, which he carries in his hand. As he pours the milk out of each cup he draws his thumb or fore-finger 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 have 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 intrument 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 by some; 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.

III.—CENTRAL AMERICAN RUBBER-TREE.—*Castilloa elastica.*

I. *Locality, Soil and Climate.*—The very extensive geographical range of this tree shows it capable of existing under considerably varied climatal condition. The forests in which it grows are usually at or near sea-level, but it has been observed at an elevation of 1,500 feet on the Pacific coast. The soil varies, but the plants avoids marshy or boggy land appearing to prefer warm deep loam or sandy clay, and especially affecting the margins of small running streams where it grows in little groups. A dry or a rainy climate seems equally suitable, but a high and equable temperature, which does not sink below 60° F. at any time, is essential.

2. *Propagation and Growth.*—This is a very much larger tree than those above described, being, when fully grown, of the imposing height of 160 to 180 feet, with a stem of 12 to 15 feet in circumference. It grows very rapidly. At Henaratgoda at two years of age it was 23 feet in height. The bark is thick and the wood soft and readily decaying. We received but a few plants of this species in Ceylon, and have had little experience in its management. No flowers have been yet produced, and Dr. Thwaites did not find cuttings of the ordinary kind to succeed well. We are now however endeavouring to propagate at Peradeniya by various other methods.

Mr. Cross has the following remarks:—"Trees in good situations will produce seeds early, but these will require to be planted without delay as drying destroys their vitality." The tree is stated to flower in January, and the fruit to be ripe in April. "Stout branches, cut into pieces each possessing a bud and covered lightly with soil, will generally be found to grow. Strong cuttings a foot in length and furnished with buds, when planted in the usual way, will become strong plants sooner. However, the propagation of this tree will not be found so easy as the Ceara rubber. In the planting out of young plants, the petiole or leaf-stalk of the lowest or oldest leaf should be buried in the soil. By following this simple rule the plant commences to grow at once, its growth is vigorous, and the trunk symmetrical. But if at the period of planting there is much bare stem above ground, the growth is usually slow, the plant remains 'leggy' for sometime afterwards, and never makes a good tree." The plant has a curious habit of dropping its young branches, which disarticulate by a regular joint, like deciduous leaves, and leave a clean scar on the surface of the stem. From what has been said above as to its native cities, it would seem that our south-western coast would present many favourable localities for this valuable tree.

3. *Collection of the Rubber.*—Milk is abundant and flows readily, but it is of a somewhat more watery consistence than that of the Para rubber. In consequence of the large size of the trees it is the practice of the collectors in Panama and other parts to cut them down. A groove or ring is first cut round the base of the trunk and the milk received into large leaves. "The tree is then felled, and rings or channels are cut out around the prostrate trunk at about twelve or fourteen inches apart," and the rubber allowed to run into leaves or vessels. In Nicaragua the trees are tapped with sharp axes in various ways, and the trees so much injured that the process is performed at intervals of three years. The milk is received into iron pails. It does not appear that this species is tapped until it has a diameter of sixteen or eighteen inches which Mr. Cross thinks might be attained in six years.

In conclusion, a few words may be said about the preparation required to fit caoutchouc for the market. It is clear that mere exposure to the air is sufficient in some cases to effect the coagulation of the milk into a solid mass. This is all the preparation apparently that the Ceara rubber receives, which comes into the market in balls consisting of the rolled up strings pulled off the tree. But it seems that a decomposition is liable to occur in the milk if exposed in any quantity, and it is usually desirable to reduce it to a solid mass as quickly as possible. For this purpose the cautious application of dry heat is the best; the best Para rubber is prepared by being poured over a flat paddle-shaped mould, which is held in the thick hot smoke from burning wood and palm-nuts still it solidifies, then slit down one side, the mould taken out and the "biscuit" hung up to dry. In several parts of Central America coalescence is effected by the addition to the milk of the juice of certain plants (especially *Calonyction speciosum*, which is a common convolvulus here in Ceylon). This causes the separation of the caoutchouc, which floats in the liquid like a mass of soft cheese, and has to be pressed and rolled to get rid of the fluid still remaining in its substance.

Probably carefully conducted evaporation in shallow pans by artificially regulated heat would be found an effective method.

The purity of the prepared rubber being a matter of first importance. all pieces of bark and earth should be removed by passing the milk through sieves. Small pieces or thin sheets of caoutchouc are preferred to large masses in the market from the facility of estimating the purity of the article.

Absolute dryness of the rubber is also a point requiring the greatest attention, and may require hydraulic pressure for its thorough attainment.

As much as 129,163 cwt. of caoutchouc were imported into England in 1874, of which 70,866 cwt. was American and obtained from the plants here under consideration. The value of this latter was £1,007,413. The demand for the best sorts is constantly increasing. On the relative market values of the various kinds of India-rubber reference may be made to the excellent "Report on the Caoutchouc of Commerce" by Mr. Collins, and printed for the Indian Government in 1872, to which I am indebted for some of the above information, and to a paper by Mr. C. R. Markham in the "Journal of the Society of Arts" for April 7th, 1876.

I may be permitted to add that it is gratifying to reflect on the prominent share which the Royal Botanic Garden at Peradeniya, under the care of my distinguished predecessor, Dr Thwaites (as detailed in his Reports from 1875-1878), has taken in the acclimatization of these valuable trees of the western hemisphere in Burmah and India; where as well as in Ceylon, it may be confidently expected that they will become a valuable source of revenue.

RUBBER INDUSTRY IN CEYLON.

(*Extract from the Report of the Director, Royal Botanic Gardens, Ceylon, for the year 1880,*)

India-Rubber.—Of the three species of South American trees here in cultivation, *Manihot Glaziovii* (Ceará rubber) is still the only one which has flowered. Seed of this has been supplied during the year to the Government gardens in India (Calcutta, Saharaupore, Ootacamund) and distributed as widely as possible among the planters in the Colony, 24,550 seeds having been thus disposed of as well as 1,879 rooted cuttings. We have also sent small quantities to the Botanic Gardens of Singapore, Mauritius, Jamaica, British Guiana and Kew, to the Acclimatization Society of Queensland, and to Mr. H. Low, H. B. M. s Resident of Perak. Soon after my arrival at Peradeniya I wrote a few "Notes" upon these plants which were printed as a Government paper, and have been distributed with the seeds. I have also given a botanical description, with an accurate figure, of *Manihot Glaziovii* in the London "Journal of Botany" for November. 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 shewn itself intolerant of wet. In the Nilgiris I am informed it is doing well at 2,400 feet, and Major Seaton reports from British Burmah that there are 500 and upwards set out and well established in the Mergui plantation.

With regard to Pará rubber (*Hevea brasiliensis*) its cultivation will be probably found to be satisfactory only in rich land not much above sea-level, where the temperature is high and equable and the rainfall large. At Peradeniya the trees are now making but slight progress and suffer from wind, especially in the dry noth-east monsoon. At Henaratgoda their progress is all that could be wished; our largest trees are now at three feet from the ground, sixteen inches in circumference. During the year 662 cuttings were raised and distributed. *Hevea* has proved completely unsuited to the climate of Calcutta, but is doing well in Burmah and Perak. In the latter place a tree has flowered sparingly (at two-and-a-half years and thirty five feet high): Mr. Low kindly promises seed if any ripen, but this must be a premature blossoming, for Mr. Jenman of British Guiana informs me that he has not observed trees to flower with a stem of less than ten inches in diameter.

Two plants of *Castilloa* have been sent to Calcutta. Those in Burmah are reported to be flourishing. Much better success now attends the propagation by cuttings of th s fine species. Our largest trees at Henaratgoda have now a circumference of nearly seventeen inches at a yard from the ground, and the the trees are beginning to take their true form.

I hope during the coming year to make an experimental trial of the yield of caoutchouc from these S. American species.

With regard to other rubber-yielding plants, we have a fine plant of a species of *Landolphia* flourishing at Henaratgoda. Several plants of this genus, all climbing shrubs, afford African rubber, which appears to be also yielded by a fig, *Ficus* (*Urostigma*) *Vogelii.* This latter, and one or more kinds of *Vahea* (not distinguishable as a genus apart from *Landolphia*) from which Madagascar rubber is obtained, have lately been imported into Ceylon by several gentlemen. Our plants of *Gutta Sanggarip* (probably *Willughbeia martabanica*) from the Malay Peninsula, sent in 1879 by Mr. Murton, are doing well.

Gutta Percha.—This valuable commodity is afforded by numerous large trees of the family *Sapotaceæ* growing in the Malay Peninsula and Islands. Of the best known and most valuable of these, *Dichopsis Gutta*, there are several young trees in Peradeniya and Henaratgoda, and I have during the year, through the kind exertions of Mr. Low, our resident at Perak, received a consignment of germinating seeds of the second best variety of that country.

This is called "Gatah Sûndek," and Mr. Low informs me that it forms a very large tree 120 feet high, but quick growing. From specimens of the foliage and fruit sent with the seeds, it would appear (so far as can be determined without flowers) to be a species or *Payena.* This is a valuable gift, as "the Gatah trees in Perak [as everywhere else] sufficiently large to produce the gum are now very rare, and very great difficulty arises in procuring seeds of specimens." The young plants are growing vigorously in Peradeniya and Henaratgoda. The commerical necessity for a systematic cultivation of Gutta-percha yielding trees is rapidly becoming a pressing one.

THE RUBBER INDUSTRY IN CEYLON.

(From the Report of the Director of the Royal Botanic Gardens, Ceylon, for the year 1881.)

Much activity is being shown in the search for new rubber yielding plants. As I have before observed, caoutchouc seems to be more or less produced by nearly all apocynaceous plants, and a large number of artocarpaceous and euphorbiaceous ones also, but it is not in a state avilable for ready extraction or for commercial purposes in any very large number of them. Thus in our native species of *Willughbeia* (*W. zeylanica*) which I have had the opportunity—through the kindness of Mr. J.C. Roberts of Udugama—of experimenting with, and which gives plenty of milk, the caoutchouc, which is abundant, after first passing through a viscous sticky condition dries into a putty-like substance of no great tenacity and scarcely any elasticity, and this whether treated by heat, with alum, with alcohol, or simply allowed to dry. The plant is a climber and the stems, which are said to attain over six inches in diameter, extend to an immense length. This result is disappointing, as a congener at Singapore (*W. Burbidgei* of the Kew report for 1880, formerly referred to *W. martabanica*) affords a very fair rubber known as "Gutta Singgarip." Of this sort we have received a case of 50 plants (which was kindly brought from Singapore by Mr. F. A. Fairlie), and we previously had a few plants from Mr. Murton. This and other less-known species of *Willughbeia* also apparently afford some of the rubber of Borneo, called "Gutta Susu" in the market.

But the most promising of the new rubber plants are the species of *Landolphia*. The African kinds of caoutchouc are mainly, and on the East coast wholly, supplied by these; and by the exertion of Sir J. Kirk chiefly, several have been now brought into cultivation. To him directly I am indebted for a consignment of seeds (in the fruit) of the narrow-leaved species called "Matere" or "M'tiri," which affords the best rubber of the Zanzibar coast and which it is proposed to call *L. Kirkii.* Of this we previously possessed but a single plant at Henaratgoda, now over two years old, and widely climbing over a wild nutmeg tree. Young plants of this have also been received from the Royal Gardens, Kew, during the year, as well as of three other species, for an account of which reference must be made to the Report of that establishment for 1880, p.p. 38-43. Of two of these, *L. Petersiana* (*Willughbeia* Klotzch), and "No. 4," (l. c. p. 43) the broad-leaved species we have some 18 plants at Peradeniya, and of the other, *L. florida* ("Mbungu" of Zanzibar), a single fine specimen. These and several other allied and undetermined kinds (including two plants of a Madagascar rubber from the Ceylon Company, Limited, and the West African "Apocynaceous" rubber of Mr. T. Christy's "New commercial Plants," No. IV., p. 15) have been planted out, some at the foot of old trees, others against large dead trunks and branches fixed in the ground.

The wonderfully rapid development of trade in these African rubbers is, in spite of their habit of growth, leading to their destruction. From two districts of Eastern Africa alone the export of rubber in 1880 exceeded 1,000 tons, the price having risen in one year from £140 to £250 per ton.

Sir J. Kirk thinks the Landolphias (especially *L. Kirkii*) by far the most promising of rubber plants for cultivation in plantations; their stems can be cut down at frequent intervals for the rubber, and fresh shoots readily spring up from the stools. He quotes with approval in reference to the extraction of the caoutchouc, the suggestion of Mr. T. Christy (Commercial Plants No. I., p. 9), that the stems after cutting "could be taken to the rolling mill, and the crushed mass digested with bisulphide of carbon in which the rubber is soluble, but which does not dissolve the gum and resinous matters contained in the plant, and which if left in the rubber would injure its quality."

Of other African kinds, Mr. T. Christy has sent a few seeds of a plant determined at Kew to be, *Tabernœmontana crassa*, and a specimen of *Ficus populifolia*; whilst we have *F. Vogelii* also from Kew.

With regard to the American rubbers, Ceara (*manihot Glaziovii*) continues to interest planters by its rapid growth, ready propagation, tenacity of life, and early production of seed. From this latter quality chiefly it has resulted that the loud and urgent demand for seed has almost ceased in Ceylon in the course of one year. We have distributed it to several private planters in India and to the Government establishments there, also some to Singapore for a further trial, as well as to Jamaica and other colonies.

A single tree of *Hevea* flowered at Henaratgoda and produced a few capsules in April. The growth of Para rubber is not rapid; our largest is now 21 inches in circumference at a yard from the ground, an increase of 5 inches in the year. New plantations of *Hevea* have been formed, and some trees at Peradeniya have been planted in a position in the new garden where they are flooded when the river is high, with a view to an imitation of their native habitat.

One plant of another species, *Hevea Spruceana*, which gives valuable rubber, was sent direct from British Guiana by Mr. Jenman, but has unfortunately not survived.

At the request of the Government of India—at whose expense the plants were originally imported to Ceylon—a consignment from Henaratgoda, consisting of 28 good stocks rooted in a Ward's case, was despatched (from Henaratgoda) in November to the Andaman Islands. The climate there is likely to prove eminently suitable for Para rubber which has not succeeded in Peninsular India, but is going on well in British Burmah.

The *Castilloa*, both at Peradeniya and Henaratgoda, also produced flowers during the dry weather of April; on examination, however, these were all male. This species is said not to produce seed till eight years old. The finest tree at Henaratgoda has now a stem of about 22½ inches in circumference at a yard from the ground.

During the early part of the year I made a preliminary and tentative investigation to ascertain the condition of the milk in our Ceara trees at Peradeniya, and the best means of obtaining it. The principal conclusion I arrived at was that the trees had not their milk in a sufficiently concentrated state to invite tapping. I was quickly led to the opinion that the method of paring the stem as practised by the natives in Brazil (according to Mr. Cross) would not be found either convenient or economical. The milk-vessels occur in two layers, the richer one is in the innermost stratum of the bark just outside the cambium, but there is a smaller one immediately beneath the thin green layer; this latter is sacrificed by the slicing process which also causes loss from the milk adhering to the shavings. In the culture of this kind of rubber the principal difficulty will, I think, be the *extraction* of the milk. It appears to be present in good quantity, but a very small amount flows from each cut, and it is difficult to avoid drip and loss if the stems are not perpendicular. It is not possible at present to make any estimate of the slightest value as to the probable average yield of a tree. The plant is evidently very hardy and rapidly recovers from bark injury. I think I should repeat here what I said two years ago (Notes p. 4) that the yield of a few trees cannot be remunerative, and only large plantations can hope to repay the cost of collection. The quality of the *dry* rubber (resulting from milk laboriously obtained from one tree by small incisions) appears identical with the Ceara scrap of commerce, in spite of the extremely watery character of the milk. Further experiments will be shortly made.

The more valuable Para and Central American rubbers have their milk already in more concentrated condition than the Ceara; *Castilloa* especially affords a milk which spontaneously coagulates in a few hours into a very elastic rubber. Mr. Cross states (Report to Madras Government, March 1881) that a tree of *Castilloa* 1½—2 feet in diameter if carefully and judiciously tapped should yield about 12 lb. of rubber per annum; and with regard to *Hevea*, Mr. Wickham, who brought the seeds from South America to Kew, informs me "it bears tapping very well if properly worked, and I have known productive Ciringals (rubber walks) the property of several generations of Indian Ciringaros. In their native woods the large trees (they grow to a great size) are selected for working as being profitable by taking a large number of cups or a long vine band, but were a plantation formed the trees could no doubt be profitably worked whilst still small—say 24 inches in circumference. The great thing is to avoid cutting too deeply into the bark."

Gutta Percha.—A plantation of the "Gutta Sundek" from Perak has been formed in the new garden. The trees are healthy, but, like all their tribe, grow with extreme slowness.

ON THE CASTILLOA ELASTICA OF CERVANTES, AND SOME ALLIED RUBBER-YIELDING PLANTS.

BY SIR J. D. HOOKER, K C.S.I., C.B., F.R.S., F.L.S.

(From the Transactions of the Linnean Society of London.)
Read December 3rd, 1885.

The great importance of the Indiarubber trade renders it necessary that the plants yielding this valuable product should be known with scientific accuracy. Of these, the Ule that which yields the rubber of Mexico and Central America (*Castilloa elastica*), is the earliest described, and might hence be supposed to be well-known. It is the purport of this communication to show that this is not so, and that probably more than one rubber-bearing species of that genus exists in Central America under this name.

Attention was first called to this subject by the receipt at Kew, from Dr. Trimen, Director of the Ceylon Botanical Gardens, of a specimen and a drawing—with complete analysis of the flowers and fruit—of the plant sent out from Kew in 1876 as *Castilloa elastica*, and which drawing differed considerably from Cervantes's figure and description of the Ule of Mexico. The tree from which the specimens were taken and drawing made, was raised from one of the cuttings procured in Darien (Panama) by Mr. Cross in 1875, and which, after being grown on at Kew, were distributed to various tropical Colonies, as detailed in Mr. Thiselton Dyer's account of Mr. Cross's mission and of the introduction into Europe of the Indiarubber plant which is appended to this communication. It will be seen from that account that Mr. Cross sent the plant under the name Caucho, and that the locality where he procured it, the forests of the rivers Chagres and Gatun (well-known localities for Indiarubber collectors) is considerably to the south of the botanically ascertained stations for the Ule. In selecting these forests for the purpose of collecting seeds Mr. Cross was, no doubt, indebted to information obtained by the late Mr. Sutton Hayes of Panama, and which is attached to specimens of an Ule, which latter, however, he procured from the Republic of San Salvador; and for assuming that the Caucho is the Ule or *Castilloa elastica* of Cervantes, he probably relied on the testimony of Cavanilles, who, in a notice of the Caucho of Darien (Panama) in the Ann. de Hist. Nat. Madrid, ii. p. 126, regards it as the same with the Ule of Cervantes, whose description he quotes at full length. Unfortunately Mr. Cross sent no other herbarium specimens of the Caucho than some very badly preserved old leaves and seeds, so that, until the arrival of Dr. Trimen's materials, the means of identification were wanting.

I have next to advert to specimens of the fruits of three forms or species of *Castilloa* from the forests of Honduras, preserved in fluid kindly procured by W. H. Langton, Esq.. Secretary of the Belize Estate and Produce Company; two of these are named Ule, and both stated to yield the Honduras rubber; the third is named Tunu, and said to yield a gutta-percha. These all differ more or less from the Caucho of Darien, collected by Mr. Cross and one of them may, I think, be safely referred to the *C. elastica* of Cervantes. Unfortúnately only one of them is accompanied with specimens of foliage, which, however, is that of the fruit which I attribute to *C. elastica*, and it further agrees with that of Mexican specimens of Ule. The other materials at Kew referable to *Castilloa* consist of:—flowers and leaves of the Ule from Mexico collected by Ervendberg, Schiede and Deppe, and by Bourgeau; leaves of the Honduras Ule from D. Morris, Esq.; of the Nicaraguan Ule collected by P. Levy, and named var. *Costa-ricensis* Boureau; San Salvador specimens of foliage and dried fruit from Mr. Sutton Hayes; flowering branches from Guatemala, collected by Fredericsthal; and leaves and flowers of the Jeve from the plains near Guyaquil, sent by Sprues as *C. elastica*.

These herbarium specimens present no characters of habit, foliage, or flowers to distinguish them from *C. elastica*: 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, have the branchlets less clothed with hairs, and the under surface of the leaves less thickly tomentose.

Turning to the fruits in fluid, to the figure from Dr. Trimen, and to that accompanying Cervantes' account of Ule, these all agree in consisting of a fleshy circular disk, 1·3 inches in diameter, clothed beneath and on the circumference with densely imbricating triangular scales, and bearing on the upper surface 8-30 confluent orange-red, thick, coriaceous, one-seeded carpels, with more or less prominent pyramidal crowns. These carpels present important differences, possibly specific; but from the materials available it is not possible to determine what may constitute a species amongst them, and I shall therefore confine myself to defining the typical *C. elastica* more exactly than has hitherto been done, and follow this by descriptions of the forms allied to it.

1. CASTILLOA ELASTICA*, *Cervantes in Gaz. Litt. Mexic.* 1794 (*translated in Tracts relative to Botany, London*, 1805, p. 235. · t. 9): ramulis crassis strigoso-hirsutis, foliis amplis breviter petiolatis bifariis oblongis v. obovato-oblongis abrupte acutatis basi cordatis integerrimis v. apicem versus denticulatis supra scabridis subtus dense hirsutis tomentosisve, nervis utrinque 17-21, stipulis 2-3 pollicaribus deciduis, receptaculis axillaribus turbinatis bracteis triangularibus persistentibus imbricatis tectis, ♂ breviter pedunculatis. ♀ subsessilibus, floribus ♂ achlamydeis densissime confertis, staminibus (floribus singulis ?) bracteolis immixtis, fl. ♀ perianthiis ovoideis infra medium connatis ere minute 3-4-lobo, receptaculo fructifero disciformi crasso, basi margineque bracteis imbricatis appressis densissime tecto, carpellis maturis carnosis infra medium connatis superne liberis pyramidatis minute pubescentibus, parte libera 3-4-sulcata angulis rotundatis apice depressa 3-4-loba—*Cavanilles in Ann, des Hist Nat Madrid* (1,800), ii. p. 126; *Trécul in Ann. Sc. Nat.* ser. 3, viii. 136, t. 5, fig. 142-148; *Ramon de la Sagra, Flora cubensis* iii. p. 223; *Collins, Report on Caoutchoucs of Commerce* (1872), p. 11, t. 2; *Hemsley, Biol. Centr.-Amer.* (*Botany*), iii. p. 149; *Morris Colony of British Honduras* (1883), p. 75, *cum ic xyl.*—C. costa-ricensis, *Liebman K. Dansk. Vidensk. Selsk. Skrift.* ser. 5, p. 319; *Mexicos og Central Americas Neldeaglige Planter* (1851), pp. 34, 35. *Hemsley l. c.* (Plate XXVIII. figs. 1—3).

Hab. MEXICO, from lat. 21° southwards; GUATEMALA; HONDURAS; San SALVADOR; COSTA RICA and NICRAGUA, in low forests.

A lofty deciduous tree with milky juice; trunk 8-12 ft. in circumference; bark smooth, soft; branchlets very stout, with large pith and brown bark, extermities, densely clothed with long fulvous hairs. *Leaves* 12-18 by 4-7 in., alternate and bifarious, firmly membranous, broadly, oblong or obovate-oblong, abruptly acuminate, base cordate, entire or obscurely toothed at the tip, margin with minute tufts of hairs, scabrid above, beneath densely clothed with tawny hairs, midrib prominent beneath: nerves 17-21 pairs; petiole ½-1 in., stout; stipules 2-3 in., clothed with tawny hairs, deciduous. *Flowers* monœcious, contained in solitary, axillary, turbinate, fleshy receptacles ¼-1 in. in diam., clothed outwardly with minute, densely imbricate, triangular, appressed, puberuluos bracts. *Staminate receptacles* ¾-1½ in diam., shortly stalked, usually subcompressed, cup-shaped at the top, and covered densely with stamens mixed with bracteoles which do not overtop the margins of the cup. *Pistilate receptacles* similar, but rather smaller, and subsessile; flowers confluent; perianth fleshy, greenish, limb minutely 3-4 toothed; ovary immersed in the disk; styles 2, rarely 3. *Fruiting receptacle* (in Honduras specimens) 1¼-2 in. in diam.; ripe carpels coriaceously fleshy, with pyramidal free pubescent crowns ⅓ in. high; crown 3-4 grooved laterally, with rounded angles and obtuse depressed 4-lobed tips. *Seeds* ¼-⅓ in. in diam.; more or less immersed in the free crown of the carpel; testa white, papery when dry; cotyledons thick, plano-convex, radicle minute, superior.

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* Published anonymously, but known to be by Chas. Kœnig, F. R. S., Keeper of the Mineralogical Department of the British Museum.

The character by which I identify this with the plant of Cervantes is that of the free part of the ripe carpels, which that author describes as "apice excavato;" in all the other forms noticed below these crowns are acutely 3-4-angled with acute tips. The reduced figure of the fruit given by Cervantes shows the character of the grooved sides and rounded angles of the carpels, but not their indented tips.

Trécul gives Cuba as a native country for *C. elastica* on Ramon de la Sagra's authority, but a reference to the latter author's 'Flora Cubensis' shows that it is known in that island only in the Botanical Gardens of Havana.

II. The Caucho, or Darien plant. Leaves less thickly tomentose beneath. Fruiting receptacles 2-3 in. in diam.; crowns of the ripe carpels prominent, pyramidal, acute, acutely 3-4-angled. Seed $\frac{1}{3}$ in. in diam., more or less immersed in the free crown of the carpel.—Darian on the Chagres and Gatun Rivers.—*C. Markhamiana*, Markham (not of Collins), Peruvian-Bark (1880), p, 453* (Plate XXVII. figs. 1-17.)

III.—Fruit referred to Ule from the Belize Estate and Produce Company. Fruiting receptacle 1-1$\frac{1}{4}$ in. in diameter; crowns of the ripe carpels prominent, acute, acutely 3 4-angled. Seeds $\frac{1}{4}$ in. in diam., more or less immersed in the free crown of the carpel—Honduras and Nicaragua. This appears to be a small seeded variety of the Darien species. (Plate XXVIII. figs. 4-6.)

IV.—Fruit of the Tunu, or gutta-percha yielding plant from the Belize Estate and Produce Company—Fruiting receptacles 2-2$\frac{1}{2}$ in. in diam.; crowns of ripe carpels very low, subacute acutely 3-4-angled. Seeds $\frac{1}{3}$ in. in diam., immersed in the receptacle far below the crowns of the carpels.—Spanish Honduras. (Plate XXVIII. figs. 7-9.)

Before dismissing the subject, it may be well to allude to the remarks made by Mr. Cross on the formation of disarticulating branches on the young plants of the Caucho, and which, no doubt, occur other species of *Castilloa*. They are thus described by Mr. Cross in a letter dated April, 26, 1877:—"In the forests the young *Castilloa* plants push up rank stems rapidly to a great height, which, during the progress of growth, throw out at variable distances a number of leafy shoots. These, on becoming mature, begin to wither, and finally separate from the surface of the trunk by an articulated or jointed process. I did not consider them true branches, just because the wood was not properly formed, the buds were imperfectly developed, and I found they were not easily propagated. It may be different shoots developed by compressed pot culture. But when the tree begins to flower, true branches are formed which do not drop off. At times the trunk, after running up to a certain height, divides into two or three stems, each furnished with numerous short, stiff, upright branches which are permanent, and ripen fruit abundantly. Probably, however, the description of shoots alluded to are produced at times during the entire period of the growth of the tree.

A similar phase of growth appears to take place with other species of forest trees in the hotter parts of America."

The above information is given in abstract by Mr. Lynch, Curator of the Cambridge Botanic Garden, with due reference to its author, in his interesting paper "On the Disarticulation of Branches," published in the 16th volume of our Journal (p. 182), accompanied by an excellent drawing of the phenomenon, and the observation that the deciduous branches strike under cultivation as freely as the permanent ones. The figure of Cervantes shows a contraction at the base of the branches, where disarticulation would occur.—J. D. HOOKER.

In the summer of 1875 the India Office despatched Mr. R. Cross (who, in 1860, had accompanied Dr. Spruce in his expedition to Ecuador to collect plants of *Cinchona Succirubra*) to Darien to obtain seeds and plants of

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* *C. Morkhamiana*, Collins, 'Report on the Caoutchouc of Commerce,' p. 12, t. 3, is no doubt correctly referred by Bentham, Gen. Pl. iii. p. 372, to *Perbea*.

*Castilloa elastica**. This mission he successfully accomplished. He reported as follows (August 4, 1875) to C. R. Markham, Esq., C. B. :—

"By this mail I have despatched (addressed to the Under Secretary of State for India) a small bag containing upwaards of 7,000 seeds of the Caucho tree which I have collected in the centre of Darien. There is only *one* species, the difference being in those growing in the shade or exposed. The seeds were collected in good condition and perfectly ripe, but from observations on a few gathered on first arrival they do not appear to keep well, containing, even when mature, a milky juice. ....

The interior of the Darien forests would frighten most people. The undergrowth is composed of boundless thickets of a prickly-leaved species of *Bromelia* often 8 to 10 ft. high, the ground swarms with millions of ants, and the snakes raise themselves to strike at any one who approaches.

"The Caucho tree grows not in inundated lands or marshes, but in moist undulating or flat situations, often by the banks of streamlets, and on hill sides and summits where there is any loose stone and a little soil. It is adapted for the hottest parts of India, where the temperature does not fall much below 74° Fahr. The tree is of rapid growth, and attains to a great size, and I am convinced that when cultivated in India it will answer the most sanguine expectations that may have been formed concerning it. I have been up the Charges and Gatun rivers. I came out on the railway about 7 miles from Colon. I go back to the same place (the village of Gatun), from which place by the river the India rubber forests are reached."

As stated in the Kew Report for 1875 (p. 8), Mr. Cross's expectations as regards the seeds were realized. The whole parcel failed to germinate. Mr. Cross, however, with considerable difficulty, and after undergoing shipwreck,† succeeded in bringing safely to Kew (Oct. 3) a considerable collection of cuttings from which a supply of plants was raised. Of these, two plants were despatched to Dr. Thwaites, Director of the Royal Botanic Gardens, Peradeniaya, Ceylon, April 27, 1876, and thirty-one on August 9 following. Of these last, twenty-eight arrived alive (Kew Report, 1878, p. 9).

A further consignment of twenty-four plants was sent, Sept. 15, 1877, to Dr. Thwaites who meanwhile had been establishing the former consignment in the tropical garden at Heneratgoda (Kew Report, 1877. p. 16). Here they made satisfactory progress, Mr. Morris describing them, May 18, 1878, as growing "into broad spreading trees with a very majestic air." Dr. Thwaites, however, met with great difficulty—contrary to the Kew experience—in propagating the tree by cuttings (Kew Report, 1878, p. 14).

In 1880 Dr. Trimen, who had succeeded Dr. Thwaites as Director of the Royal Botanic Gardens, Peradeniya, reported :—"Much better success now attends the propagation by cuttings of this fine species. Our largest trees at Heneratgoda have now a circumference of nearly seventeen inches at a yard from the ground, and the trees are beginning to take their true form." (Kew Report, 1880, p. 17).

In the following year Dr. Trimen reported, "The Castilloa, both at Peradeniya and Heneratgoda, produced flowers during the dry weather of April ; on examination, however, these were all male. This species is said not to produce seed till eight years old. The finest tree at Heneratgoda has now a stem of 22½ inches in circumference at about a yard from the ground." (Kew Report, 1881, p. 13).

Dr. Trimen further reported, Oct. 20, 1882 :—"We have some sturdy little seedlings of Castilloa coming on from our seed. Only three fruits ripened in June, and the fifteen seeds from these were sown at once, and germinated in fifteen days." (Kew Report, 1882, p. 22.

It is not necessary to pursue the history of the introduction into the East Indies beyond the appearance of a new seminal generation. It will be sufficient to quote from the Kew Report for 1882, p. 40, the account of the

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* See also Mr. Markham's account of the enterprise in 'Peruvian Bark' (London, 1880) pp. 452-454

† Markham, *l. c.* p. 453.

first sample of Caoutchouc obtained from the *Castilloa* under cultivation in the Old World.

"In October 1882, the Director of the Royal Botanical Gardens, Peradeniya, Dr. Trimen, forwarded to Kew a sample of the rubber of *Castilloa elastica* grown in the Experimental Gardens at Heneratgoda, 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 strengh or tenacity is required.' It was valued, Dec. 8. 1882, as worth 2s. 9d. to 3s per pound."

It remains to add that the Darien *Castilloa* has been successfully introduced by plants sent from Kew into Liberia and the Cameroons River on the west coast of Africa, and into Zanzibar and the Mauritius on the east ; also into Singapore, Java, Jamaica and Granada. From Ceylon plants have been sent to Calcutta, Burma, and Madras, and from Singapore to Perak and Queensland.—W. THISELTON DYER.

REPORT ON THE INVESTIGATION AND COLLECTING OF PLANTS AND SEEDS OF THE INDIA-RUBBER TREES OF PARA AND CEARA AND BALSAM OF COPAIBA.

(*By Robert Cross.*)

To the UNDER-SECRETARY OF STATE FOR INDIA.

Grove Street, Edinburgh,
29th March 1877.

SIR,

Respecting the service on which I have recently been employed in the collecting of plants yielding the Para India-rubber of commerce, I now take the liberty to forward a detailed account of my proceedings.

On the 10th of June 1876 I left Liverpool by the "Red Cross" Steamer "Cearense," which, after calling at Havre and Lisbon, sailed direct for Para which was reached on the 15th of July. This city is situated on the southern bank of the river Amazon, which, at the point where it debouches to the sea, has a breadth of 33 miles. Para is distant 80 miles from the ocean.

The population numbering about 40,000 are chiefly engaged with the despatch of import and export produce. Everything is very dear, and notwithstanding the reputed fertility of the Amazon valley, I found that nearly all the necessaries of life are imported. Thus, butter and fish come from Norway, rice and flour from the United States, while sugar, coffe, and *mandiocca* are brought from the southern ports of Brazil. Import duties are high, and so also are those on produce exported, amounting in some things, such as rubber, to 25 per cent. of the value of the article. The houses are mostly built of mud and roofed over with tiles. The windows are chiefly formed of wood hinged at the top, and push out from below, whence the inmates, unseen, obtain views of the street and passers by. Throughout the course of the day many of the occupants are invariably congregated behind these window lids. The great bulk of the citizens go about more ostentatiouly dressed than the people of London, the attire considered essential being fine black coat and hat, with snow-white ironed vest and trousers, and fancy French boots. Those who do not conform to this style of dress are stared at. Even at the beginning I did not agree with the fashion, and afterwards was farther removed from it by being almost daily bedaubed over with the mud of the *gapos*. Coloured females and slaves may be seen stepping into carriages perfectly oaded with large necklaces and glittering ornaments and even the families of foreign residents are frequently dressed in the most excessive and extraordinary manner.

The phase of slavery that exists is in so mild a form that it is at first not observed. In very many instances the slaves are allowed to hire themselves out on condition of paying their owners a certain sum of their daily earnings. The whole system is evidently dying out more rapidly than the Government laws enacted for its abolition require it to do.

Merchandise and other effects are removed from one place to another in the old primitive way, thus employing many hands, who earn high wages, Emigrant Portuguese, of whom there are about 5,000, are mostly the carriers, boatmen, and shopkeepers of the place. The supply of water of the city is carted through the streets in barrels, and sold at the rate of three-halfpence per *poto*. The *poto* contains 21 English imperial pints. Within 12 hours after being deposited, the water is found to precipitate a greenish substance amounting to nearly one-fourth the quantity, which is not removed even if filtered through several folds of stout cloth. In the courtyards of the majority of the houses are open cesspools, which in such a glowing atmosphere may assist in developing much sickness. Dysentery, yellow fever and various other forms of a typhoid character, appear to be permanent, although of late there have been no serious outbreaks, and the place is reported more healthy than formerly. Tetanus and other forms of nervous affections are of frequent occurrence, especially among the native-born population. I have no doubt that Para is far more unhealthy than any city in India. It may not be so naturally, but by a combination of circumstances ; such I belive to be the case.

I found on arrival, after considerable inquiry, that the great field for caoutchouc collecting was the province of Para and the Islands which are scattered over the lower portion of the Amazon river. Chief of these is the island of Marajo, which is about the size of Holland. A good deal of the rubber from the Rio Negro, Madeira and other tributaries, appears to come in the form of "negrohead," or *sernamby*, while the para region seems to produce to a greater extent the finer kinds of smoked biscuit rubber ; the preparation is attended to more carefully, besides which the Para tree is reported to be a different variety. Its milk leaves no very prominent stain on the hands or clothing, while the milk of some of the varieties of rubber of the Upper Amazon gives a black ink-like mark to the hands and clothes of the collectors. Black rubber is stated by some to be deficient in recoil or elasticity. In order to form and establish a collection of plants, and for the purpose of making the various observations on the soil, climate, and mode of collecting and preparing the rubber, it was necessary to obtain a place to live in while so employed. Every one told me I would experience great difficulty in finding a dwelling, and this proved true. After trvelling round Para, and searching for about eight days, I succeeded in hiring a house, but at a very high rate, as the place was large and adapted for a family with attendants and slaves. However, it was secure and offered every facility for my various requirements, which was important. My next work was to examine the district where the rubber trees grew. Mr. Henderson, who was known to Dr. Spruce, kindly introduced me to an old rubber collector, called Don Henrique, who undertook to lead the way to the *ceringal*, as the rubber locality is termed ; but after disappointing me twice, I resolved to lose no more time, and procuring from him the services of a lad as guide, I commenced to inspect the forest. On the 25th of July I made a preliminary journey to the region where the trees were wrought.

The land around Para, including where the city stands, rises from the banks of the river southward in the form of gentle undulations, indented, however, in many places by deep gully-like natural ditches, called *gapos*, which often peneterate for many miles into the interior of this vast forest region, and are filled daily by diurnal tides. To those navigable by canoes or sailing craft the term *ajarapc* is often applied. The intervening land between the *gapos* is frequently flat and moist, and owes its origin first to tidal deposits, and afterwards is raised higher by the decayed remains of successional rank growths of vegetation. On the elevated lands beds of white sand 20 feet in depth are met with, covered with a layer of decayed vegetation. At a similar level to this, we find a deposit approaching to clay or very fine sand and mud, with here and there masses of sandstone or granite cropping out. In every direction where a view can be obtained, the country is seen to be covered by dense exuberant forest. Leaving Para, I travelled over the high ground for several miles, until the primitive forest was reached, and then went down towards the *gapos*, following through the wood a path used by the caoutchouc collectors, and we soon came to a large tree in a state of decay, which had been tapped many times. At first sight I felt extremely puzzled and perplexed at the apperance it presented. From the ground up to a height of 10 or 12 feet the trunk was one swollen mass of warty protuberances and knots, covered with thick scales and flakes of hard dry bark.

This singular state of growth, the result of the practised system of tapping, has not yet been recorded by any one, and so was to me unexpected. A few minutes of careful examination soon showed the real cause of these deformities. The collector makes use of a small axe-like implement an inch broad. At each stroke he cuts through the bark and into the wood for fully an inch. Hundreds of these are made in the wood of each tree in the course of a few years; and cannot heal under any circumstance; but a layer of wood is formed over the injured part, at the expense of the bark, and general vitality of the tree. The newly-formed wood is again cut into and splintered and so the process is repeated on each successive layer until the trunk becomes merely a mass of twisted wrinkled wood with very thin insipid bark. In this condition hardly any milk flows from the cuts, and although for years a few green leaves may continue to sprout from the points of the twigs, yet the tree may be considered as dead, and, in fact, finally withers away. It is, therefore, the injury done to the wood, and not overtapping which lessens the flow of milk and ultimately causes the death of the tree.* The cuts in the wood are of course unnecessry, since the milk is met with only in the bark. The healing over process which afterwards takes place is similar to that seen where a branch has been lopped from a trunk. The wood is compact and rather hard, and for this reason the tree lives on for a number of years, although cut and hacked every season; but the flow of milk becomes so lessened that many are practically abandonded for years before they die. This and several large adjoining trees were growing in moist deep heavy soil of a fertile character, but quite out of the reach of any inundation.

On the 2nd of August I went in search of plants and descended to the region of the *gapos*. It had rained a good deal previously, and the collectors' footpaths were ankle deep with mud. After wading several little pools, we came to a deep *gapo*, into which the tide flowed. It was connected with many lesser watercourses that formed a kind of network, extending over a wide district of forest-covered country, the more elevated parts of which were raised only from three to four feet above the highest tides. A considerable number of rubber trees grew along the margins of both the larger and smaller streams, intermixed with cacao and forest trees. Three were observed, the base of the trunks of which were flooded to a height of one foot; yet the roots seemed to run up to the brow of the bank, and no matted rootlets were observed as is the case with the willow tree when growing on the margin of a rivulet. Most of the others occupied dry situations. Those *gapo* ditches were lined with soft rich mud, without doubt possessing great fertility. The exhalations from such places, shrouded by a forest growth of 80 or 100 feet high, were sensibly felt, and on nearly every occasion when I visited those localities I experienced slight attacks of fever afterwards. The collectors, also, during the working seasons are often indisposed from the same cause. Although the forest was excessively damp, yet tapping was being carried on, as a man was seen mixing up some clay at the side of a *gapo*. A number of good plants were met with beneath the oldest trees. The seedlings did not usually grow in any place where the ground was covered by more than two or three inches of water at flood tide. However by far the greatest number were met with on sites above the reach of the highest tides. I measured a few of the largest trees, all of which had been tapped for periods varying from

* This applies to other kinds too, I presume besides the Ceara.—*A Ceylon Planter.*

5 to 15 years. Those found growing in shallow *gapo* ditches are preceded by an asterisk. The circumference of each one yard from the ground was as follows :—

		Ft.	In.			Ft.	In.
No. 1	...	6	9	No. 7	...	4	0
No. 2	...	6	10	No. 8	...	5	10
No. 3	...	4	7	No. 9	...	4	0
No. 4	...	3	0	No. 10	...	4	6
*No. 5	...	5	10	No. 11	...	4	8
No. 6	...	5	3	*No. 12	...	2	8

Most trees occurring within the limits of the worked districts are tapped if possessing a diameter of six or eight inches. Regularly tapped trees, as a rule, do not exceed 60 feet in height.

August 7th.—I went in search of more plants, and on the 10th made another collection. About 2,000 in all were obtained, but a number had to be rejected. I had cases previously made so that I was able to plant the plants in them without delay. The soil coonsisted of decayed leaves brought from the forest. The rougher portion was charred and put in the bottoms of the cases to serve as a sort of drainage. Then a layer mixed with some wood ashes was placed above the plants planted therein. Four cases, containing upwards of 1,000 plants, were finished in this way, one being reserved for copaiba or any other sort of rubber plants I might meet with. While the plants were being established I commenced a series of experiments, in order to ascertain how the tree might be readily multiplied in a simple rough way by any person not specially acquainted with the principles of propagation. Two seperate beds, the one of brown sand, the other of decayed leaves, were formed. The terminal portion of shoots, but with a bud at the lower end, were planted in the beds in a reclining position, with only two inches of the points above the ground. Owing to the great distance between the buds, consequent on vigorous growth, many of the cuttings were a foot or more in length. At the same time a number were set deeply in an open vessel containing only rain water. The cuttings in the sand-bed were the first to grow, and soon made strong shoots and root fibres. Those in the leaf mould pushed more slowly, but developed green leaflets of great substance. The cuttings placed in the water had a small portion of tap-root at the base, as the object was to determine if the roots would actually develope in water alone. Within 14 days these plants had several roots formed, and one or two rather weak growths came up, but a few days after I had thrown into the water some burnt earth and wood ashes the increase in vigour was very apparent. After these experiences, I felt convinced that the Para rubber tree delights in abundance of moisture and rich fertile deposits.

Method adopted in tapping the trees.—When the plants were somewhat established I resolved to examine attentively the process of tapping as practised by the caoutchouc collectors. In the investigaion of the subject I travelled over a very wide extent of flat forest country, much divided by miry hollows and tidal *gapos*, which stretched along the bank of the river Guama. Although this river is at least three times as broad as the Thames at London Bridge, it is not to be seen on any ordinary map. In the region alluded to there were hundreds of trees wrought by different collectors, each of whom had a separate piece of land to work on. When on these excursions, I had to go away from my place of abode at about three o'clock in the morning, as I had some miles to travel over paths not always in good condition, and it was necessary to be as near as possible to the spot where the tapping operation was performed, because 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 down 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 sapline growths, and the bridges over the *gapos* 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 of rubber, 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 alreaey stated, are of burnt clay, and are sometimes round, but more frequently flat or slightly concave on one side, so as to stick easily when with a small portion of clay they are pressed against the trunk of the tree. The contents of 15 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 penerates 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 directly 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 a 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 their duties. Some take care to get good clay previously and incorporate it well, so that a very small portion is needed to lute the cups to the trunks; 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 came 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 overtapping, as some have stated. Indeed, I do not believe it is 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 twelve 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 seventy-two. 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 be always carried on when the weather is fine. It is a common report that the trees yield the greatest quantity of milk at full moon. In order to ascertain this, a number of very careful experiments would require to be made, extending over one or two years. Even if such an assertion was found to be true, it would probably make little difference, as tapping will have to be carried on when circumstances are most favourable.

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 or 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 finding round the trunk the stout flexible stem of a climber, and claying it round securely so that no milk might 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 to the large quantity of clay employed in the process.

Collection of the Milk.—Going from tree to tree at a sort of running pace, the collector empties the contents of the cups 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 have 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 for less cost and labour.

Method of preparing the Rubber.—The collectors of the region I visited, resorted with their milk to a large shed situated on the bank of the river Guama. Here were quantities of various species of palm nuts, representing an *Attalea* and *Euterpe edulis*, stored in heaps, and several jars for the preparation of rubber. These jars were 18 inches high, and the bottoms were broken out. At the base they were 7 inches in diameter, bulging out in the middle to 12 inches, and were narrowed at the mouth to a breadth of 2 inches. Each person wrought on his own account, and so small jars were employed; but where a number of men are collecting for one master much larger jars are in use. The milk, on being put into a large flat earthen vessel, is put down on the floor in a convenient place. Adjacent thereto the jar is set on three small stones, which raises it to 1½ inches above the floor. The narrow space between the base of the jar and the floor allows the air to enter, which causes a current of smoke to ascend with remarkable regularity and force. When the fire commences to burn strongly, several handfuls of nuts are put on, then

* 72 cups say three-fourths full, would give about 3½ pints of milk.—*A Ceylon Planter.*

some more wood and nuts alternately. These are dropped in at the mouth of the jar until it is filled to within four inches of the top. Due care is taken that a sufficient proportion of wood is put in with the nuts. The mould on which the rubber is prepared resembles the paddle of a canoe ; in fact, at many places on the Amazon this is the article most frequently used if there is much milk, and when the rubber is prepared in bulky masses. Occasionally the mould is slung to the roof, as the weight in handling it during the process would otherwise be very fatiguing. A little soft clay is rubbed over it to prevent the rubber from adhering, and it is afterwards well warmed in the smoke. The operator holds the mould with one hand, while with the other he takes a small cup and pours two or three cups of milk over it. He turns it on edge for a few moments above the dish until the drops fall, then quickly places the flat side two inches above the jar mouth, and moves it swiftly round as if describing the form of a cipher, with his hand, so that the current of smoke may be equally distributed. The opposite side of the mould is treated in the same way. The coating of milk on the mould on being held over the smoke immediately assumes a yellowish tinge, and although it appears to be firm on being touched, is yet found to be soft and juicy, like newly curdled cheese, and sweating water profusely. When layer after layer has been repeated, and the mass is of sufficient thickness, it is laid down on a board to solidify, and in the morning is cut open along the edge on one side and the mould taken out. Biscuit rubber, when fresh, is often four or five inches thick. On being hung up to dry for a few days, it is sent to market. When I saw the process of smoking the rubber performed, as just described, I was considering the statements of Keller, and other travellers who write on this subject, all of whom seem to believe that the smoke from the palm nuts possesses some peculiar or strange property by which means the milk instantly coagulates. But on one occasion, when the collector was commencing to smoke some milk, I saw him wait for a short time, during which he put his hand repeatedly to the mouth of the jar, and soon learned that he could do nothing until the smoke was hot. The dense white smoke rose abundantly, but the milk would not thicken on the mould. After a little while the jar became heated, and the operation went on quite satisfactorily. I put my hand above the mouth of the jar, but could not bear the heat scarcely a second, and although the temperature of the smoke was apparently less than boiling water, yet I judged it must have been at least 180° Fahrenheit. Therefore the rapid coagulation of the milk is simply produced by the high temperature of the smoke. I have to doubt that with a strong current of heated air, or a good pressure of steam from a pipe, a similar result would be obtained. The finely divided particles of soot which forms a large proportion of the smoke undoubtedly absorbs a considerable amount of moisture, although at the same time it must be looked on as an impurity. I have no hesitation in giving my opinion that equally as good rubber could be prepared by putting the milk in shallow vessels, and evaporating the watery particles by the heat of boiling water.*

Temperatures of the Para Rubber district.—The region of the Para rubber tree has a sustained high temperature, a fact which has already been remarked by Dr. Spruce and other travellers. The lowest I could record was 73°, but Mr. Handerson assured me he had frequently seen it down to 72°, and I have the statements of another observer, on whom I could rely, that on one occasion the thermometer fell to 65.° The place, however, where this observation was made was fully 100 miles to the westward of Para. In the neighbourhood rubber trees abounded.

Sites, propagation and planting in India.—The sites most suitable for the planting of this tree will be found in the hottest parts of India. The flat, low lying, moist tracts, lands subject to inundation, shallow lagoons, water holes, and all descriptions of mud accumulations, miry swamps, and banks of sluggish streams and rivers, will be found best

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* A most tedious operation and one which will most assuredly be improved upon when the Para rubber is extensively cultivated in Ceylon.—*A Ceylon Planter.*

adapted. The tree will also grow perfectly in deep humid land, fitted for cane or coffee planting. The Malay peninsula, Burmah, the island of Ceylon, and the southern portion of India on to about as far north as 20° north latitude, should possess many localities proper.

The temperature of rain-water varied from 74° to 75° for planting. But in no place would I recommend the formation of a plantation where the thermometer at any time falls below 60° Fahrenheit.

It seems to me that the propagation and planting may generally be combined in one operation, the object being to reduce the expense, simplify and accelerate the work, and promote the more perfect development of the primary roots and trunk. The green coloured terminal shoots of succulent growth, with the leaves fully matured, make the best cuttings. These should be cut off low enough, so that there is a joint at the base. When it is desirable to plant in dry firm land, a spadeful of soil should be turned over at each place, and the cutting planted in a sloping position. It should be covered with mould to within three inches of the point. That portion above ground should rest on the earth on one side to its termination, so as not to suffer during hot sunshine. In all stages the crowns of the plants may be exposed to the rays of the sun. Plants intended for cutting stocks may be planted in open places, in the richest dark loam capable of producing a luxuriant rank crop of sugar cane. Seeds might be planted out permanently at once, also in the same way as the cuttings. These would prosper much better if at the time of planting a handful of wood ashes were added to the soil with each seed. Good ashes may be obtained by the burning of any description of green wood or newly felled piece of forest. If the wood is allowed to rot before burning, almost the whole of the fertilizing principle will be found to have vanished. If stored in a damp place the value of the product is diminished. 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. I would not advocate, at least for the present, the extensive planting of this tree in fertile cane-producing lands, because in such a description of soil it would not be able to complete with the Central American rubber tree, already introduced from the State of Panama, which grows rapidly to a much greater size, and yields a far larger quantity of caoutchouc. It should rather be planted in places where nothing else could be profitably cultivated, such as frequently inundated river margins, marsh land, and mud deposits. Above 4,000 tons of Para rubber are exported annually.

BALSAM OF COPAIBA.

Search for plants of the tree yielding the Balsam of Copaiba Capivi, of Commerce.—I was recommended by Mr. Markham, just before leaving, to endeavour to obtain at Para some plants of this tree, which abounds in the forests of the Amazon valley. These balsam trees have a wide distribution, and are likewise found dispersed in the forests of Guiana and Venezuela, and in the wooded littoral districts of New Granada, especially in the States of Santa Martha, Carthagena, and Panama. In those regions different species of trees varying in size and yield, furnish balsam, but all are leguminous, and belong to the genus *copaifera*. The finest sort in commerce, called by the collectors white copaiba, is met with in the province of Para, and is shipped from Para and Maranham. Very large quantities are annually sent to the French market.

After protracted inquiry discovered that few people really knew the tree and I was beginning to think that I might not be able to obtain any knowledge of it, when fortunately I learned where a practical copaiba collector lived. Formerly the tree might be seen growing in places easy of access, but owing to the method of collection practised it is now comparatively rare. At present a collector must make a journey, occupying several weeks, in a canoe up some of the Amazon tributaries, or penetrate into the dense forest lying between the rivers, to find any considerable quantity of copaiba.

It cost me three successive journeys on foot, occupying three days, before I could arrange with the collector. He was drinking a supply of cane rum (*cachass*), and he would not go anywhere until it was finished. Few occupations are so perilous and fatiguing as that of the balsam collector. Exposed daily to the drenching rains in the depths of the forest, with often an insufficiency of food, bitten by large formidable ants, and tormented unceasingly by day and night by swarms of mosquitoes, his life is of a wretched description. When living under these conditions the smallest scratch from the underwood is apt to become a sore, and increase to the size of a florin in forty-eight hours. On the 17th of September I left with the lad, and joined the collector at the entrance to the forest. The path led through a dense lofty vegetation, the majority ot the trees being from 80 to 100 feet in height. The extremely fertile soil was of soft white sand, 20 feet or more in depth, covered by a thick surface layer of vegetable mould with which the sand was intermixed. Slight undulations were traversed, and three little running streams were crossed, none of which contained more than a mill of water. The land was everywhere quite mealy and dry, and was elevated at least 50 feet above the region of the *gapos* or tidal floods. Large black ants, some of which were nearly two inches in length, called by the natives *candela*, ran over the ground everywhere. The bite of this ant is quite as painful as the sting of a wasp in this country. After travelling several miles we came to a balsam tree of gigantic dimensions. The saplings had been cut down around it by a person who lived some distance away, and who consequently was considered the owner. The tree appeared to be 80 feet in height, with a clear trunk of 50 feet. On account of the great thickness of the trunk, and absence of branches, no one was able to climb it. The clearing away of the underwood admitting freely air and light had induced the tree to bear seed, which, however, was just beginning to ripen. Little perpendicular rents were observed in the bark of the trunk from eight inches to a foot in length. From some of these which had occurred quite recently a little balsam had exuded, and flowed down the trunk. A diligent search for plants was made, and one small seedling was found by the collector, which I rejected, as I doubted whether it was really a balsam plant. Without much loss of time we continued our journey along a narrow path lined with tall grass and shrubs. At mid-day we came to some copaiba trees, one of which had been tapped some years ago. It had a massive lofty trunk, and wide spreading crown, and must have borne many crops of seeds, but not one plant was to be met with. A further search beneath a number of other trees which were scattered about proved alike fruitless. The collector explained that the seeds on falling were immediately eaten up by an animal about the size of a rat. This fact fully accounted for the scarcity of seedlings. Everywhere underneath the trees a close network of little paths traversed the ground. We penetrated this day into the forest for a distance of 12 or 14 miles, and got neither plants nor seeds. I had a little fever afterwards for about a day, which, although mild, weakened me considerably. I felt that the daily exposure in the sun afterwards fed the symptoms which remained. On the 9th of October I took with me the lad, and returned to examine the copiaba tree in fruit already noticed. A number of capsules were found beneath it, but all were empty. The ground was thickly covered with the little paths of the animal which had devoured the seeds. Whilst engaged in searching about a gentle breeze of wind arose, which moving the branches, brought down a few seeds in the best possible condition. These were carefully gathered, and in all 18 seeds were collected. Each little pod contains only one seed, which is coated over with a white wax-like substance, possessing a delicious aroma. When this is removed the seed is found to be black, and about the size and form of a field bean. The time was at hand when I purposed to leave with the rubber plants, so as to get to England before the cold weather set in, but I resolved, if possible, to see the method of tapping the trees actually performed. This operation has not yet been accurately described by any traveller and no scientific work or class book in the English language gives a correct account of the process, for which reason I take the liberty of recording my observations.

Early in the morning of the 13 October, I proceeded to the forest, accompanied by the lad and the copaiba collector. To each was assigned a fair travelling load, consisting of food or other necessities, but the most prominent object was a large tin capable of holding about 40 English pints, which the collector carried on his back. We travelled by a path to a point beyond the place reached on a former occasion, and then diverged into the forest, where there was no track of any kind. Entering on a district where the trees were of an amazing height, we in a short time came to a very large copaiba tree. This and a number of others, were previously known to the collector, who tapped one or two when convenient. I found he did not want the lad to see the largest of these trees, lest he might show them to others. On reaching the tree, he struck the trunk two or three blows with the handle of his axe, when a sort of hollow sound was produced. The grand symmetrical trunk was clear of branches to a height of at least 90 feet, above which the crown spread out flatly, the slender interlaced boughs, clothed with little pinnate foliage, forming an agreeable shade from the rays of the sun. The circumference at 3 feet from the ground was 7 feet 2 in. Several old fissures in the bark were observable, and one, which had occurred quite recently, was nearly 5 feet in length. Very little balsam had exuded. These rents are reported to be occasioned by the accumulation of oil in the tree, and that when they happen a loud report is heard.

The person who successfully taps a copaiba tree must be a skilful axeman. A chamber or cavity is cut in the trunk, not much broader than the axe, but sufficient to allow the workman to vary the course to the heart of the tree in such a way that he may not miss what is termed the "vein" or channel, usually met with near the centre, from which the balsam flows. The base or floor of the chamber must be carefully and neatly cut with a gentle upward slope, and it should also decline to one side, so that the balsam on issuing may run in a body until it reaches the outer edge. Below the chamber a pointed piece of bark is cut and raised, which, enveloped with a leaf, serves as a spout for conveying the balsam from the tree to the tin.

The collector commenced the work by hewing out with his axe a hole or chamber in the trunk about a foot square, at a height of two feet from the ground. The wood at first was white to a depth of four or five inches, when it changed to a purplish red, very much resembling a piece of old oak taken from a peat moss or bog. The whole of the interior of the tree is of this colour. When the centre appeared to be reached I was about to remark that there was no balsam, when suddenly the collector laid down his axe and called hastily for the tin. The balsam now came flowing in a moderate sized cool current, full of hundreds of little white bubbles possessing a pearly transparency. At times the flow stopped for several minutes, when a singular gurgling noise was heard, after which followed a rush of balsam. When coming most abundantly a pint jug would have been filled in the space of one minute. Owing to the diminished light consequent on the thick masses of foliage overhead, I could not distinguish the "vein" in the heart of the tree, but I observed a number of fissures that appeared to radiate from the centre outwards. Whilst making these observations I was surprised to see that the whole of the wood cut through by the axeman was bedewed with drops of balsam, and so also were the ends of the chips. This remarkable and important fact shows that every atom of wood in the tree contains a certain amount of copaiba. The bark did not appear to possess a particle. In the course of an hour nearly one-fourth of the tin was filled. A little roof, thatched with leaves, was placed over it as rain began to fall heavily. We then returned home. The collector considered the tin would be filled, and proposed to return for it in a couple of days. Although balsam may be seen slowly dropping from a tapped trunk for a month after it has been operated on, the common practice is to allow a tree, if it be good, only two or three hours to drain, and then to proceed to another. Occasionally large trees are met with, which, when tapped, yield little balsam. The cause of this has not been ascertained. Trees of the largest size in good condition will sometimes yield four "potos," equal to 84 English imperial pints. A collector, where trees are abundant, and with plenty of vessels, can, it is said, make at the rate of 5*l.* per day. Mr. Clough, an English missionary, in describing in a recent work* the method of collecting balsam, says that it " is obtained by making a gash in the bark of the tree, and plugging the space with cotton, to absorb the juice which exudes." I will venture to state that not a drop would be obtained by this process. Nor is the practice, as stated by some, of closing the cavity cut in the tree for a time with clay or wax, to allow the balsam to accumulate, ever resorted to. Even if tried it would not answer, for a number of reasons. Balsam, as it comes from the tree, has a powerful pungent fragrance, which is not particularly disagreeable, although on passing the doors of the houses where it is stored at Para and odour, by no means pleasant, is experienced. Possibly some change may take place in keeping. Little, if any, care seems to be taken to preserve the commodity pure. Those who go up the rivers to collect on a large scale take in their boats, all descriptions of jars and barrels which may have been imported with liquors, grease, or any kind of article. Paraffin cans are special favourites and so are much sought for. Most of those vessels, on being emptied, are stowed away in dusty places, uncorked and uncovered, thus affording free ingress to ants, spiders, and all classes of insects. It is urged by some that balsam precipitates all impurities, but even if this were so, a better system might be adopted. As some of the seeds brought home have germinated at Kew, I may add a few remarks regarding the cultivation in India, whither a few plants should be sent when strong enough for removal. I trust care may be taken at Kew to keep this sort separate from other species cultivated there, mostly natives of the West Indies, and which, although interesting in what may be termed a "botanical sense", are of no value for the production of copaiba. The temperature required is the same as that for the Para rubber tree, which at times is found growing beside it. Wet or marsh land must be avoided. The site should be of the best dry loam, suitable for cane or coffee planting. The stock for planting will have to be obtained from seeds ripened in India, so that, if a few plants can be transferred thither, they should be planted in good situations, where plenty of sunshine is admitted, in order that seed may be early produced. Seedlings may be planted tolerably thick, so as to shoot rapidly up when they can be thinned out to proper distances.

I would not recommend the planting of these trees on a large scale with a view to early profit, as the growth would be slower than Panama or Para rubber trees. The return would, I think, be realized in about the same time as is the case with oak plantations. However, a few hundred of copaiba trees growing on a planter's estate ought to enhance the value of it. Apart from the medicinal value of copaiba, it might be well to ascertain if it would not be equal to castor oil for lubricating machinery. The journeys relating to this work were among the most fatiguing I have experienced in these countries.

CEARA RUBBER.

Examination and Collection of Seeds and plants of Ceara India-rubber.—On the morning of the 26th, I went on shore, as I wished to gain some knowledge of the method adopted in preparation and collection of the rubber exported from Ceara. I had to land from the ship in a *jangada* which is a craft 12 or 14 feet in length, formed of moderately-sized trunks of a tree fastened together, and furnished with a mast and large sail. A piece of board a foot in breadth and four feet long is pushed down in the middle between two logs, to serve as

* "The Amazon: a Twelvemonth's Tour," by S. Clough

a keel. The tree selected for those rafts has a peculiarly light wood said to be brought from Bahia or Pernambuco. With a good fair wind they are said to run sometimes at the rate of 15 knots an hour. The surf is so strong that no boat or canoe could often reach the shore safely. Even the *jangadas* are sometimes overturned, and when this happens there is a risk of getting a blow from the timbers of the raft, a danger considered greater than the sea. In the town I saw a large quantity of rubber in a merchant's store, and afterwards observed that it was freely traded in by most classes of shopkeepers. I expected to have seen the tree yielding it somewhere near, but after travelling about over the sand-hills and adjoining country for the greater part of the day, I returned to the ship completely tired. I was assured by a native, who said he knew the Para Rubber tree and that of Ceara, that both were completely indentical. But the great diversity in the climate induced me to think differently, and so I resolved to follow out the dictates of my own judgment, and not be influenced by any one until I could satisfy myself on the matter. Yet there was little time to explore, as the steamer was expected to leave in a very few days. Next morning an Indian from the interior happened to come on board the ship, and I took the opportunity of asking him the names of some of the villages and localities in the retired districts. I knew from previous travelling a good number of the Indian substantives, with their meanings, and this, together with further conversation, enabled me to form some idea of the character of the region where the rubber was collected. A single line of rail, formed to facilitate the transport of sugar and cotton, runs from Ceara, into the interior to a place called Pacatuba, distant about 40 miles. Contiguous are a number of large plantations with some slaves. On Sunday, October 29th, I landed with the *jangada*, and proceeded through the town to the railway station. I had previously arranged with a native to accompany me, but he did not appear, so I went off alone. Leaving Ceara, a flat parched-up region was traversed diversified by a few undulations and moist hollows. Thorny thickets of bushes and slender trees, chiefly myrtles and legumes, overspread the country, with many groups of the carnauba-palm, *Copernicia cerifera*, rising high above the ordinary vegetation. The crowns of these palm trees waved about by the wind and visible over such a wide expanse presented an appearance extremely picturesque, whilst in the distance beyond rose a multitude of conical peaks and mountains, the whole combining to form a landscape of surpassing beauty. After a journey of two hours I stopped at a little village with about a dozen thatched houses, called Maracanahu. The distance may be 30 miles from Ceara. I went to a man and boy who were standing in front of a hut, and made some proposals to them to show me the locality where the rubber trees grew. The man was advising the boy to accompany me, who seemed rather reluctant, when a poor lad who had lost an arm came up and at once consented to go with me. It was fortunate I met with this one-armed lad, as I could hardly have succeeded so well with any one else. I told him I wanted first to see trees that were being wrought, because I wished to make sure of the tree, and also observe the method of collection. We proceeded along a dusty path for some distance, at times running, as I proposed if possible, to return with the train which passed the village in the evening. Plantation establishments were seen dispersed at wide intervals over the country. Cultivation was only carried on in very low moist situations, or where the water during the rains was stored up in artifical ponds for irrigation. Some of these were so large that at first I took them to be natural lakes. After travelling for some time the lad turned from the path and dived into the forest. In a few minutes he brought me among a number of rubber trees which had recently been bled. 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 the underwood, and there was an entire absence of ferns, mosses, and other plants. I soon saw that the tree was totally different from the rubber tree of Para, and also that it would probably thrive perfectly over a very wide extent of the drier regions of India. At first sight it much resembles in appearance a birch tree, and the surface or epidermis of the bark comes off in the same way in thin silvery peelings. The largest of the trees were about 50 feet in height, with trunks nine inches to a foot in diameter. The crown is divided into many branches, which grow in the form of a basket. The tree is deciduous, and there were neither leaves, flowers, nor fruit to be seen. I spent some time in examining attentively the process of bleeding the trees, and then commenced to search for plants. A few were found growing in an open space, but the roots were so firm that not one could be pulled up. It seemed strange that the lad and myself, exerting all our strength, could not pull up a young seedling plant about two feet high. I went and got a pointed branch of a hard wood tree, and scraped and dug about the roots, and in this way, with very arduous work, during which I hurt and lacerated my hands, some plants were got up. The real difficulty was now apparent. The roots of the plants were furnished with tubers, the largest of which were about the size of kidney potatoes. These tubers, although quite near the surface, adhered with such tenacity to the sandstone, or hard gravel, that most of them had to be smashed in order to get away an uninjured portion of root with the stem. In the young state they are soft and spongy, and are seen to contain milk, but afterwards become lengthened out, and form a part of the root. With diligent search and hard labour we succeeded in collecting 18 plants. At the station, a number of natives from Ceara gathered round the "bundle of sticks," but could not make out what they were. However, an old man from the forest district came up, and, peering through the crowd, said "Manisoba." This is the Indian name of the rubber tree which I knew before. I got back to Ceara just before dark, and fortunately found a *jangada*, which put me on board. Thus in one day, I was fortunately able to discover the origin of a tree, hitherto unknown and undescribed, yielding an important article of commerce, and at the same time resolved the mode of collection and preparation, and secured a number of plants. It is true I had no instructions regarding this Ceara rubber plant, probably because it was supposed to be the same as the Para tree. But I thought it would be well to secure more plants, and told the owner of the *jangada* to come for me in the morning. This sort of raft was expensive, each voyage cost me three *milreis* (6*s.*), and I could not possibly have got one for less. The distance was only about three hundred yards. Next day the sea was very rough, and three *jangadas*, one of which carried the Brazilian Government mails, were overturned in the surf. The person I arranged with came for me, and I embarked. Although I was not in the least alarmed, the size and violence of the waves completely surprised me, while the *jangada* at full speed went groaning through the surf, covered by nine inches or a foot of water. I cannot help wondering that not a farthing has been spent in improving the safety of these Brazilian ports.

Returning to Maracanahu, I proceeded to an adjacent house, where I was previously told I could stay. The son of the owner assisted me in obtaining a quantity of seeds, 700 in all. The pods when ripe burst and go to pieces, and so the seeds are showered on the ground. At daybreak next day we went in search of plants. We brought a strong iron hoe, as my intentions were to take up a good number, for I did not place much confidence in the seeds, although I am glad to state they have turned out well. Our course was directed to a more distant part than I had previously visited. Shortly after entering the bush-like forest we came on a large tract of land covered by immense masses of grey granite, some of which might be 50 tons or more in weight. These had been broken where they lay, and were the result of a volcanic explosion. Rounded masses of the same rock also cropped out in many places. Travelling now became very difficult, as we had occasionally to scramble from one block to another on our hands and knees. Many good sized rubber trees were growing in the spaces between those granite masses, but no plants were seen. The situation was very dry, but no doubt some seedlings had sprung up, which, owing to numerous thickets of shrubs were not perceived. After fully an hour of tiresome exploring I resolved to go back to the place where I got plants previously. We there succeeded in collecting a number, which, with those formerly gathered, amounted in all to 60. The handle of the hoe broke, for which reason the work was not further prosecuted. Taking with me the seeds and plants, I returned to the steamer in the afternoon.

System practised in Bleeding or Tapping the trees and Collecting the Rubber— This is an operation of a very simple description. On commencing to 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 tree 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.

Climate and Temperature.—The flat country from Ceara, running back to the mountains, in which the tree abounds, manifestly possesses a very dry arid climate for a considerable part of the year. This is evident from the fact that mandioca 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° Fahrenheit, but inland it is often propably 90°.

The localities traversed by me nowhere seemed to be elevated more than 200 feet above the sea. The situations selected for cultivation in India should possess a rather dry and sustained high temperature. In the comparatively low lying coast country of the southern portion of the peninsula of India including the districts of Madras, Cochin, Calicut, Cannanore, Mangalore, and Bombay will be found many localities possessing all the conditions essential for the growth of Ceará rubber. The plant might likewise be tried in the deep tropical valleys of Assam, and, indeed, in all the parched regions of India within the limits of coffee planting. It may not be safe, at least until some experience is gained, to plant in any locality where the temperature at any time of the year falls below 50° Fahrenheit.

Propagation and Planting.—Seeds are early produced if the tree is not shaded. They should be buried in brown sand, kept pretty moist until there are indications of growth, when they may be planted out permanently. In some situations where the ground is rough and strong they might be sown broadcast. Meantime I would suggest 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. Dry hard 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 cuttings might be laid down flat, and a little heap of stones or any kind of *debris* about the size of a mole hill, 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 wher-

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* Propagating the Ceara by cuttings has been found more difficult than was anticipated. Seeds germinate readily if properly prepared.—*A Ceylon Planter.*

ever there is any sort of stunted tree or scrub vegetation, with an occasional sprinkling from a monsoon shower, the tree is likely to prosper. Ceará rubber occupies a good position in the market. The export has been stated to amount to 1,000 tons per annum.

Specimens of India-rubber.—I have forwarded to Mr. Markham the following samples of caoutchouc, No. 1, prepared as follows:—An imperial pint of rubber milk was put into a tin can previously blackened, and exposed for fully two hours to the sun during the hottest part of the day. The lid of the can was put down close. The temperature obtained exceeded 120°, but only about the half of the milk coagulated. The mass was pressed when a whey-like juice came from it freely. It was then put to dry. No. 2 formed the remaining portion of the milk. It was put into a shallow tin vessel, and evaporated at 212°. Every drop of the milk coagulated. The entire produce of the pint was found to weigh 10 ounces. This yield exceeds any calculation I have seen on the subject, but I did everything correctly. In the process followed with No. 1, it was probably the richest portion of the milk that thickened, as may happen in the same way with various principles obtained from vegetable structure.

Nos. 3 and 4 comprise a "biscuit" and half a biscuit of rubber prepared by the smoking process as already described. These and the previous preparations are from trees whence the plants were obtained yielding the white variety. It abounds chiefly in the lower districts of Amazon Valley.

No. 5. A choice sample of seasoned rubber kindly selected for me by Her Britannic Majesty's Consul. Mr. Green.

No. 6. This is a black sort of rubber, and in appearance agrees perfectly with a species described by Dr. Spruce, which he saw wrought on a tributary of the Upper Amazon. Some Para merchants say that it is not so elastic as the white variety.

No. 7. The best kind of "negrohead" or *sernamby*, resulting from detached portions and droppings during the smoking operation.

No. 8. "Negrohead," or *sernamby*, being the gatherings from tapping cups.

No. 9. A small piece of Para rubber, prepared by the German method with alum. A few grains of finely-powdered alum was thrown into a little milk and stirred, when it coagulated in less than a minute.

No. 10. "Mangaba" rubber, obtained from a shrub (*Hancornia* species) growing along the southern coast of Brazil.

German merchants have taught the natives to prepare it with alum. It brings a low price in the market.

No. 11. Ceara rubber of commerce now being introduced into India.*

Observations relating to the Rubber-producing Tree of Central America.—I will now add a few remarks concerning this tree, which I collected in the interior of the Isthmus of Panama towards the latter end of 1875. This, because I think it has not received the attention it deserves. There are now a good collection of plants at Kew, and I am surprised that more have not been sent to India.

The tree inhabits wooded regions near Guayaquil and Buenaventura, and has likewise been met with abundantly in the State of Panama, and in the Republics of Costa Rica, Nicaragua, Honduras, Guatemala and Mexico. It is one of the largest and most massive of the trees of western tropical America. The trunk often attains to a surprising thickness and height, yielding in some instances above a hundred pounds of India-rubber. The wood exremely soft, and when cut into decays rapidly. The destructive method of cutting down the tree to be tapped has exhausted extensive rubber localities, and although others may be opened up, yet the supply is certain to diminish at no distant date. Even where the trees are not felled, as in Nicaragua, the method of tapping, by which the wood is injured, is so unskilful that it has been considered by some as preferable to cut the tree down at once. The climate of various of those rubber districts is hostile and severe, and

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* Of the several samples of rubber brought out by myself from England the Para was priced the highest being 3s 4d per lb.—*A Ceylon Planter.*

some places, such as the forest regions of Buenaventura and Choco, have no parallel in the universe. Throughout the State of Panama drenching rains are almost of daily occurrences and occasionally on the Atlantic side hurricane blasts make avenues in the forest.

The district investigated by me, and where the plants were collected, was reached by ascending for some distance the River Chagres, and then travelling for several miles through a stately forest into the heart of the isthmus. The trees seen exceeded in height and dimensions those met with in the wooded districts of the Amazon. An undergrowth of a thorny wild pine-apple (*Bromelia*), 10 feet in height, everywhere formed extensive thickets. Large powerful snakes were numerous, and so audacious that they deliberately rose up to strike at any one that approached. The young rubber saplings were found growing most abundantly on the banks of cool clear running streams and little dribbling rivulets. The roots could easily be traced over the surface of the ground running down to the very margin of the water. But the tree grew also on eminences, steep declivities, and varied elevations, and in such abundance that the first explorers gave the name "Caoutchouc Hill" to a height which they found crowned with a forest almost entirely composed of rubber trees. It was not seen growing anywhere on swamp or marsh land. Although the rubber districts are proverbially rainy, yet the tree was seen by me growing beside a stream on the border of a desert tract of country bounding the Gulf of Guayaquil, where only a few light showers of rain fell during the year. On both sides of the stream there was a strip of good forest, but beyond thickets of cacteæ and low spreading legumes formed the characteristic vegetation. I mention this fact to show that the tree will probably succeed well in regularly irrigated districts, even if the atmosphere be dry and dusty. The temperature in the woods of the isthmus ranged from 75° to 88° Fahrenheit. Rain water, examined the moment it fell, was never found to be below 74°. The usual practice in collecting the milk was by felling the tree, and then making deep notches around the trunk at distances not exceeding one foot apart. Broad leaves were placed beneath these to receive the milk, which afterwards was collected in a large calabash or other vessel. A hole was then dug in the ground, and the milk poured into it and thatched over with leaves. It coagulated in about two weeks. Another method was, to bruise a handful of the large broad heart-shaped leaves of a climber—a species of *ipomea*, and stir these about in the milk. By this operation the milk thickened in less than an hour, having the appearance of a jelly-like mass, but very porous, and exuding profusely a black ink-like water whenever touched or moved. This system of preparation produces an inferior article, and I have seen some buyers from the United States cut up the large juicy flakes into slices an inch or so in thickness, and dry them in the sun. The temperature of the sea-water along the west coast, where the rubber tree grows, is high, and does not vary much during the year. In the Gulf of Guayaquil it is usually 78°, at Buenaventura 80°, and in the Bay of Panama 79°. The water of the River Chagres, although 80° in fine weather, falls during violent rains to 76°. On such occasions many fish are to seen in certain places floating about in the water as if benumbed or dying. I do not know if this is the result of the sudden lowering of the temperature, or if it is to be attributed to the great quantity of decayed vegetable matter brought down by the discoloured swollen torrents from the interior of the forests.

In India there are many districts which possess all the climatic conditions necessary for the successful cultivation of Central American rubber. From Bombay southward the majority of the deep debouches of the Ghauts coming from the base of the western slope of the Malabar hills, including the humid forest region extending in places down towards the coast, contain many excellent sites. In Ceylon and Southern Burmah, and the Malay peninsula, the tree is likely to thrive in all proper situations. Calicut is about in the same latitude as the centre of the region occupied by this rubber tree in its wild state. The deep recesses of the Sispara Ghaut really closely resemble some of the caoutchouc districts adjoining the River Dagua. The sites selected ought to be at low elevations, and no place should be tried where the temperature at any time during the year falls below 60° Fahrenheit. Marsh land must be avoided. In dry desert localities the tree may be expected to do well when planted along the banks of canals, or any description of channels where water is flowing for the whole or a portion of the day. Trees in good situations will produce seeds early, but these will require to be planted without delay, as drying destroys their vitality. But cuttings must be resorted to first, and stout branches, cut into pieces each possessing a bud, and covered lightly with soil, will generally be found to grow. Strong cuttings a foot in length and furnished with buds, when planted in the usual way, will become strong plants sooner. However, the propagation of this tree will not be found so easy as the Ceara rubber.

In the planting out of young plants, the petiole or leaf stalk of the lowest or oldest leaf should be buried in the soil. By following this simple rule the plant commences to grow at once, its growth is vigorous and the trunk symmetrical. But if at the period of planting there is much bare stem above ground, then growth is usually slow, the plant remains "leggy" for some time afterwards, and never makes a good tree. If the plants get a little attention until they are four or five feet in height, I do not think there is any description of weed or forest growth in India that will afterwards overtop them. The rapid growth of this tree, by which a large amount of vegetable mould is added to the soil, is an important feature. My own opinion is, that if planted in suitable places and properly wrought, it will be found to yield a larger return per acre than any other plant or tree cultivated in India.

Concluding Remarks.—In commencing the cultivation of these trees in India, it may be well to ascertain by actual experiment as early as possible the species likely to yield the largest amount of caoutchouc. It is possible that as regards quality there may be little, if any, difference in the milk of the various kinds when collected and prepared in the same way. *

As has been already stated, each of the three sorts require rather different sites, a wet or swamp situation being most natural to the Para tree, while the moist banks of rippling streams or rivulets will be found well suited for the species from Panama. The Ceara tree is not delicate and will grow and produce rubber in situations where other kinds if planted would be dried up. For these reason, it is likely to prove a valuable plant in India in parched-up regions and stony unproductive lands thinly covered with soil. The cup method, if employed in an extended way, may be found a convenient mode of tapping. Thus 20 rows of cups distributed over the entire trunk might be put on at one time. The earth could also be cleared away from underneath the large roots to allow of their being properly tapped. Even by the rude method adopted in South America, by which the wood is much hacked, the roots are found to yield milk abundantly at all seasons of excellent quality. But whatever method is adopted, it is evident that if care is exercised tapping may be carried on continually. The Para tree in many localities gets no rest, except during a very "wet moon," or when the collectors are drinking *cachass.* Therefore the idea of giving the trees one or two years' rest ought not to be entertained. The Ceará method of paring off the surface of the bark might be tried on any of the sorts in dry weather. Para and Panama trees may be tapped on attaining a diameter of say 6 or 8 inches, and that of Ceará with a diameter of 4 to 5 inches. A collector in a plantation working with cups should be able to collect easily from 8 to 10 pounds of rubber per day. On the Amazon, in newly opened districts, where the trees have not been operated on before, practised hands are sometimes able to collect from 20 to 30 pounds daily. A much greater quantity may be collected in even a shorter time on the Isthmus of Panama and adjacent regions, but then the trees are cut down to obtain the milk, a plan which it is assumed will not be followed in India. The cup process of tapping, the most general in use in the Amazon valley, is an Indian method, and is said to have been in use amongst them at the time America was discovered.

* This is the point on which information is most wanted.—*A Ceylon Planter.*

No time should be lost in reducing the milk, when collected, to a solid state, for if this matter is delayed, decomposition takes place, which furnishes much of the impurity complained of by manufacturers. If possible the milk should be coagulated on the day it is collected. The milk of some species, such as that of the Panama rubber tree, may keep for a week or more in a cool shady place, but Para-rubber-milk spoils within the space of twenty hours, and gives off a most disagreeable odour. All the Para rubber is prepared by the smoking method I have described. Where nuts cannot be easily found green foliage is used instead. The "fumes of sulphur," "ammonia," or "acetic acid" are never employed. Alum is generally used in thickening the "mangaba" milk in the south of Brazil, but it appears to destroy the elasticity of the rubber. The watery portion may be evaporated by placing the milk, in small quantities at a time, in shallow vessels attached to any simple form of hot-water apparatus. Either this or the adoption of a smoking method similar to that of Para will probably be found the best. The material should be prepared in thin flakes about $1\frac{1}{2}$ inches in thickness. Those pieces, if made square in the form of a bale, could be fastened together and covered with coarse cloth. In this way rubber would be both easily handled and stowed.

The milk of *Messeranduba* (*Lucuma procera*), and of one or two milk yielding trees of the Amazon districts reported to be mixed frequently with Para rubber possesses no elasticity when prepared separately.

The island of Borneo has been suggested to me as a place specially suited for the formation of India-rubber plantations. No doubt they would grow there as well as in India, but probably not any better. Although the position in point of latitude may appear in favour of Borneo as regards the Para tree, I doubt if the climatic conditions of that island excel in any particular the southern portion of the Madras Presidency at low elevations. It must be remembered that what is termed by some the "equator of heat" is considerably to the north of our geographical equator. On the American continent it may, I think, be placed at not less than ten degrees of north latitude. In the dense forest regions of the Amazon and Panama Isthmus, the most striking feature in the extraordinary development of certain trees, occupying large space of ground, chiefly *ficus* and *bombax*, mantled by a dense profusion of leafy climbers, the trunks and branches clothed with parasitical plants. In India, as for instance in the best forest portions of the Sispara Ghaut, there are no conspicuous large trees with buttressed roots, but there is a far more even development of general forest trees, and I have no doubt if an acre of such land was cleared, and the wood thereof weighed, it would be found to equal if not exceed the product of a similar extent of ground in the wooded districts of tropical America. Apart, however, there remains a more positive proof of the capabilities possessed by the climate of Southern India. The coconut and mango trees can only be cultivated in the hottest regions of the tropics. Now I have visited places where these trees were planted by the natives, such as Jamaica, Hayti, St. Domingo, Porto Rico, Santa Martha, Carthagena, Panama, Buenaventura, Jumaco, Bahia, Esmeraldas, Guayaquil, and Para, but nowhere was the fruit superior, nor hardly so large as the mangoes or the coconuts of the Malabar coast. For these and other reasons I have confidence that there exist the necessary conditions for the successful cultivation of the American rubber-yielding trees in many parts of India.

In conclusion, I trust the way in which I have performed these services may be considered satisfactory.

I am, Sir,

Your most obedient servant,

ROBERT CROSS.

THE AMERICAN INDIA-RUBBER TREES AT NILAMBUR.

Letter from R. Cross, Esq., to the Conservator of Forests, Madras, dated Ootacamund the 6th, March 1881.

(From the *Indian Forester*, October 1881.)

Respecting my previously-arranged journey to visit the sites proposed for the cultivation of the various species of American India-rubber trees, I beg to state that I proceeded on this duty on February 15th, and arrived at the bungalow at Nilambur on the evening of the 17th. The course pursued was by Naduvatam, Gudalur, and Nadgame, descending afterwards by the Carcoor Ghat to the plain land below.

On the following day, accompanied by Mr. Ferguson and Mr. Hadfield, his successor, I visited the site of the newly-introduced rubber plants. These have been planted in an open space of teak forest-land on the bank of the Nilambur river.

The first sort examined was that which furnishes the rubber known in the market as "Ceara scrap." The tree belongs to the Mandioca family, and the roots are furnished usually with tubers, which vary in size and number in accordance with its growth. The plants of this sort have, in the brief space of two years, shot up in the most surprising manner the highest upwards of 30 feet in height, and are now yielding an abundant crop of seeds. I was shown one strong rank sapling, which, in five months from the time of planting, had grown up and produced flower.

This region is without doubt, admirably adapted for the growth of the tree; and the robust and vigorous appearance of those already planted is certainly quite equal to any trees of the same apparent age and size I saw when engaged in collecting the original plants near Ceara on the coast of Brazil. At the same time I would confine the general planting of the Ceara rubber to rather dry, arid situations and poor soils, reserving the good, deep, moist sandy loam of the Nilambur river and its tributaries for the *Castilloa*.

Mr. Ferguson was desirous of proof of the actual existence of rubber in his Ceara saplings; and, although these were too young to yield this product, I resolved to make an attempt to satisfy him. The natives at Ceara, in bleeding this sort, simply slice off the outer portion of the bark on one side of the tree from the base to a height of four or five feet. The milk exude from the pared portions of the trunk and runs down in little courses. By the following morning the milky juice of these courses is sufficiently solidified to be pulled from the tree in strings, which are rolled up into balls as the work of collection proceeds.

When this process was tried on one tree the milk exuded freely, but next day on examination it was found that the greater portion had evaporated, showing the watery and immature state in which the milk exists in young growing plants. However, on making incisions on the collar and largest roots of the plants milk of good quality was obtained, which next day was found coagulated. From the collar of five saplings about an ounce of rubber was obtained, which in appearance, elasticity and odour, could not have been distinguished from "Ceara scrap" as seen in commerce. But it is manifest the trees ought to be allowed to attain some size before being wrought.

The propagation of this sort is as easy as a willow. I made a few cuttings just to show the proper method, and these were planted near the bungalow. But now that the trees are producing seeds, recourse to cuttings may not often be necessary. Each seed before sowing should have a small portion of the outer shell broken off by a pair of pincers, simply to allow the moisture to reach the embryo, which in the operation should not be injured or by merely burying the seeds in moist sand germination will take place much earlier.

The Para Rubber.—This rubber tree, which yields a valuable commercial product, has seemingly not found its proper habitat at Nilambur. The young plants have shot up like long whip-handles with a bunch of leaves on the top. There is not, however the slightest reason to despair of success. Some plants, say a dozen, should be planted in the Carcoor Ghat at an elevation of 1,000 feet, and another dozen might be put down at 2,000 feet or, for example, somewhere in the vicinity of "Campbell's Rock." A little clear site at each place a few yards in extent and easily reached from the road would suffice for these experiments. The Para tree is easily multiplied, and recourse may be had to the same way as that adopted for willows. I made some cuttings, which were planted in a moist situation on the river bank. From these it may be seen whether additional humidity improves the character of the plant.

Central American Rubber.—The *Castilloa elastica*, yielding this description of rubber, and of which there are only three plants, has evidently found a home on the bank of the Nilambur river. It may be considered premature to judge or form an opinion from the appearance of only three plants, from three to four feet in height, and indeed this is so. But besides having looked carefully and attentively at the physical appearance and development of these plants, I have considered and remembered the characteristics of the extensive region inhabited by this tree. The *Castilloa* is found growing throughout the Central American Republics always at low elevation, and certainly I do not think I noticed it anywhere above an elevation of 2,000 feet. North of the Equator, it is met within the wooded districts, which bound Jembico in Mexico, extending southward through the dense exuberant forest-regions of the Central American Republics and stretching across from the Atlantic to the Pacific on as far as the river Atrato, after which it is confined to the forests and base of the mountain ravines bordering on the Pacific coast, and thus continues to Santa Rosa and Arenillas near Tumbex districts, which lie adjacent to the Peruvian desert. Throughout this vast expanse of country there is, without doubt, considerable variation of climate. But it so happens that the periods representing the wet and dry seasons coincide in a remarkable manner, at least as far as I can learn, with the occurrence of the same periods in the Western Ghats. In the region of the *Castilloa*, especially on the Pacific side, the dry season sets in about the beginning of January and continues until April. During this time the rank swamp growth is occasionally so dry that it is set on fire and burned. In the dry season the tree becomes deciduous, and in March pushes forth a fig-shaped fruit, which ripens with a beautiful scarlet crown, all the rest remaining green. In August the fruit is ripe during the heavy rains. The seeds cannot be dried, and must be planted as soon as the fruit falls. It is not found growing on swamps or inundated land, but on the flat moist banks, of rivers and steep sides of ravines, where the roots may be seen running down the banks, for a distance of 15 or 20 feet to the very margin of the streams.

The *Castilloa* is the largest known rubber-producing tree, its massive trunk sometimes rising in close humid spots to a height of 80 feet clear of branches, and is only exceeded by the "Quipo," a gigantic species of *Bombax*. Sometimes the trunk divides into two stems, evidently from the leading bud having been broken when young, and those trees are less prized by the rubber collectors. In order to extract the milk, the usual course is to cut the tree down and make notches round the trunk at about a foot apart. Broad leaves or calabashes are then placed underneath these into which the milk drops. In a few localities, especially at Nicaragua, the trees are not felled. The practise is to make a perpendicular channel in the bark from the base of the trunk upwards, and then make a number of cuts on each side leading into the main channel. A good deal of milk always adheres and solidifies in the primary and side channels, which is afterwards collected. These "dregs" are much valued in the markets of the United States. I have heard it argued among the natives that it was probably more profitable to cut the tree down than trust to the bleeding channel process. My own opinion is, that the channel method is good, specially for the *Castilloa*, but the collectors gash the trees so badly in working that the after-flow of milk is much lessened. Besides, at the base of the main channel, they drive an iron spout into the trunk in order to convey the milk from the tree to the calabash. A piece of bamboo, luted by means of clay to the base of the channel, would serve the same purpose just as well, whilst the wood of the tree would escape permanent injury. In combination with the channel process, collecting by the cup method will often be found useful, especially in the case of large trees, as cups can be applied to various parts of the tree, which, if operated on by channels, would result in the loss of much milk. I have described the cup process in my Report to the India Office on the collecting of Para rubber plants with date of 1877. Respecting the quantity of rubber which may be obtained from a tree, the amount would depend on the age and size of the tree, season, habitat, and likewise mode of collecting.

During the rainy season the flow of milk is greater, and this also is the case with the trees growing in humid localities. The skill and care of the collector must also be taken into account; some spill and waste a great deal of milk.

A *Castilloa* tree, if carefully and judiciously tapped with a diameter of 1½ to 2 feet, may be expected to yield about 12 pounds of rubber per annum.

Of all the different species of rubber-producing trees, the *Castilloa* should prove under cultivation the most remunerative. The banks of the Nilambur river and its tributaries afford, in my opinion, suitable sites for planting; and I have no hesitation in stating that the lower portions of the Carcoor Ghat would grow and sustain as fine *Castilloa* trees as any district of Central or South America. The conditions on the bottom and deep side ravines of the Carcoor Ghat are of the most superb description. But no doubt many excellent sites exist along the course of the Western Ghats southwards towards Sispara, and likewise to the northward in the Nagar region. In planting, the land should be cleared so that the trees may grow up robust, but there will be little mamatie work; for, once the *Castilloa* gets up it will overtop the majority of the Ghat trees.

The propagation of this sort from a limited stock will require more skill than would be necessary for multiplying the Ceara or Para rubbers.

As yet that plant at Nilambur presents few materials for propagation, though, as the growth of the tree is rapid, a supply of cutting shoots will probably be available after the burst of the monsoon. By erecting a small platform, we were able to lay a branch with seven shoots, so that when these are rooted the stock will be at once fully doubled. I would certainly advocate the multiplication by cuttings of the *Castilloa* as it is not an early seeder. In America the trees do not usually bear seed until they are about eight years old. Before the lapse of such a period, thousands of *Castilloa* plants might be grown up into young trees at Nilambur, derived by means of propagation. I regret to state that time did not permit me to visit the Silent Valley as a special site for the *Catilloa*. I have no doubt, however, that it will be found well suited for the growth of the tree.

I returned to this place on the 25th of February.

In conclusion, I trust the way in which this duty has been performed will meet with approval.

(Copy of a despatch from the Secretary of State for India to the Government of Madras, No. 21, dated 21st July 1881.)

I learn with satisfaction from the copies of the Proceedings of Government which accompanied Your Excellency's letter No. 6 of the 19th May last, that Mr. Robert Cross, who was deputed to visit the Cinchona Plantation on the Nilgiri hills and the American Rubber Plants at Nilambur, has been able to report favourably upon them. Well acquainted as he is with the habitat of both these plants in Southern and Central America, and their introduction into India being greatly due to his enterprise and ability, I attach importance to his opinion that Southern India is a perfect field for the cultivation of the various commercial products of tropical America, and that the banks, of the Nilambur river and other sites along the course of the Western Ghats as fitted as any district in Central or Southern America for the growth of the *Castilloa* trees, which, of all the different species of rubber-producing trees, should, he considers, prove the most remunerative.

2. I agree with your Excellency that Mr. Cross's reports are valuable additions to the information already recorded on the subjects with which they deal, and I approve of your action in retaining his services in India until such time as the *Calisaya de Santa Fe* plants may be considered sufficiently established and safe from all ordinary risks.

THE *PARA* INDIA-RUBBER TREE (*HEVEA BRAZILIENSIS*).

Inquiries have for some time past been set on foot, with a view to obtaining complete information regarding the production of indiarubber, and the great intrinsic superiority of the rubber from *Para* in Brazil (*Hevea Braziliensis*) over all other kinds has now been placed beyond doubt. The experimental cultivation of the *Para* tree has been tried in Bengal, but it has failed. It is feared that the plant will not find a congenial home in Bengal or in Assam, or in any part of Northern India. The *Para* tree is essentially a tropical plant requiring an equable moist climate without any distinct season of cold or hot weather. Endeavours have, however, been made with more success to acclimatise the *Hevea* in Tavoy, Mergui, in the Nicobars, and at the Botanical Gardens in Ceylon. The following note on the cultivation of the tree has been recorded by Mr. H. A. Wickham, and has been received in India through the office of the Secretary of State :—

"The introduction into India of the true *Para* India-rubber (*Hevea*) may be said to be now fairly inaugurated. If it is not a great success I think, without doubt, the fault will be that it has not been planted out in suitable localities. The India-rubber tree (*Hevea*) grows naturally throughout the Amazon valley, with the exception of certain localities. I found it very abundant high up, on the Orinoco above the junction of the Guaviare (the letter stream by right indeed should be styled the Orinoco). It is plentiful on the banks of the Cassiquiare, the curious bi-furcation of the Orinoco by wich it contributes water to the Rio Negro, and converts Guagana into an immense island. I do not know how far it may extend up the Maranon into Peru, never having been there. It is abundant and very fine about the cataracts of the Tapajos, and it was on this river that I obtained the seeds which produced the plants now to be despatched from Kew to India."

"I also found it growing in the interior between the Tapajos and Xingu. The rivers from which the largest supply is now brought by the traders are the Purus and the Madeira. In its native forests, it grows dispersed among the other forest trees, two or three trees rarely being found in juxtaposition. In appearance the *Hevea* are handsome trees, with straight cylindrical trunks. They differ wholly from theUle trees—the Central American Indi-rubber trees (*Castilloa*), which I had seen in Moskito and Nicaragua. The wood is soft and perishable. As in the great majority of tropical American trees, the bark is not very thick. It is of a grey colour on the surface, but when scraped (as has frequently to be done before it is possible to tap them in some of the moister districts owing to the thick growth of the moss, ferns and orchids on the bark) approaches in appearance and colour the coat of a light bay horse. Under the native mode of tapping, however, they soon present a warty, disfigured appearance. The seeds grow three together in a sort of hard pod ; this pod bursts when it is ripe and becomes heated by the sun, with a sharp popping sound, and scatters the seed for a considerable distance around the trees. I have been assured by an Englishman, long resident in the country as a trader, that an oil closely resembling linseed oil in its properties, can be extracted from the seed."

"It is worthy of notice that the tree casts its seed at the same time of the year both on the Orinoco and Amazon, although the wet and dry seasons are reversed in the two valleys. It would be interesting to note whether the seed continues to fall at the same time of year in its new home in India. The rainfall varies considerably in different districts where the *Heveas* are found. In some districts, the year is nicely divided into wet and dry seasons, each of about six months' duration, in others it rains more or less all the year round. In such districts it is more difficult to collect the *caoutchouc* profitably. If the stem of the tree be wet when it is tapped, the milk spreads over the surface of the bark and is lost. Again, if a shower should come on before the milk is collected from the cups, and it become mixed with water, it will not congeal and so is also lost. The range of temperature in the India-rubber country is from about 73 deg. to 88 deg. throughout the year, on the Lower Rio Nigro it increases in the afternoon to 100 deg."

"From what has been said, it may be seen that the main part of the rubber must be collected during the dry season, although the 'Ciringeros,' who live near their 'Cringals,' or India-rubber walks, improve their opportunity by tapping their trees whenever fine days occur during the rainy season. The 'Ciringero' occasionally give his trees a rest, but the trees are always tapped excessively. It is astonishing to what a degree they will stand tapping. I have seen large trees apparently none the worse, further than that they were somewhat disfigured by the gnarled appearance of their bark, the owner of which assured me he had tapped for twenty years successively, but then he tapped them himself, and had an interest in their preservation. These same trees scattered their fruit in abundance. An industry more in accordance with the character of the South American, it was difficult to find, the labour so small and so remunerative. I have myself collected 10lb. of rubber per day, tapping 70 or 80 trees of various size. An experienced Tapuyo Indian can collect much more. If such be the case in woods, where the trees are scattered and much time is necessarily lost in getting from one tree to another, what will be the profit of a well arranged plantation of these trees under good supervision? In the 'igapo,' or low lands of the rivers, flooded during the rise of the waters, there is a spurious kind of *Hevea*. It is called by the Natives '*Ciringa do igapo*' or 'Barigordo,' from its habit of growing with a bulged stem. The seeds of this species are much longer and larger than those of the true rubber. The milk appears to be worthless."

"When the native has discovered for himself a district in which 'Ciringa' trees are sufficiently numerous and near together, he first connects them together by cutting a "picado," or path, with his bushknife. Having thus discovered their relative bearing he next straightens and clears out his path, endeavouring at the same time to take in as many trees as possible in each path, and to make all the paths converge to a certain spot where he has put up his '*rancho*' or '*barraca*'. This done, and having collected a supply of the old nuts of the Inaja (*Meximiliano Regia*) or other palm trees, or of the outer shell of the Brazil nut, he is ready to commence operations on the first fine day. There is some diversity in the manner of taking the rubber milk on the Amazon. In some districts long strips are procured from the inner pith of the foot stalk of the leaf of the Inaja or the Bacaba palm. These are attached obliquely round the stem of the trees, with sharpened pieces made out of the hard covering of the same leaf stalks. This being smeared on the inside with wet clay serves to form a channel to collect and conduct the milk into the cup placed to receive it. In the other way, which I consider the better, three or four cuts about an inch long, are made in the back with a minute axe. The cups are put in a ring round the trunk, usually a span or more apart. In this way the number of cups is proportioned to the size of the tree."

"Tin cups are used. They are made slightly concave on one side in order to fit the convexity of the tree trunk. These are fastened to the tree with a piece of kneaded clay, of which the "Ciringero" carries a supply in his bag. The tapping always takes place as soon as there is light enough in the forest to see by. One man is apportioned to each path, say, containing 100 trees. When he has tapped and cupped his trees, he sits down at the end of the walk for half an hour or so. As soon as he perceives that the tree last tapped has ceased to drip the milk, he starts at a trot on the back track, detaching and emptying the cups into his *calabash* as quickly as possible. The cups he leaves up-side-down at the base of the trees. Speed throughout is a great object, as the milk speedily coagulates; than it can only be sold for an inferior price as "*sernambi.*" When the men arrive at the central hut from their different paths, they empty their milk into one of the large native earthenware pans. Care is taken to squeeze out with the hands all the already coagulated curd-like masses. These are thrown to one side to be made up into balls of "*sernambi.*" Earthen pots resembling miniature kilns are placed over small fires, and the "Ciringero" sits down to the really tedious part of the business. He drops a handful or so of the palm nuts down the narrow neck of his little kiln, and forthwith arises a dense smoke. He now takes his wooden mould, not unlike a *fives* bat in form, and holding it over the pan pours some of the milk over it, keeping it turned, so that it shall not run off before he succeeds in drying it in an even surface, as it soon does, while being passed backward and forward through the smoke. This is continued, one coating of milk after another, until he has finished the supply of milk for the day : he then sticks his mould up in the thatch for the repetition of the process next day, and until he is satisfied with the thickness of the "*burcuit.*" I believe very good rubber might be made by simply allowing the milk to congeal in moulds during the night of the day on which it has been tapped, if, on the following morning, it were placed under a very powerful press in order to expel the fluid contained in the cheese-like cells. When fresh, the milk has a very agreeable smell and taste, but it soon becomes putrid. The child of an Indian woman employed on my "*ciringal*" used to drink considerable quantities of the fresh milk. I suppose it was rendered harmless by becoming mixed with saliva, as it will not congeal if mixed with water. There are many trees in tropical America which produce milk from the bark yet more copiously than the *Hevea*. Who knows but that some day equally economic use may be made from some of them? With regard to the success of the introduction of the *Hevea* into India, much will, of course, depend on the nature of the soil on which they are planted. In Venezuela and Brazil I found the *Hevea* growing on two classes of country, the high clayey uplands embraced by the branching rivers, but still at considerable distances from them, and on the low alluvial lands immediately bordering on them."

From the far greater size and apparent age of the trees, I cannot but imagine that the original locality of the tree was in these uplands. The fact of their being so generally found on low lands bordering on the waters may be accounted for. The seeds are scattered widely when they burst; many of them fall into ravines and gullies, and are carried by the watercourses of the rainy season into the rivers, to be cast up by tide and windy squalls, and readily take root on the rich soil of the alluvial islands and shores of the back waters. In illustration of this, I have frequently seen a string of *Hevea* growing even on a beach backed by sandy lands, far from their proper localities. Although I know nothing personally about the climate of the East Indies, yet I imagine, from what I have read, that the Malay Peninsula is most likely to combine the climatic conditions required by the Indiarubber tree of the great Valley of South America."

"It is a mistake, naturally fallen into it by the travellers who have passed up and down the great waterways of South America, without having penetrated far into the interior high clay lands enclosed by them, to suppose the *Hevea* are confined to the low, often-flooded islands and margins of rivers. Growing on these clayey uplands, I met with the largest of these trees, rivalling in height and girth all but the very largest trees which grow in these parts. At the same time, perhaps, on rich alluvial lands, would be found the best localities for establishing plantations of these trees. Nor do I think it would prove a serious drawback, if they should be planted on lands which become annually flooded to the depth of a foot or so for a few weeks in the year. The land selected should, I think, be heavily timbered. The timber to be cut down some eight or nine weeks before the first rains are expected in order to give time to get a good burn over the ground. The ground also should be cleaned up sufficiently by piling and burning the logs; those remaining to be rolled on one side. The plants might be set out in walks, converging to a central point in order to facilitate the collecting of the milk. I would strongly advise that the *Hevea* should be planted alternately with *Cacao*; these low bushy trees, would shade and keep the ground moist, without interfering in the least with the *Hevea*, which would soon tower above them. This plan would also much increase the value of these plantations."

"Another thing I would recommend. The milk of these trees is yielded in much greater abundance near the ground, and when by some chance, an elbow of root is protruded above the ground, the flow of milk from it, on its being tapped, is very much greater than from any other part of the tree. Now would it not be possible to devise some method by which the roots might be induced to put up elbows above the surface of the ground? Great caution must be used in tapping the trees not to penetrate beyond the bark into the wood. Great numbers of trees are destroyed in this manner on the Amazon. As soon as the wood is injured, certain species of boring beetles attack the tree, and it soon dies. From what I have seen of these trees in their native country, where I have occasionally known them planted, and have made some experiments on their growth myself, I have ventured on the foregoing remarks, feeling at the same time satisfied that this will be found to be quite the best manner of forming a plantation on a large scale. If this plan were followed in a suitable locality on rich alluvial soil, the tapping of the young trees might commence gradually in from seven to ten years after planting out, and would soon become the source of great revenue."—*Indian Agriculturist.*

CAOUTCHOUC CULTIVATION IN BRITISH INDIA.

(*From Clements Markham's Peruvian Bark* pp. 441-466.)

In 1870 I came to the conclusion that it was necessary to do for the india-rubber or caoutchouc-yielding trees what had already been done with such happy results for the cinchona trees. The area of yield of caoutchouc is far more extensive than that of febrifuge alkaloids which only grow wild on the slopes of the Andes, and all belong to one genus. The caoutchouc-yielding trees are of several genera, and are found in the forests of India, the Eastern Archipelago, Africa, Madagascar, Mexico, and Nicaragua, as well as in South America. But the same danger threatens the one product as had threatened the other. Owing to the enormous demand for caoutchouc, the most reckless felling is now going on in all the tropical forests which yield this valuable product. The time has come when plantations must be formed of caoutchouc-yielding trees, in order to prevent their eventual destruction, and to provide for a permanent supply.

The increase in the demand for india-rubber is very remarkable, and the enormous number of uses to which this product is now put, renders the consideration of measures for its cultivation, and for securing the permanency of an edequate supply, a question of great moment. In 1830 only 464 cwt. of india-rubber were imported into this country. In 1840 the quantity had increased to 6,640 cwt. ; and in 1846 the duty on india-rubber of 1*s.* per cwt. was repealed. In 1857 the quantity had further increased to 22,000 cwt., and in 1874 there were 129,163 cwt. imported into this country, worth £1,326,605. In 1878 the quantity imported into England was 149,724 cwt., worth £1,313,209. Caoutchouc is now used for an infinite number of purposes. Wherever steam-power is employed either on shore or afloat, it is impossible to do without india-rubber : it is required as packing for the piston-rods and glands of the engines, valves for the pumps, washers for making joints, belting for driving the shafting, hose and tubing for conveying steam and water, buffer-spring for railway carriages, and many other such purposes too numerous to mention. When it is considered that every steam vessel afloat, every railway train, and every factory on shore employing steam-power, must of necessity use India-rubber, it is hardly possible to overrate the importance of securing a permanent supply, in connection with the industry of the world.

For purposes connected with telegraphy this product is also now extensively used. It is employed as the insulating material for submarine, subterranean, and aerial cables. In the hard form of ebonite it is employed for insulators to carry the iron wire along the posts, as well as for battery cells, for the electro-magnetic coils, and in many parts of telegraphic instruments in place of the more expensive article, ivory. India-rubber is also used for waterproof clothing, carriage aprons, fishing stockings, diving dresses, water and air beds and cushions, door mats, ground sheets in camping out, and tubing. India-rubber elastic thread is largely used in the form of webbing, by the Leicester, Derby, and Nottingham manufacturers. India-rubber is necessary, too, for life saving apparatus, for surgical instruments and appliances, and for hose, gas-tubing, and innumerable domestic purposes, including door-springs, and just now, a great many rings for the rinking skates. Ebonite—which is the form of India-rubber vulcanized hard by the addition of extra sulphur, so that it can be turned in a lathe and made into articles of any form or shape—is used very extensively for combs, photographic baths and trays, syringes, taps and tubing for aquaria, and in chemical works.

Such being the infinity of purposes which give rise to the demand, it will easily be understood how bravely the work of destruction is being carried on. In British India there is an indigenous caoutchouc-yielding tree, which should be brought under cultivation on the spot. But there are other kinds in other parts of the world, and it became necessary, in the first place, to ascertain whether they are superior to the caoutchouc in British India; for, if so, their introduction would needs be an essential part of any scheme for initiating the cultivation.

The caoutchouc-yielding trees grow in a zone on each side of the equator, encircling the globe, but by far the richest and best source of supply is in South America. It was M. de la Condamine, the leader of the expedition to measure an arc of the meridian near Quito, who first gave an accurate description of caoutchouc, and of the tree from which it is procured. The tree is the *Siphonia* or *Hevea*, which grows in all parts of the basin of the Amazon, and yields the Brazilian caoutchouc. This is the best and most abundant, and is known as Para india-rubber. The *Hevea* is a euphorbiaceous tree.

On the Western side of the equatorial region of South America, in Ecuador and Colombia on the isthmus of Panama, Central America, and Mexico, the india-rubber tree belongs to the *Castilloa* genus, so named after Don Juan del Castillo, a Spanish botanist, who died in Mexico in 1793. The native name of the tree in Mexico is *ule*. The *Castilloas* belong to the family of *Artocarpaceæ*, of which the breadfruit and jak tree, and the *anjeli* of India are members. It is worthy of note that the *Artocarpaceæ* are closely allied to the *Moraceæ*, the fig tribe, to which the caoutchouc trees of India belong. The *Heveas* and *Castilloas* are the india-rubber trees of the New World.

In India the *Ficus elastica*, a tree so named by Dr. Roxburgh in 1810, which yields caoutchouc, is found in the forests which border the valley of the Brahmaputra, in the province of Assam. The family of *Apocynaceæ* includes the other caoutchouc-yielding trees of Asia and the eastern islands the *Chavannesia* of British Burma, the *Urceola* of Borneo, and the *Vahea* of Madagascar, as well as the *Landolphias*, which produce the caoutchouc of Africa.

In commencing caoutchouc cultivation in India, it was in the first place necessary to take stock of all existing knowledge on the subject, and in the second place to ascertain whether any of the other kinds were intrinsically superior to the *Ficus elastica*, because if this proved to be the case, their cultivation in India would also be desirable.

With these objects in view, I intrusted the duty of making the necessary researches and investigations to Mr. J. Collins, formerly curator of the Museum of the Pharmaceutical Society, who drew up a very able and exhaustive report on the subject in 1872. The conclusions then arrived at were that the establishment of plantations of *Ficus elastica* should at once be undertaken in Assam; but that the caoutchouc from the *Heveas* and *Castilloas* of South America was superior to that of the *Ficus*, and that consequently those trees should be introduced into British India.

The first step, therefore, was to commence the cultivatin of the native Indian caoutchouc tree, which is found in the forests along the northern and eastern boundaries of Assam, as well as in the low valleys of the Naga and Jaintia hills to the south. The *Ficus elastica*, like the banyan and other trees of the same genus, has aërial roots, and is of an epiphytical habit. When wild in the forests it often commences its growth in the fork of another tree, which it eventually overshadows and destroys. It grows to a great size, and one tree planted at Tezpur in Assam, 36 years ago, is 112 feet high, the diameter of the crown measures 140 feet, the circumference of the central mass of aërial roots surrounding the stem is 70 feet, and it has over a hundred aërial roots the largest of which measures six feet in girth. The forests containing *Ficus elastica* are excessively moist in the rainy season, and they remain moist all through the dry season with a temperature of about 98°

in the shade. The trees thrive best under conditions of excessive moisture and great heat, but with good drainage.

Hitherto the caoutchouc has been collected in Assam by men of the wild tribes, who cut every part of the tree they can get at, and allow the milk to flow into holes made in the ground. The collectors are encouraged to obtain the largest possible quantity during the shortest possible time, without any regard to future supplies. This has led to the most outrageous wholesale destruction of these valuable trees, by felling them so as to render the operation of tapping more convenient. Messrs. Martin and Richie, who had a lease of the caoutchouc yield at Tezpur, are said to have given it up before their time expired, because the supply had diminished so much that their business was no longer remunerative.

So that no improvement of the yield can be expected from private enterprise, except at the risk of exhausting the remaining sources of supply; and it is consequently necessary to place the collection of caoutchouc in Assam under the control of public officers who have an interest in the protection and improvement of the forests; and to commence the formation of plantation of *Ficus elastica* on a large scale, and in accordance with a well-considered plan. Dr. Brandis, Inspector-General of Forests in India, strongly urged the necessity of these measures in 1872; and good progress has since been made, under the superintendence of Mr. Gustav Mann, the conservator of Forests in Assam.

The first attempts, which were started in July, 1873, in the Darjiling Terai and in the Goalpara district of Assam, were failures, but in July 1874, Mr. Gustav Mann took charge of the experiment with very satisfactory results. Three plantations have been formed. One, on the right bank of the river Kulsi, in the Kamrup district of Assam, consisted of 95 acres in 1879, on which were 2,895 plants. Another is at Charduar, at the foot of the Himalayas, 18 miles north of Tezpur, in the Darrang district of Assam, where there were 685 acres under cultivation in 1879, the growth of the trees being excellent and most vigorous. The third plantation is at Bamuni, also near Tezpur. Here, there were 8 acres planted with 459 trees in 1878; but the climate is too dry. No artificial shade is now given, and the young trees are healthy and vigorous. Experiments are in course of trial, to plant the *Ficus elastica* in strongly made baskets placed in the forks of trees, and on grass lands, as well as in the regularly prepared beds. The trees may be tapped at the age of 25 years. After 50 years they will yield 40 lb. of caoutchouc every third year, worth £3 3s. In Cachar the india-rubber tree was discovered in 1862, and 760 cwt. were collected, the yield being increased to 1,500 cwt. in 1863. The yield from the first tapping is 35 to 40 lb. The tree is then untouched for three or four years, and second tapping yields much less. Mr. Edgar reports that the Cachar forests would yield 2,000 cwt. annually. In 1879, the quantity of caoutchouc exported from India was 10,033 cwt. valued at about £61,685.* Besides extending the cultivation of the trees, the officers in charge of the plantations will carefully investigate all such questions as the most favourable time of the year for tapping, and the best methods for collecting and preparing the caoutchouc. The experimental cultivation of the *Ficus elastica* has thus been satisfactorily commenced in India, under the able superintendence of Mr. Gustav Mann.

Another caoutchouc-yielding plant belonging to the *Apocynaceae* has recently been discovered in British Burma, and reported upon by Mr. Strettell of the forest department. It is the *Chavannesia esculenta*, a creeper which it has hitherto been the object of foresters to extirpate, as injuring the growth of teak trees. Some of these creepers, growing near Rangoon, have a girth of

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* Caoutchouc exported from British India during six years and succeeding seasons:—

1874—16,837 cwt.	valued at	£117,775	1883-4=R1,133,586
1885—19,893 ,,	,,	£108,618	1884-5= R773,289
1876—15,258 ,,	,,	£97,861	1885-6= R656,204
1877—13,308 ,,	,,	£90,169	
1878—13,794 ,,	,,	£89,381	(For later exports, see elsewhere.)
1879—10,033 ,,	,,	£61,685	

18 inches round the stem, while the crown covers an area of 200 square feet, at a supposed age of five years. It may be propagated either from seeds or cuttings; and instructions for its cultivation have recently been published in the *Indian Agriculturist*. The estimated result of cultivating trees 30 feet apart over an area of 400 acres, or in all, 19,200 creepers, is that there will be an annual yield of 19,200 *viss* (a *viss* is about 3½ lbs.), which at R200 per 100 *viss*, will give R38,400 a year. After the first year, the cost of cultivation will be very slight, and the profits will begin to come in after seven years.

As regards the cultivation of indigenous kinds of caoutchouc-yielding trees in British India, it will thus be seen that the initiatory steps have already been taken. The second, and not the least important part of the undertaking, is the introduction of plants yielding a better kind of caoutchouc, from other parts of the world, but especially from South America.

The most valuable trees, and those which now yield by far the largest quantity of india-rubber, are the *Heveas* of the Amazon valley, called Para from the port of shipment. We learn from Keller that, during the last few years, both the quantity and the value of india-rubber exported from Para have been steadily increasing. In 1874 England received 56,580 cwt. of Brazilian caoutchouc, £720,000; the average price being 2*s*. 6*d*. to 3*s*. a lb. Next to the Para rubber in value and yield, comes that obtained from the *Castilloa* trees, which grow over a much wider area of South and Central America. The quantity of *ule* or *Castilloa* caoutchouc imported into England in 1874 was 24,286 cwt., worth £287,413, at 2*s*. a lb. Thus out of the whole import of 129,263 cwt., 70,866 come from South America.

The remaining 38,775 cwt. are divided among British India, Borneo (1*s*. 9d. a lb), Africa (1*s*. 5*d*. a lb.), and Madagascar (2*s*. 3*d*. a lb.) But the South American source of supply, is, beyond comparison, the most valuable, and the cultivation of *Castilloa* and *Hevea* trees in India is an important part of the undertaking.

Several reasons led me to the decision that a cllection of the *Castilloa* seeds should first be obtained. As the *Castilloas* grow over a much more extensive area than the *Heveas*, where there is a greater variety of soil and climate, it is more certain that suitable sites for their cultivation would be found in India and Burma. They belong, too, to the *Artocarpaceæ* which are so well represented in India, especially on the Malabar and Travancore coasts, by the jak trees, and the *anjeli*, of which wood all the canoes are built.

The *Castilloa* trees flourish in all the equatorial forests on the west coast of South America, and in 1878 the quantity of india-rubber exported from Guayaquil was 6,561 cwt., worth £22,963.* The trees also abound all over the isthmus of Darien, where they are being destroyed most recklessly, in Central America,† and in the southern States of Mexico. In Ecuador the india-rubber is called *heve*; in Mexico and Central America the Aztec word *ule* is used.

The trees, which are the giants of equatorial American forests, belong to two species, the *Castilloa elastica*, and that which Mr. Collins has named *Castilloa Markhamiana*. They thrive in dense steaming and warm forests, and are particularly abundant in the valley of the San Juan de Nicaragua, where it rains for nine months in the year. In Nicaragua the yield is said to be about 10,000 cwt., giving employment to 600 *huleros* or collectors. From Carthagena, Guyaquil, Panama, and Vera Cruz, are exported supplies of *ule* india-rubber, the greater part of which goes to the United States; but it has been seen that as many as 24,286 cwt. arrive in this country.

The collection of *Castilloa* plants for introduction into India was a very difficult service, for the trees grow in wild and unhealthy forests, with no means of transit, and no facilities of any kind. In Mr. Cross I found a man with all the requisite qualifications for undertaking it. He is an excellent gardener, possessed of great energy and determination, combined with

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* This shows a large falling off. In 1873 it was 16,635 quintals, and in 1874, 10,690 quintals. In 1876 it again rose to 10,138.

† From San Jose de Costa Rica, 78,231 lb, of india-rubber were exported in 1878. The quantity is not given for Guatemala, but the value is stated at $1,540 in 1878.

judgment, is acquainted with the language, and has had much experience in South American travelling. No better man could be found to execute the difficult task of obtaining a supply of *Castilloa* plants, and conveying them in a healthy state from their native forests to the gardens at Kew.

Mr. Robert Cross left England on the 2nd of May, 1875, and reached Panama on the 26th of the same month, my instructions to him being to endeavour to make the collection on the isthmus. He found that great destruction was going on among the *ule* trees in all parts of the Darien isthmus, the native collectors cutting down the trees in order to tap them more easily, as is the case in the Assam forests. After obtaining all the information that could be procured in Panama, Mr. Cross determined to select the forests on the banks of the large tributaries of the river Chagres as the base of his operations.

He ascended the Charges river in a canoe, and then made a journey on foot through the dense forest, into the heart of the *ule* district. He found the *Castilloa* saplings growing on the banks of streams, with their roots often running down to the edge of the water. They abound in rich soil along the base of the hills, and are also met with on the summits of ridges; everywhere, except in swampy ground. The trees, which proved to be of the species named by Mr. Collins, *Castilloa Markhamiana*, are from 160 to 180 feet high, with a diameter of 5 feet, and a yield of 100 lb. of india-rubber. The wood is spongy and soft, and decays rapidly when bruised or injured, Many of the leaves measure fourteen inches in length, and seven inches in breadth. The temperature of the forests ranges from 75° to 80° Fahr., and they are excessively damp. The range of the *Castilloas* is so wide that, in some places, the trees must flourish in climates which at one time of the year are dry. It is probable, however, that the species with the best and largest yield of caoutchouc flourish best in a hot and very damp and steaming atmosphere, like that of the forests of the isthmus.

Mr. Cross collected 600 plants, and also drew a quantity of milk, in order to prepare a specimen of the rubber. The sample he brought home was examined and reported upon, and was pronounced to have much less impurity than is usual for this kind of rubber, and thus proved Mr. Cross's plants to be of the best species. He left the isthmus with the plants on the 6th of September 1875, on board the mail steamer *Shannon*, but in the morning of the 8th, when going 13 knots an hour, the vessel ran on the Pedro reef of rocks, off the coast of Jamaica, and her bows were immovably fixed upon them, while the stern continued to bump heavily for many hours. The rest of the passengers left the ship in boats, but Mr. Cross Stuck manfully by his plants and was eventually taken on board H. M. S. *Dryad*. He came home in the mail steamer *Nile*, reaching Southampton on the 2nd of October. Considering all the extraordinary difficulties of the undertaking, it reflects great credit on Mr. Cross that he should have been successful, and thus have performed an important public service with ability and sound judgment. There were some 134 of Mr. Cross's *Castilloa* plants in a flourishing condition at Kew Gardens, and in the course of 1876 a good supply of *Castilloas* was forwarded to India, to form the nucleus of a series of plantations.

Thus the introduction of one out of the two valuable South American species was provided for.

It remained to take measures for obtaining plants of the most valuable kind of all from the valley of the Amazon—the *Hevea* yielding the famous Para india-rubber of commerce.

The *Heveas* are of several species, and, like the *Castilloas*, they are large trees growing in humid tropical forests. Dr. Spruce, who is the highest authority on this genus, considers that the Cordilleras of the Andes separate the *Castilloas* from the *Heveas*, and that the caoutchouc-yielding trees to the eastward of the Andes are of the latter genus. They extend up to the very foot of the mountains, and I have myself passed some time among *heveros*, collecting for local use in the *montanas* of Paucartampu and Laris. While in Peru and Ecuador the india-rubber is called *heve*, in Brazil the name is *seringa*, and the collectors are *seringueiros*. Eight species are enumerated by Collins, namely:—

Hevea Brasiliensis	(Mull.)	*Hevea Rigidifolia*	(Mull.)
,, *Spruceana*	(Mull.)	,, *Benthamiana*	(Mull.)
,, *Discolor*	(Mull.)	,, *Lutea*	(Mull.)
,, *Pauciflora*	(Mull.)	,, *Guyanensis*	(Aube.)

The *Hevea Brasiliensis* is the species which prevails round Para and the forests of the lower Amazon; *H Spruceana* is met with round the mouth of the Tapajos, and the other species occur on the banks of the Rio Negro and Casiquiari; but the genus is far from having yet been thoroughly studied.

In the Para district of the lower Amazon very little rain falls from August to February, the heaviest rains being in May and June; and the temperature varies between 74° and 95° Fahr.; the mean of a year being 81°. The Amazon valley is remarkable for uniformity of temperature, and for regular supply of moisture; the dry season extending from June to December, and the wet from January to May. In the Upper Amazon the atmosphere is densely vaporous.

Our latest authorities on the Para caoutchouc are Mr. Wickham and Mr. Franz Keller. The latter traveller, writing in 1874, says that the *hevea* trees on the shores of the Amazon have nearly disappeared, owing to the destruction and death of trees, the places of which have never been filled up. But the forests of caoutchouc-trees on the banks of the Madeira, Purus, and other tributaries, yield over 1,600,000 lb.; while the yield of the whole of this colossal river basin amounts to 12,800,000.* Keller laments the fact that no attempt is made, in the Amazon district, to cultivate these useful trees; which, owing to frequent tapping and rough treatment, suffer much and die soon. The *seringueiros* have to go farther and farther into the interior, to seek fresh trees in undiscovered valleys. It is to be feared that, owing to the indolence of the mestizo population, and the shortsightedness of the Brazilian Government, measures of conservancy will not be adopted until too late.

The *Castilloa*, like the *Ficus elastica*, though requiring a very humid climate, will only thrive when there is drainage at the roots, but Keller says that the *Hevea* yields the largest supply of milk when, during the annual inundation, its stem is at least five feet under water.

The scene presented by an encampment of caoutchouc collectors is extremely picturesque. Their huts are lightly built among the trees, and round them tower the majestic *mosqucteiro* palms, and the lofty *Bertholletia*,† while in front is the gleaming river with its sunny sandbanks. From the huts narrow paths lead through the dense undergrowth, cut by the axe of the *seringueiro*, to the lonely caoutchouc-trees. The collector makes small holes in the bark, to which tubes of clay are fixed, which lead the milk into bamboo receptacles going from tree to tree he collects these bamboos, and on his return to the hut the contents are poured into the carapace of a large tortoise. The milk is then subjected to the process of smoking without delay, for if left standing too long the resin separates. In this process the milk is subjected to the smoke of the *urucuy* or nuts of the *Athola excelsa* palm, which alone, it is said, possesses the power of liquefying. An iron pot, without a bottom, and with a narrow neck like a bottle, is placed so as to form a chimney over a heap of these burning nuts, and the white steam rises in masses through the narrow opening. The *seringueiro* pours a small quantity of the white fluid, of the consistency of thick milk, from a calabash over a light wooden shovel, as evenly as possible, and then rapidly thrusts it into the white steam. The milk soon takes a greyish-

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* Keller gives the following statement of the export of caoutchouc from Para:—

1865—256,967 arrobas.
1866—291,091 ,,
1867—301,370 ,,
1868—334,975 ,,
1869—365,354 ,, (4,558 tons.)

† *Bertholletia excelsa* yields the Brazilian nuts.

yellow colour, and becomes firm. Then they add layer upon layer, until the caoutchouc on each side of the shovel is about 8 inches thick.

The *plancha* or slab is then finished taken off the shovel by cutting down one side, and hung up in the sun to dry, as there is a good deal of water between the layers. The colour of the *plancha* is at first a light silver-grey, but by degrees becomes yellower and yellower, until it turns the dark colour known in commerce ; a practised hand can, in this way, manufacture 5 or 6 lb. in an hour. The thicker and freer from bubbles, the better the quality and the higher the price. The cheapest is called *surnamby* or *cabeza de negro* (negro-head), and is made from drops found at the foot of the trees and from the refuse in the vessels. The export of caoutchouc from Para in 1876 amounted to 6,493 tons, worth £955,000.

There are two other india-rubber trees of South America of less value, whence come the Pernambuco and Ceara rubbers. The Perambuco is an apocyneaceous tree, *Hencornia speciosa,* known as the *mangiaba* by the natives, and is found in the provinces of Rio de Janeiro, Bahia, Pernambuco, and Goyaz. It is a small tree about the size of the apple, and is more valued for its fruit than for its caoutchouc, which is not much collected. The Ceara tree (*Manihot Glaziovii*) is more important, especially as it flourishes in a dry climate.

For obtaining plants yielding the india-rubber of Para and Ceara I was again so fortunate as to secure the services of Mr. Cross ; who left Liverpool on June 19th, 1876, and reached Para, at the mouth of the Amazons, on July 15th. He found, on inquiry, that the great field for caoutchouc collecting was the province of Para, and the islands formed by the delta of the river, especially Marajo. The land round Para rises from the bank of the river southward in gentle undulations, cut by the deep gully-like natural ditches called *gapos,* which often penetrate for many miles into the interior of the vast forest region, and are filled daily by the tide. To those navigable by canoes the term *ujarape* is often applied. The intervening land between the *gapos* owes its origin first to tidal deposits, and afterwards has been raised by the decayed remains of a long series of rank growths of vegetation. On the more elevated lands, beds of white sand 20 feet deep are met with, covered with a layer of decayed vegetation. In every direction the country is a mass of dense exuberant forest.

Mr. Cross explored this region, in order to make observations on the soil, climate, and mode of collecting and preparing the rubber. On the 2nd of August he was following the tracks of the rubber collectors through the dense forests ankle-deep in mud, until he came to a wide *gapo* into which the tide flowed. It was connected with many lesser watercourses, forming a kind of network over a whole district of forest, the most elevated parts of which were only raised three to four feet above the highest tides. India-rubber trees grew along the margins of the streams, and Mr. Cross observed three, the trunks of which were flooded to a height of a foot. Most of the others occupied dry situations. The *gapos* are lined with soft rich mud, and exhalations from such places, shrouded by a forest growth of 80 to 100 feet heigh, always produce attacks of fever. Mr. Cross measured a few of the largest trees, all of which had been tapped for periods varying from five to fifteen years, and found their circumference, one yard from the ground, to vary from 3 feet to 6 feet 10 inches. Regularly tapped trees do not exceed 60 feet in height.

Mr. Cross went on with the work of collecting plants, and established them at once in cases. In this way he made a collection of 1,000 plamts in four cases. The range of the thermometer from July to October was from 72° 92°. On the 17th of October 1876, the collection was shipped for Liverpool, and Mr. Cross proceeded, in the same steamer, to the Ceara region. He landed in a heavy surf, on a kind of raft called *jangada,* and found himself in a very different country from that of the Amazon.

South of the Amazonian forest, there is a region known as *Sertao* or wilderness ; extending in a broad belt from the Parnahyba river to the Sao Francisco. The province of Ceara is within this belt—a high rolling plain, broken by abrupt elevations and chains which are, in fact, outlying fragments of the great central table-land of Brazil. The only high forest is found on these mountain sides, the summits and the plains below being occupied either by thin forest growth, or by pastures and sandy tracts, with groves about the river courses. From

June to December the climate is extremely dry, and the streams and rivers disappear, except along the mountain sides. The rains, at times very heavy, come in December and January. The principal commerce of the country is in hides and jerked beef; and there are plantations of sugar, coffee, and cotton, along the mountain sides. In 1877-78, Ceara was visited by a terrible drought and famine, when about half the population perished.

Ceara is connected with a place called Pacatuba, forty miles inland, by a railway made to facilitate the transport of sugar and cotton. It traverses a flat and parched country, covered with thickets of thorny bushes, and slender myrtles and *Leguminosae*. Here and there clumps of the *carnauba* palm (*Copernicia cerifera*) rise high above the other trees and bushes. The crowns of these palm-trees, waving with the wind, are visible over a wide expanse, and the back ground is formed by a range of mountains. Mr. Cross stopped at a village called Maracanahu, about 30 miles from Ceara, where he obtained a guide to take him to the india-rubber trees. The forest was tolerably high, but the sparse small foliage did not afford much shade from the fierce rays of the sun. Neither grass nor weeds grew under the trees, and there was an either absence of ferns, mosses, and other plants. Mr. Cross concluded that Ceara rubber-tree would thrive perfectly over a very wide area of the drier regions of British India. At first sight the tree resembles a birch, and the outer bark comes off in the same way, in thin silvery peelings. The largest tree was about 50 feet in height, with the trunk about a foot in diameter. Having found some young plants, Mr. Cross had great difficulty in uprooting them. The roots have tubes the size of kidney potatoes which adhere with great tenacity to the soil. After diligent search and very severe labour eighteen plants were collected, and brought safely on board the steamer. Thus in one day Mr. Cross was able to discover the origin of a tree hitherto unknown and undescribed, yielding an important article of commerce, and at the same time to secure a number of plants. Next day he again went to Maracanahu and obtained 42 more plants and 700 seeds.

Mr. Cross arrived at Liverpool on the 22nd of November, 1876, and his valuable collection of plants was deposited at Kew the next morning, consisting of a thousand plants of Para rubber-trees (*Hevea Braziliensis*) and forty-two Ceará plants.

Thus all the valuable caoutchouc trees of South America had been obtained, and were ready for experimental cultivation in India; but Government was very lukewarm on the subject, and I considered it most safe to send them, in the first instance, to the Ceylon Gardens at Péràdeniya. From that centre their cultivation could be extended to India hereafter, when its importance is better appreciated by the authorities. The Ceara plants (*Manihot Glaziovii*) arrived from Kew in October 1877, and grow admirably in the Peradeniya and Heneratgoda gardens. They have produced ripe seeds; and plants have already been sent to Calcutta, Madras, Burma, and the hot districts of Ceylon, for trial. The *Hevea* also grows extremely well. A few trees are already nearly 30 feet high, with a girth of 14 inches. Already 500 *Hevea* plants, raised from cuttings, have been sent to Madras and Burma. The *Castilloa* trees grow well at Peradeniya, still better at Henaratgoda. Some are 16 feet high, with a girth of 16 inches. The increasing demand for caoutchouc must eventually convince the Government of the great importance of its systematic cultivation. The Para rubber is the best and choicest, the Castilloa will grow over the largest area in the moist belts, and Ceará thrives on the drier and hotter plains.

A writer in the *Indian Forester*,* after reading Mr. Cross's Report on the Castilloa region pointed out the Ghât forests as far as the Nagar division of Mysore as the most likely region to constitute a new habitat for the Castilloa trees. He says:—

"In the interesting account of the *Castilloa elastica* in the last number of the *Indian Forester*, the low forests about Coimbator and the base of the Nilgiri Hills are recommended as the locality in India where it is perhaps most likely to succeed. Were the writer acquainted with the line of Ghat forests extending from thence northwards as far, say, as the Nagar division of Mysore,

* Vol. iii. p. 57. (July 1876.)

we feel confident, after a careful perusal of his notes, that he would place his finger on this region as the most likely to constitute a new habitat for his species. After the names, and his description of the climate, soil and general surroundings of the forests where his caoutchouc tree grows will exactly suit that of the lower valleys of the Ghat range. Indeed, looking at the map of the world with our knowledge of winds and rain in the tropics, were it otherwise a very fertile brain would be required to strike out a plausible explanation of the fact. As it is, we know, from the general accounts of travellers that there is a very striking resemblance between the two regions. Where the difference lies, and that a great one, is in the two floras. In the ordinary course of things there can be no doubt about one's ability to grow *Castilloa elastica* in the lower Ghat valleys, but the point which nothing but experiment on the spot can determine is, whether in this tract of teeming fertility and bewildering wealth of species, it can so far intrude on the closely fitting vegetative economy as to conquer an independent position in the forest flora. Most probably it would require some artificial aid to maintain itself, but if its economic value is anything like that stated, this we can afford to give it. Only to a limited extent though, for the same poisonous climate exists here as in the tree's New World habitat. Up to this limit great facilities for working exist. The region we are speaking of is permanently inhabited by aboriginal tribes, who sometimes settle down into villages in healthy localities, at other times retire to the most lonely and malarious portions of the belt where they seem to be dying out, and who sometimes can be depended on for regular work, at other times not. With or without their aid labour for a portion of the year could be easily got from the settled and healthy country above. Very often villages with surplus labour exist on spurs of Ghats almost overhanging the low country, a cool and non-malarious climate two or three thousand feet above the sea. Here the forest officer has his hut, and rides up after the day's work is done. Back here too he brings his fever-stricken coolies for a change of air, better than any medicine. The whole forest region below is now pierced by easy Ghat roads at intervals of about 50 miles—the ports of Mysore, as the talented engineer who made most of those in that province has aptly described them. All the most accessible passes are lined by a dusty streak along which the produce of the up country passes to the sea, In a word, in the lower Ghat forests we can offer *Castilloa elastica* a habitat quite as unhealthy as its own in America, and an amount of care and culture it could not get there.

"Away from the trunk roads and the valleys abutting to them, minor forest produce should be attended to.

"It is a question whether the existent minor forest produce could not profitably be more extensively worked; it is certain that the successful introduction of *Castilloa elastica* would unmistakably turn the scale in the right direction. We would not, however, have it thought that we staked bringing down the trembling beam on this one species. Many others will occur to everybody, but *Castilloa elastica* seems to open up a fairer prospect than them all. There is our old, now familiar friend, *Ficus elastica*, which seems likely to grow well enough here, provided we kept down hardier native species; probably it would require a good deal of aid in this way. There is also *Hevea elastica*, and in fact the whole series of caoutchouc-yielding trees, not forgetting the wonderful Burmese climber, *Chavannesia esculenta*. Since, however, *Castilloa elastica* admittedly produces one of the finest India-rubbers one would naturally wish to begin by trying that. Considering the inaccessibility and unhealthiness of the lower Ghat forests, we seem to have a case here of what our forefathers would have described as a providential adaptation of ways to means, in the fact that the locality is nevertheless so well fitted to produce an article, so necessary in the arts, and of such a growing application, as caoutchouc.

While the *Castilloa* will find a new home in Western Ghats, the *Hevea* is introduced into one of the moist zones of India, the *Ficus elastica* is cultivated in its native forests of Assam, and the *Chavannesia* in Burma, the *Ceara* rubber, with quite different habitat and requirements may be extensively grown on the hot dry plains of Eastern India. The measure if intelligently and continuously followed up will thus ensure in the future, and as the demand increases, a regular and large supply of the best kinds of caoutchouc from British India.

MR. BRANDIS ON RUBBER IN INDIA.

From the Liverpool and London price lists for 1871-72 given in Mr. Collins' report, it appears that the principal descriptions may be classed as follows with regard to price and quality :—

Name of article, and country whence obtained.	Name of plant yielding.	Price paid for last Parcel. Lowest.		Price paid for last Parcel. Highest.	
		s.	*d.*	*s.*	*d.*
Pará (Pará and Amazonas) ..	Hevea sp.	2	8	3	1
Madagascar	Vahea sp.	1	10*	2	4½
West India (Central America) ..	Castilloa elastica	1	11½	2	3½
Carthagena	Do.	1	10	2	3
Guayaquil (pressed)	Do.	1	7½	2	3
Singapore (India Archipelago) ..	Ficus sp.	1	10½	2	3
Assam	Ficus elastica	1	4½	2	3½†
Ceará (Ceará in Brazil)	Hevea sp.	1	10	2	1

The African rubber (Landolphia) varies exceedingly in price and quality, and the Borneo Caoutchoc, the produce of Urceola elastica, is only quoted at 1s 7½d to 1s 10¼d per lb. Assam rubber stands low in the list at present, but there seems good ground to believe that this is mainly due to the large proportion of impurities (bark, sand, stones) with which it is commonly mixed. The Caoutchouc which was collected and prepared by Messrs. Martin, Richie and Company of Tezpore, while they had the lease of the Caoutchouc forests previous to 1865, and which was known in the London market under the name of fine slab Assam, was a very superior article, and quite lately an improvement has again taken place in the quality of the Assam product.

Mr. Mann specially insists on the following points being observed :—

1. Fresh cuts to be made only in February, March, and April, and the trees to have rest for two years between each tapping.
2. The cuts to be at least 18 inches apart, to peneterate into the bark only, not into the wood, and to be made with an instrument more suitable than the others at present used. Mr. Mann prefers the German timber scoring knife.
3. As far as possible the milk to be collected in a fluid state in narrow mouthed rattan baskets, and to be brought to central manufactories,
4. Endeavours to be made to convert the milk into a solid state by a process of slow drying similar to that practised in Para,
5. In case this method should not succeed, then the process employed by Messrs. Martin and Richie to be followed.
6. Those varieties of Caoutchouc which dry naturally on the tree, to be collected with care, and to be picked so as to get rid of all impurities.

Under all circumstances should plantations of the Ficus elastica be commenced at once in Assam on a large scale. The tree strikes readily from cuttings, its cultivation therefore is easier than that of most other trees. In one of his first reports on the subject Mr. Mann suggests that lines be cleared through the forest and that cuttings, as large as possible, be planted at convenient distances on either side of these lines. Very likely this will be a good plan to commence with, and as the carriage of big cuttings over long distances would be expensive, nursery beds should be prepared and enclosed for the growth of such cuttings from small slips.

D. BRANDIS.

* Madagascar Caoutchouc is a very superior article, which has recently only become known in this country, the lowest price quoted was early in the year, before it became appreciated.
† Price of a parcel of Assam of great purity.

ROYAL BOTANICAL GARDEN, CALCUTTA.

(*Extracts from the Report for 1880-81 by the Superintendent, Dr. Geo. King.*)

India-rubber.—The Ceara rubber-trees (*Manihot Glaziovii*) continue to grow vigorously, and a few of them are now beginning to yield seed. The demand for young plants and for the seed of this species continues to be considerable; and of all the recently imported-rubber-yielders, it is the only one that promises any kind of success in this part of India. The Para rubber (*Hevea*) and the Madagascar rubber vine (*Vahea*) have utterly failed. Of *Urceola elastica*, and *Castilloa elastica* two well-known South American rubber-yielders, I have not hitherto been able to get more than two or three sickly plants. Of the great rubber creeper of the East African Coast (a species of *Landolphia*) seeds have—thanks to the kind exertions of Dr. Kirk, Consul-General at Zanzibar—been received at the garden, and some of them have germinated. But I fear, even if it were to turn out to be suited to the climate of Calcutta, *Landolphia* would prove rather an unmanageable crop, for it is described to be an enormous creeper, climbing to the tops of the highest trees. With regard to all these exotic rubbers, it must be remembered that (with the exception of Ceara) they are either very large trees or climbers; and although it may pay well to collect rubber from them in their native forests where they have grown to maturity without cost to the collector, it is quite a different matter when their planting and protection have to be paid for, and their coming to maturity has to be awaited for years.

CEARA RUBBER.—*Germinating the seeds.*—File each seed carefully on both sides, until the kernel is *just* visible, The two ends may be rounded off a little, but the operation requires care. When the filing is finished, have ready a solution of kerosine oil and water (one to ten) and immerse the seeds in it for a second or two. This prevents ants and other insects from coming near them. This operation over, the seeds should be thrown into a tin box containing some coir fibre refuse, procurable in Colombo. Cover them well over with a further supply of the same material and shut down the box. In two days' time, they will be found, on examination, to have commenced to germinate. Take them out and put them (germ downwards) into Wilton's transplanters filled with good soil, on a table, with its legs in saucers of water. Three or four days more will suffice to let the seedlings develop into nice, healthy little plants, and ten days from the date of the commencement of the operation they can be finally transplanted. When the seeds are in the box of coir refuse no water is required, and even when put into the transplanters very little moisture is needed.

"The young plants are remarkably strong and love the sun. They are, however, very impatient of moisture, and should therefore be placed under cover during a shower of rain. The filing operation may be done on a grindstone; but to ensure *perfect* success each seed should be rasped carefully with a file.

"Some planters lose as many as 60 and 70 per cent, and in one instance, which has come to my knowledge, five plants only were secured out of 300 *seeds.* I am indebted to a gentleman in Colombo for the above simple but carefully effective way of germinating the seed, and can confidently recommend its general adoption. Not a single seed need be lost if the directions are followed.

"*Planting out.*—It being important that the Ceara species of rubber should be induced to grow coconut fashion with a tall, clean stem, it will be found necessary to plant them pretty close to each other, say 500 to the acre; and, so far as my experience goes, plants grown from seed are more likely to develope into this style of three than those propagated by cuttings. This latter grow faster, perhaps, and blossom earlier—a matter of some importance in cases where a supply of seed is required; but, for a permanent plantation, I am of opinion that every tree should be raised from seed.

"Mr. Cross's statement, that the Ceara rubber may be expected to grow and flourish in soils where hardly anything else will live, is not supported by Ceylon experience. On the contrary, there is no tree I can name that enjoys more thoroughly richness of soil, and the difference between plants in good and bad land is very marked.

"*Collection Value and Quantity of Produce.*—Nobody is yet in a position to say which is the best way to tap the tree when it reaches maturity; but, from experiments I have made, I believe it will be found impossible to improve upon the method adopted by the natives of Ceara. They bare the trunk of the tree and allow the milk to trickle down the stem. Two or three days afterwards the gum or caoutchouc is pulled off in strings and sent to the market. As may naturally be supposed, the rubber reaches England in a very impure state. Hence its value is less than the Para kind, which is prepared with the greatest care. My reason for thinking it impossible to improve upon the native method of collection is because the flow of milk from a Ceara tree is very slow, and any other system would increase the cost, a contingency which must be guarded against. It may, perhaps, be found possible to purify the caoutchouc in Colombo before shipping it to England. Labour is cheap, and the machinery necessary for the operation is by no means complicated. As regards the yield per tree, a very small quantity will pay, provided the cost of production is restricted, and an inexpensive method of collection adopted."

Indiarubber Gathering In Columbia.—An interesting account is given of this process in a report just issued by the United States Consul at Carthagena. When the hunter has found a rubber-tree he first clears away a space from the roots, and then moves on in search of others, returning to commence operations as soon as he has marked all the trees in the vicinity. He first of all digs a hole in the ground hard by, and then cuts in the trees a V-shaped incision with a machete, as high as he can reach. The milk is caught as it exudes and flows in to the hole. As soon as the flow from the cuts has ceased the tree is chopped down, and the trunk raised from the ground by means of an improvised trestle. After placing large leaves to catch the sap, gashes are cut throughout the entire length, and milk carefully collected. When it first exudes the sap is of the whiteness and the consistence of cream, but it turns black on exposure to the air. When the hole is filled with rubber it is coagulated by adding hard soap or the root of the mechvacan, which have a most rapid action, and prevent the escape of the water that is always present in the fresh sap. When coagulated sufficiently the rubber is carried on the backs of the hunters by bark thongs to the banks of the river and floated down on rafts. The annual destruction of rubber-trees in Columbia is very great, and the industry must soon disappear altogether, unless the Government puts in force a law that already exists, which compels the hunters to tap the trees without cutting them down. If this law were strictly carried out there would be a good opening for commercial enterprise, for rubber-trees will grow from 8 to 10 inches in diameter in three or four years from seed. The trees require but little attention, and begin to yield returns sooner than any other. Those that yield the greatest amount of rubber flourish on the banks of the Simu and Aslato rivers. The value of the crude indiarubber imported into the States annually is about $10,000,000. —London *Times*.

CHARDUAR RUBBER PLANTATIONS IN ASSAM.

[By Gustav Mann, Esq., Conservator of Forests, Assam.]

I have the honor to submit a report on the Charduar rubber plantations in the district of Darrang, including its past history, the results gained, and a sketch of my views as to the furture treatment and extension of that plantation.

2. The past history of rubber plantations in Assam, and, for the matter of that, in India, dates from the year 1872, when Mr. James Collins was charged by Her Majesty's Secretary of State for India to prepare a report on the caoutchouc or India-rubber of commerce, the plants yielding it, their geographical distribution, and the possibility of their cultivation and acclimatisation in India. The only rubber tree indigenous in India, *Ficus elastica*, is noticed on pages 19 to 21, 32 to 39 and 48 to 54 of that report.

3. The numberless uses to which caoutchouc is applied, the daily increasing demand, and the very high price paid for it, as well as the total absence of any other product, whether raw or manufactured, that could be used as a substitute, with the sole exception of gutta-percha, which is still more expensive than rubber, had for years attracted the attention of thinking men to this matter, and Mr. Collins' report was therefore welcomed by all, and particularly so by men who took an interest in the development of the resources of India.

4. This report was largely circulated by Government in this country,and the attention of Local Governments was directed to the necssity of protecting the trees which yielded this valuable commodity because it had become quite evident that the caoutchouc trees were being recklessly destroyed in all parts of the world, and particularly so in Assam, which is, so to speak, the only province in India where caoutchouc trees grow, and the experimental cultivation of the indigenous rubber tree *(Ficus elastica)* was accordingly ordered in May 1873 by his Honor the Lieutenant-Governor of Bengal. But by the time these orders reached the Commissioner of Assam, the season was so much advanced, that but little could be done that summer, because there was only one small forest plantation with a resident forest officer in existence at that time, and this was at the Kulsi river, which is not as favourable a locality as the Charduar, in the Darrang district. In the latter district forest work had not had been started, and, consequently, the first commencement in the present Charduar, rubber plantations was not made until the next cold season. A detailed account of these first attempts at planting rubber will be found in paragraphs 80 to 114 of the Assam Forest Report for 1873-74.

5. A particular impetus was given to this work by the complications and difficulties that had arisen at about the same time in the proper management of and control over the India-rubber trade in this province, brought on by competing speculators, which had necessitated an order from the Supreme Government that the operations of the Forest Department should be limited to conservancy and reproduction of the rubber trees in certain well-defined areas, and to the collection and manipulaton of the produce in such limited areas through their own agency.

6. This order of the Government of India was repeated in 1876, and has been acted up to until now: all work in the way of rubber plantations is based on it, and what is more, the experience gained in the twelve years that have elapsed since the issue of that order has made it clear that the effectual protection of selected areas, *with naturally grown rubber trees on them* is next to impossible, on account of the localities where these trees grow being, generally speaking, very inaccessible, and the unequal way in which these trees are scattered about in the forests, as it would mean the protection of enormous areas to ensure anything like the present export of rubber from Assam, and this in turn would mean the employment of very large establishments to watch over the forests, because rubber is so very portable, and its removal not necessarily confined to roads or tracks, rivers and so forth, as is the case with timber

and the cost of such establishments would altogether exceed the advantages arising from the rubber trade. This simply reduces the whole question of permanently keeping up the export of this valuable product from India to making plantations of the tree that yields it.

7. In April 1874 the Government of India called for a special progress report on the caoutchouc plantations in Assam, which was furnished with my letter No. 23A., dated 27th May 1875, forwarded by order of the Chief Commissioner to the Government of India with letter No. 1,305, dated the 4th June 1875, and subsequently printed and circulated with the Government of India, Department of Revenue, Agricultural and Commerce (Forests), letter No 22, dated the 31st August 1875. The efforts made up to that time in the way of planting caoutchouc trees in Assam, and all information regarding the yield of caoutchouc trees then available have been fully stated in that report, so that there is no necessity for repeating it now; the views expressed by me at that time I hold still in all the main points, and the progress made in planting and the results gained have been recorded in the Annual Forest Reports for Assam up to date, as quoted, so that there is no necessity for repeating this either here beyond pointing out a few of the main orders bearing on the subject the chief occurrences which have taken place, fresh experiences gained, and changes adopted in the management;—

Report of	1874-75,	paragraphs	250 256 and 272-306
do	1875-76,	do	65 and 68-77
do	1876-77,	do	83 and 96-110
do	1877-78,	do	106 and 122-131
do	1878-79,	do	111 and 127-136
do	1879-80,	do	125-127 and 146-151
do	1880-81,	do	113-118 and 137-145
do	1881-82,	do	110-115 and 136-142
do	1882-83,	do	77-78 and 83-85.

8. The Charduar plantation has, as was maintained from the commencement, proved in every respect the best locality in Assam where the rubber tree has been planted. The land, it is true is not high, and so we must, no doubt, have some area planted on higher ground, if for no other reason than to enable us to make comparisons. This is to be done at once on the high land immediately to the west of the present plantation, as the Chief Commissioner has sanctioned an extension of 200 acres. The plant area under cultivation is fully stocked, containing 12,511 trees; they have been planted at 25 feet apart in the lines, which latter are 100 feet apart. This is double the number of trees that was planted on an acre at the commencement. The oldest trees are about 30 to 40 feet in height, and a few from 45 to 50 feet, but this cannot be put down as the average growth of *Ficus elastica* in ten years, since half this time, and longer, these plantations were entirely experimental and everything had to be learned, as for instance, the first trees were all raised from cuttings, which mode of propagation has entirely been given up since the trees raised from seed have proved much hardier and faster growing and as to the planting of rubber seedlings high up in the forks of other trees, this also has almost entirely been given up, because such trees in most instances did not make more than a few leaves in the year and it would, as a matter of course, be out of the question to plant rubber trees where they would take a century to become large enough for tapping, when such trees can be grown in a different way in one-fourth this time.

9. On the other hand, it has been found that trees planted on small mounds of earth, 3 to 4 feet in height, grow very much better than if they are planted on ordinary level ground, and this plan has therefore also been adopted, although it adds considerably to the cost of making these plantations, but the faster growth of the trees amply compensates for the higher expenditure.

10. The method of planting adopted from the beginning has been to clear lines from east to west through the forest for the young trees a hundred feet apart; the width of the lines is 40 feet, so that a broad strip of forest 60 feet wide is left standing between these lines, to ensure the utmost amount

of moisture in the atmosphere for the young rubber trees. At first the lines were only cleared 20 feet broad, but it was found after a few years that these closed up very soon, and thus retarded the growth of the young trees by shutting out the requisite amount of light. However, the widening of the lines also brought about the faster growth of the scrub in them besides that of the rubber trees, and more money, time, and attention has in consequence to be spent, especially in the rainy season, on these plantations than had at first been anticipated ; but the greatest and most costly difficulty that had to be overcome was the effectual protection of the rubber trees against deer, which during the first few years constantly bit off the young plants, and, where they were not entirely ruined by this, they were so much injured and retarded in growth that a considerable increase in the expenditure on these plantations had to be incurred on fencing to prevent it. But for the future this expenditure will not be necessary, since it has been found that saplings 10 feet and more in height can be transplanted without difficulty and with perfect success, and if such saplings are tied firmly to stakes, the deer can do little or no damage to them.

11. The efforts made to interplant with timber trees besides the rubber so as to obtain a yield of timber in addition to that of caoutchouc, have up to the present met with but partial success in the Charduar plantation, but there is no reason to doubt that this will soon improve as the officer in charge gains more experience ; in the rubber plantation at the Kulsi, in the Kamrup district, this work has been most successful.

12. The total area of the Chardur caoutchouc plantation is now 892 acres, and has cost R64,351, or R72 per acre. This is abnormally high, since much of the work during the first five years had to be done twice over, and sometimes oftener, because the planting of caoutchouc trees was new, and everything had to be learned and found out by experiments, which naturally took some time. But matters have changed in this respect. We know now what we are about, and the officer in charge of this work, Mr. T. J. Campbell, has estimated the cost of the extension which is at present being carried out at R9 per acre, to which another R6 for subsequent cultivation and clearing should be added, bringing the cost, including everything up to R35 per acre.

13. Besides the experimental nature of the work, to which the cost of R72 per acre of this plantation must to a great extent be attributed, we have also prepared extensive nurseries, covering an area of about 23 acres, and containing some 184,000 plants of different sizes, which is sufficient to extend the plantation by 200 acres per annum for the next 151 years, or a square mile per annum for the next five years, if desired, and these nurseries have been so planted that, if for special reasons it is considered advisable not to extend the plantation at any particular time, the trees can be kept almost stationary for 15 to 20 years, without becoming less suited for transplanting—a particular advantage enjoyed by *Ficus elastica* in common with other semi-epiphytes as compared with ordinary trees.

14. These extensive nurseries were got up in accordance with the orders of the Chief Commissioner communicated to me in Mr. Ridsdale's letter No. 63 T., dated the 10th January 1879, to which I replied in my letter No. 133A., dated the 25th Janury 1879, that I hoped to be in a position to extend the Charduar plantation by one square mile annually in 1881-82 and thereafter. At the same time Mr. Ridsdale's letter quoted above was written, the Inspector-General of Forests visited Assam, and after close inspection of the Charduar plantation declared it a great success. His views on the subject have been recorded in paragraphs 91 to 104 of his report regarding forest administration in Assam. He suggested an annual extension of the Charduar rubber plantation by 200 acres, at an estimated cost of R36 per acre, or about the same as I estimate now the cost of future extensions.

15. Thus far I have given an account of the Charduar rubber plantation as an experimental undertaking only, and shown that it has been a perfect success as far as the growing of the trees is concerned ; but it remains to be considered what the financial results of the undertaking are likely to be, since, as I have always held and do now, the financial success of

forest-management is the only sound basis on which it can be permanently established and maintained. To make an even approximately correct estimate of the probable revenue that may be expected from these plantations, it is first and foremost necessary to know what a rubber tree will yield, and on this point our information is most imperfect. The statement made by rubber collectors are quite unreliable, and the exhausted state of the naturally grown rubber trees has prevented us until last year from making experiments; the result of last year's experimental tapping, as recorded in Appendix IX of last Annual Forest Report (1882-83), interesting as it is, and much as it has increased our knowledge of the yield of caoutchouc from *Ficus elastica*, still leaves us in considerable doubt on the subject, as has been stated in paragraph 118 of that report. However, so much is certain, that a full-growing rubber tree of about 50 years old will yield at the very lowest 5 seers of rubber, if very carefully tapped, and this quantity may be expected about sixteen times, which will be an equally safe estimate for calculating the yield of a rubber tree. To be quite on the safe side, I will only calculate 10 trees per acre, which would give us about 20 maunds of rubber from every acre. This, at the price at which rubber was collected last year, in the Darrang district and sold, and deducting the expenditure incurred on collecting it, would give us a net profit of R54 per maund or R1,080 per acre in 50 years, and if the rubber trees have a longer life, the yield may be reckoned for their remaining years of life at the same, if not at a higher rate.

16. An acre of first-class timber trees would cost about double as much to plant and maintain at the rate of 60 trees per acre; and taking the value of the trees at R10 each (the present royalty charged), this would give us R600 only, as compared with R1,080 from rubber, and most of the first-class timber trees will require 100 years to reach maturity, or double the time of a rubber tree. This means, in other words, especially if the compound interest on the capital used is taken into consideration, that an acre planted with rubber-trees will give about four times as much revenue as an acre planted with first-class timber trees.

17. It may be, and in fact has been, argued that rubber might be produced artificially, and that thus a fall in the price might be brought about. I think there is little to be feared in this respect, not more so than timber has to fear from the extended use of iron; and rubber being a raw product, has a great advantage, inasmuch as the artificially produced article would have all the cost of manufacture added to the cost of raw materials, and I myself have not the slightest fear in this respect. The price of rubber has been very high for many years now, and during this time it is known that efforts have been made to produce artificial rubber, but that they have failed.

18. It now only remains for me to consider the value of *Ficus elastica* as compared with other trees yielding rubber, both as regards quality and quantity, and although it must be admitted that the rubber yielded by our indigenous tree is slightly inferior to that from some other rubber trees, the difference is so little that in my opinion it has nothing to fear in this respect, and as to the quantity yielded by other species we have positively no authentic information to make comparison; but I am very doubtful whether any of them will yield more than *Ficus elastica*, and certainly the difference, if any, could not be so much as to make the cultivation of the latter unadvisable.

19. Of the two exotic rubber trees which have been tried in Assam, viz, *Hevea braziliensis*, the Para rubber, and *Manihot glaziovii*, the Ceara rubber, the former has failed completely, as the climate of Assam is altogether too cold for it, and although the latter tree grows remarkably fast during the first year or two, and seems to thrive very well, its appearance is not at all such as to make me hope that it will do as well, as our indigenous trees, much less that it will do better. Nothing positive can be said on this score until experiments with both have been made under careful supervision by a competent and responsible officer.

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—*Indian Agriculturist.*

NOTES ON THE EXPERIMENTAL TAPPING OF RUBBER-TREES IN THE CHARDUAR PLANTATION, ASSAM.

Experiments in tapping 21 selected trees in compartments two and three of the Charduar rubber plantation during the years 1896-97, and 1897-98 the results of which are shown in detail in Appendix VI of the Assam Forest Report for 1897-98, gave a yield of 23 seers in 1896-97, and of 24 seers in 1897-98. The trees experimented on have been lightly tapped, and show no signs whatever of having suffered in any way; there appears to me, therefore, to be no reason to suppose that other trees in the plantation of similar age, the oldest experimented on being over 20 years and the youngest 17 years, would be damaged if subjected to similar light tappings.

The compartments that contain trees not less than 17 years of age, that is, in which vacancies were finally filled up over 17 years ago, are Nos. 1, 2, 3 and 4. These compartments cover 318 acres, and contain 5,221 trees, as ascertained by actual counting; of these alternate trees (say, 2,600) were overtapped for three successive years in 1889, 1890, and 1891, with a view to killing them out, as the trees had been planted too close together to admit of proper development of their crowns, on which the full growth of a tree depends. It was found, however, that no amount of tapping affected the continued growth of the tree, and the opening out of the roots showed that all the trees in these compartments had become fairly anastomosed, or, in other words, that the plantation had become practically one huge tree.

The question now for consideration is whether the systematic light tapping of all the trees in the compartments Nos. 1, 2, 3, and 4 should be carried out every year, under the personal supervision of the Divisional Forest Officer and his Divisional Forest staff as an experiment, and with the view to Government's obtaining some present return for the expenditure incurred in forming the plantation. This expenditure from 1873-74, when work on the plantation commenced, up to 30th June 1898, amounts to R1,67,627, or R75-8 per acre for the 2,218 acres that had been planted up to that date, including 518 acres that were disforested in 1896-97 for tea cultivation.

The present value, taking it to be the cost debitable to the existing plantation, may be accepted as :—

	R	R
Total cost incurred up to 30th June 1898 ...		1,67,627
Deduct—		
Value to be recovered for rubber-trees on 518 (sic.) acres disforested, fixed by the Government of India at R39 per acre on 482·87 acres actually established ...	18,832	
Expenditure that may be written off as incurred on the experimental stage *i.e.*, on learning how to plant rubber successfully, taken to be cost up to 1880-81 and partly up to 1882-83, up to which years almost all previous plants had to be replaced	34,000	
Sales of rubber, seed, and seedlings, 1897-98 ...	1,050	
		53,882
Balance ...		1,13,745

which on 1,700 acres of plantation existing on 30th June 1898, equals R67 per acre. With the experience gained, it is estimated that future extensions will cost a maximum of R40 per acre.

Tapping lightly all the trees in compartments Nos. 1 to 4, including the 2,600 that it was attempted to kill out and the 21 that have been experimentally tapped during each of the last two years, may, it is expected at a *low* estimate, give the following results :—

	Mds.	Srs.
Two thousand and six hundred untapped trees may be expected to yield annually an average of 1 seer per tree ...	65	0
Two thousand six hundred and twenty-one tapped trees at ½ seer per tree	32	30
Total ...	97	30

say, 8,000 lb., the cost of collecting which will be 8 annas per lb., or R4,000.

The value in London of the samples sent from the plantation tappings in 1896-97, through the Reporter on Economic Products to the Government of India, was 2s 8d. per lb. The report on the value of samples (24 seers) sent to that officer, the result of tappings in 1897-98, has not yet been received.

Mr. W. H. B. Lawes, Superintendent, Bashwanta Tea Company, has kindly placed the following information at my disposal regarding the result of tappings of 121 rubber trees that were planted about the coolie lines of Dikorai garden, some 17 to 20 years ago, and have not been looked after, having been cut about from time to time by the coolies. These trees were lightly tapped by tappers supplied by the Deputy Conservator of Forests, Darrang Division, and rubber was shipped to London early in 1898.

Rubber obtained by tapping		180 lb.
Rubber sold in London		170 ,,
Consigned in London to Messrs. George Williamson and Company; realised in London on 170 lb. at 3s. 3d. per lb. £27-12-6 (say)	415 8	
Deduct—	R As.	
Cost of tapping	90 0	
Freight to Calcutta, R1 per maund (say)	2 8	
Freight, Calcutta to London, and other charges, £2-2-6 (say) 3 annas per lb. on 180 lb.	32 0	
		124 8
Profit ...		291 0

or R2-6-0 per tree.

From the above data and statistics it may be assumed that, taking the sale value of the rubber in London at 2s. 8d. per lb. as reported by the Reporter on Economic Products, the financial results of the annual experimental tappings proposed may be safely estimated as follows:—

Sale value of 8,000 lb. rubber in London at 2s. 8d. per lb., at 1s. 4d. per rupee		16,000
Deduct:—	R	
Cost of tapping 8,000 lb. at 8 annas per lb.	4,000	
Freight to Calcutta at R1 per maund, say	98	
Freight, Calcutta to London, and other charges at 3 annas per lb.	1,500	
		5,598
Profit ...		10,402

which equals about R2 per tree, or on 318 (sic.) acres, R32-11-4 per acre, and on cost per acre over nearly 50 per cent.

I have been somewhat diffident at putting forward proposals for systematic tappings for fear of eventual evil results on the capital value of the plantation as a property in which a considerable amount of Government money has been expended. I think, however, that, *given proper personal supervision by the Divisional Forest Officer and his staff*, the time has come when at least the experiment should be tried on the most mature area of 318 acres out of the 1,700 acres that have been planted up, and I therefore advocate, after having visited the plantation again, that action should be taken in this direction during the present tapping season.

A. L. Home,
Conservator of Forests, Assam.

Dated Camp Tezpur, the 10th November, 1898.—*Indian Forester.*

CEARA RUBBER.

Relative to the extraction of rubber from the ceara rubber (*Manihot Glaziovii*), Mr. Hooper shows by the results of the experiments that the scheme of preparing rubber from the dry bark of this introduced tree is impracticable. He adds:—

"I have since made a microscopical examination of the inner bark with the result that while the laticiferous vessels or caoutchouc ducts are not absent, they are scantily distributed in the bark and are undeveloped and in some cases empty. While the cultivation of the ceara rubber trees has been fully established in Southern India, it is a matter for regret that the climatic conditions or soil are not suitable for encouraging the secretion of rubber in the trees to make their introduction a commercial success."

REARING INDIA-RUBBER PLANTS IN DEHRA DUN.

I received about 4 lb. of Assam India-rubber seed from the Director, half of which was sown in nursery beds, which were specially prepared with one part pieces of bricks, one part charcoal and one part dried cowdung well ground, on the 23rd April, 1898. This did not germinate till the end of the first week of June, 1898, *i.e.*, it did not germinate till the rains had commenced, although the nursery beds were well-watered and kept moist. Of the remainder of the seed, $1\frac{1}{4}$ lb. were sown in nursery beds on the 7th July, 1898. The first lot of the seeds sown germinated well, but the seedlings being very small and not able to catch hold of the soil, were washed away when the heavy monsoon rains came. The second lots of seed began to germinate five days after sowing, but the seed was so light, that much of it was washed away. The remaining $\frac{3}{4}$ lb. of the seed was sown on the 7th July, 1898, in 16 boxes and flower pots, and the boxes and flower pots were kept in the potting sheds, where they could get little light, in the School compound and fruit garden. The following was the compost in which the seed was sown in boxes and pots; one part, half-inch or smaller pieces of bricks, one part charcoal, half-inch pieces, and one part leaf mould with a little dried cowdung well ground for top dressing. The seed began to germinate five days after sowing and continued to germinate till the 15th August, 1898.

From the nursery beds I got 108 plants of India-rubber; the remainder of the plants and seeds were destroyed or washed away in the monsoon rains, though carefully protected with thatch. From the 16 boxes and pots I got about 1,600 plants, out of which about one thousand plants have been potted and basketed and about 600 plants, being very small are still in the boxes.

From the above experiment I conclude, that India-rubber seed requires for its germination that the atmosphere should be well charged with moisture, so that the dry season is unsuitable. The best time, therefore, to sow India-rubber seed at Dehra is during the early part of July; it also germinates in August, but it is almost too late, as the whole of the seed will not be able to germinate before the atmosphere begins to cool, and also the young seedlings have no sufficient time to grow before the cold season begins. The sowing of the India-rubber seed in the open is objectionable because the rain, either directly or indirectly, when tatties are put over the nursery beds, destroys and washes away the young seedlings and seed. The best way to grow India-rubber seed is to sow the seed in boxes and large flower pots in the compost mentioned above, and place them in potting sheds or verandahs, where they can receive a little light, and never to allow the boxes and pots to get dry. The watering should be carefully managed, so that the seedlings are not rooted out and the seed is not washed away.

BIRBAL.

THE GROWTH OF THE SEEDLING.—At first a pair of cotyledonary leaves appear, which are, about one-tenth inch in diameter, orbicularovate, emarginate, dull green, minutely petioled. Above these come out a pair of opposite leaves. These are stipulate (as are also all succeeding leaves), slightly crenate, distinctly emarginate, membranous, with faint indications of arcuate nerves at the sinuses of an intramarginal vein, very shining above until superseded by the next leaf; one of the two leaves is somewhat larger than the other. Above these the leaves are sub-opposite when they appear, but soon become distinctly alternate by the elongation of the stem, each succeeding one larger in size than the one next below, and much brighter especially when fully grown. The fourth leaf above the cotyledons is about 1 by ·6 in., ovate, distinctly crenate, emarginate. The next two leaves, the 5th and 6th, are oblong, 2 to 3·5 in. long, still emarginate, but the crenations are very shallow in the last leaf; lateral nerves 4 to 6 pairs, slightly arcuate. Then comes out the 7th leaf, all by itself, 3 by 1·2 in., oblong, with 6 to 8 pairs of parallel nerves and 2 to 3 intermediate ones between, no longer emarginate, but acute and almost entire, with a row of white glandular dots along the margins. This is the first leaf that reveals the identity of the plant, beyond this the leaves become thicker and thicker, the 11th being about as thick as a normal India-rubber leaf. By the time the 5th leaf appears, a swelling is noticed below the root-collum, which goes on increasing in size, as is seen in Fig. 3. Neither *F. bengalensis* nor *F. religiosa* seedling has any swelling of this kind.

UPENDRANATH KANJILAL.

—*Indian Forester* for March, 1899.

RUBBER AND FOREST PRODUCE IN BRITISH GUIANA.

The headquarters of the Balata industry are in Berbice, the trees being abundant in certain localities on low lands bordering the Berbice, Canje and the Corentyne rivers. The local distribution is, however, unequal and variable. The trees are also found in the western parts of the Colony in tracts on the Pomeroom, Waini, and the upper reaches of the Cuyuni rivers. The yield per tree varies a good deal, not only in regard to size but also the seasons of the year. The largest trees may yield as much as 12 to 20 pounds of balata, whereas a young tree a foot in diameter will yield only about four or five pounds. In collecting balata the tree is often cut down, and the timber, which is valuable, is sacrificed merely for "the juice contained in the bark." As the interior of the Colony is opened up, this timber would be accessible and capable of being exported. Latterly the Government has issued regulations which have tended to restrain the reckless cutting down of bullet trees. Grants are limited to a frontage of four miles on a creek or river. This necessarily limits the area to about 20 square miles, for the bleeders do not care to go many miles in, as they almost invariably bring out their milk to the riverside to sun or air dry it. A number of grants of the same size can be taken out together, or in other parts of the country by one person.

Rubber.—There are probably several species of trees yielding indiarubber to be found in the Guiana forests. One, the Hatie (*Hevea Spruceana*) is closely allied to the tree yielding the Para rubber of commerce, the most important caoutchouc tree now existing. The Hatie is found in the upper basin of the Essequebo and Mazaruni 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 theplant 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).

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 fiill the vacant places. The cost of this plan would not be considerable, as the trees would require little attention after they are well started.

The forest lands at present yield a yearly revenue of about 48,000*l*, made up of "acre money," royalty on timber, shingles, charcoal, balata, and gums. Considering the vast extent of the forest region of the Colony this is a trifling sum, and probably nearly all of it is absorbed in the cost of collection. These forests, rightly controlled, should constitute an important source of wealth to the Colony. Owing to the difficulty of reaching the region above the falls, the forests below have been cut over several times and the best timber removed. In some localities firewood cutters and charcoal burners are destroying valuable timber and preventing the growth of young saplings. The time has arrived when the Government might take in hand an investigation of its forest resources and employ a competent forest officer from India or elsewhere to advise as to the best means of regulating and developing them. The Guiana forests are the most valuable of any in the West Indian Colonies. Hitherto they have only been partially protected and it is evident that they are in danger, at least in the most accessible districts, of being seriously injured. The vast regions above the falls are safe only from their inaccessibility.

If suitable means of reaching them could be devised, and the cutting carried on under proper regulations, they would be capable of supplying valuable timber and contribute largely to the wealth of the Colony.

CEARA RUBBER.

(*Manihot Glaziovii*, Muell. Arg.)

(From *Kew Bulletin*, dated Jany. and Feby. 1898.)

A SUMMARY OF INFORMATION AND RESULTS OF EXPERIENCE UP TO DATE.

The plant yielding what is known in commerce as Ceara rubber or Manicoba, and shipped from the Brazilian ports of Ceara, Bahia and Pernambuco, was identified at Kew eleven years ago. The following note on the subject appeared in the *Kew Report*, 1877, p. 17 :—

"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, RioJaneiro, 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 moderately-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 turf 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 andplants 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 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 of 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, 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 4s. 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 up 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 radical 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, Jamica, &c., flowered at the age of eighteen months, and at the present time (at 2½ years) the larger ones from 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 results 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 Society 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 lb. 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. Trimen 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 lb. 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 lb. 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, 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 Nilambur. 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 artifical watering is required during the subsequent dry season. This is what I have done with a hundred seedling 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 lb. 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 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 forwárd, 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 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 of 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 propagate 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 troublesome weed where once introduced to a plantation."

NATAL.

The *Kew Report* for 1880 (p. 18) records :—

"Mr. Keitt, 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 cilmate 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*, 1899, 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 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, ¼ 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 lb.) 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.

RUBBER IN TRINIDAD &c.

The experience personally gathered during twenty-three years of active service in the West Indies; what has been gathered from writers on the subject who have detailed their observation from the point of view of both traveller and cultivator; and from actual travels and observations personally made in Nicaragua and other parts of Central America : lead to the conclusion that for the present, the most valuable rubbers for planting in Trinidad and Tobago are, *Castilloa*, *Hevea*, and *Ceara*. The first mentioned is the kind from which a crop can be most quickly obtained, and is the fastest grower; Hevea produces a finer rubber, but takes longer to grow, and therefore is most suitable for permanent plantations ; while Ceara, is best adapted for culture at higher elevations, in poor and dry land, and is not at all suitable for planting in low and wet lands.

The following extracts, I think, will be found to strongly support these views :—

Central American Rubber.—*(Castilloa elastica)*.—Robert Cross, the well known collector, in his report on collecting seed of the various rubbers furnished to the Indian Government says: "My own opinion is that planted in suitable place and properly wrought it will be found to give a larger return per acre than any other plant or tree cultivated in India."

In the Indian Forester, 1881, reprinted in "All about rubber" by Ferguson, Ceylon, Cross again says: "*Catilloa* is always found growing throughout the Central American Republics always at low elevation, and I have nowhere noticed it above 2,000 feet. The seeds cannot be dried but must planted as soon as the fruit falls." It is not found growing in swamp or inundated land, but on flat moist banks of rivers. Of all the different species of rubber-producing trees the *Castilloa* should prove under cultivation the most remunerative.

Mr. Cross further reported to the madras Government (March, 1881) that a tree of *Castilloa* 1½ to 2 feet in diameter should give 12 lb. of rubber per annum.

In 1882 the late Dr. Trimen of Ceylon wrote:—The trees of *Castilloa* are now six years old, the largest is 26 inches in circumference at a yard from the ground and made an increase of girth of 3½ inches during the year.

In 1884 he again wrote:—The measurement of the largest tree 43 feet high and 32½ inches in circumference at three feet from the ground.

In later reports from Ceylon it is seen that *Castilloa* has not received so much attention; but that more energy is devoted to the development of plantations of *Hevea* or Para rubber, of which Ceylon has now large quantities.

PARA RUBBER (*Hevea brasiliensis.*)—In 1888 Dr. Trimen strongly recommended the Government of Ceylon to start large plantations in suitable places, and speaks of a ten year old tree having a girth of 49 inches at 3 feet above the ground. In 1889 experiments were conducted with the object of ascertaining the relative flow of latex from *Hevea Castilloa* and *Ceara*. It was found to be as follows:—From *Hevea* 4 oz. was obtained in 3½ hours; From *Castilloa* 4 ozs. in 2 hours, and from *Ceara* 4 oz. in 5 hours.

A tree yielded in 1888—1 lb. 12 oz.; in 1890—2 lb. 10 oz.; in 1892—2 lb. 13 oz., and was reported to be no worse for the treatment, and seed sold st 10 rupees per 1,000.

In 1893 Dr. Trimen reported:—"Though I have expressed the opinion that this is a cultivation more suited to a Government Department than for private planters; yet if the cultivator can afford to wait for about 12 years. there is little doubt of a profitable return." The tree previously tapped in alternate years was in 1894, reported as yielding 3 lb. 3 oz. of dry rubber, Commenting on the increase of yield with age Dr. Trimen remarked:—"I do not think it desirable or indeed of any use to commence bleeding the trees before they are at least 10 years of age."

CEARA (*Manihot Glaziovii.*)—Cross reports:—"The tree is nct pelicate, and will grow and produce rubber in situations where other kinds if planted would be dried up. For these reasons it is likely to prove a valuable plant in India in parched up regions and unproductive land but thinly covered with soil."

In 1883 Dr. Trimen reported 977 acres as being in cultivation in Ceylon with *Ceara* rubber, but that no export had been made. In 1884, he writes that a tree 8 years old, on being cut down, gave 1½ lbs. of dry rubber, but adds:—"I have nothing further of a practical nature to report, as to the method of collecting *Ceara* rubber at a cost sufficiently low to make it profitable to the planter." He had previously reported 1882:—A tapping was made at the end of April (dry weather) and about 20 oz. of dry rubber was obtained from 10 trees. One afforded 4 oz., but another which had been bled the year before gave hardly 1 oz. In 1883 he wrote:—"while it is found that the yield of individual trees varies extremely, none of the experimenters are satisfied that the small quantity of rubber obtainable by present methods is sufficient to make the industry profitable at the existing price of rubber.

The present prices of rubber, it must be noted are much above those of 1883, and it is therefore probable that on a certain class of lands, it may be now a profitable business to cultivate this kind of rubber. It must be fully understood that the cost of starting and maintaining rubber plantations, whether of *Hevea*, *Castilloa* or of *Manihot*, is very low in comparison with that of other tropical cultures; and that, what would be an unprofitable crop 15 years ago, may now be a paying industry.

The latest market rates for rubber (July 1898) show that *Hevea* or Para rubber is worth 4s 2d. per pound, *Castilloa* or Central American, 3s. 9d., African 2s 2d. Colombian 3s. 3d., and various others at rates ranging from 2s. 2d. to 3s. 3d.

Specimens of rubber produced by trees in the Royal Botanic Gardens have been valued: *Castilloa* at 3s. 7d., and *Hevea* at 4s. 2d., and the quality of the rubber has obtained high commendation. It is found that by exercising care in the preparation, the value of the rubber is greatly increased.

A tree of *Hevea brasiliensis* over forty feet in height, several of *Castilloa* of similar size, and a single *Ceara* tree of 25 feet, can be seen at the Royal Botanic Gardens.

Hevea will grow in moist lands, and become in time large forest trees, requiring but little shade except in their earlier stages. *Castilloa* is best put out under shade, and even in its mature stage, it rejoices in shady situations. *Ceara* rubber requires a dry situation, but does not require direct shade. It will however be benefitted by the protection afforded by high growing trees planted at considerable intervals. I am of opinion that properly and economically conducted the growth of rubber trees of the kinds mentioned, and probably others, not yet so well known, offers a safe and suitable investment in the Islands of Trinidad and Tobago.

J. H. HART, F.L.S.,
Superintendent, Royal Botanic Gardens.

4th August, 1898.

COAGULATION OF RUBBER.

In an article in the Board of Trade Journal for July, "The Brazilian process of smoking rubber" (*i.e.*) the old process of smoking the latex for the purpose of coagulating it, is once more described. Reference is also made to a process of separation by centrifugal action, and to a possible treatment with Carbon bi-sulphide.

R. H. Biffen in Annals of Botany for June 1898, deals with the subject of coagulation from several points of view, and records experiments with various classes of rubber. He describes the separation of rubber with a centri-fugal machine and subsequent coagulation, by pressure, by drying, and by heating; and states that no coagulation takes place, if the separated particles are throughly washed with water and treated with alkalies. (p. 168 Ann. Bot.)

At page 167, Mr. Biffen states however, that, *the addition of alkalies bring about coagulation in the latex of Castilloa elastica*" and further says, "*the addition of acids does not cause coagulation.*"

Now in the course of experiments made in the Royal Botanic Gardens, some fresh latex, to which four volumes of water had been added, was treated with pure acetic acid, which coagulated it in the space of a few minutes.

Further trials showed that the addition of 10 per cent. of acetic acid to latex having 100 per cent. added water, readily coagulated and produced a clean white rubber, which if kept in the dark, oxidized but slowly.

Another experiment showed that if, after the addition of water, the mixture is well shaken; the globules of rubber (having a lighter specific gravity than the albumenoids and proteids contained in the latex) will float quickly to the surface. It is found moreover that on the addition of further volumes of water and the removal of the albumenoid liquors from below the floating rubber, the globules rise much more quickly to the surface.

Good rubber can therefore be made without loss, by simply washing out the albumenoids and other matters from the latex. Coagulation it is true is not effected by washing, but as Mr. Biffen shows, this can readily be effected, either by pressure, by drying, or by heating, and in our experiment much quicker by heating, if done in the presence of acetic acid. Tubes treated with acetic acid, and then heated readily gave up the rubber in successive clots, until the residual liquor was perfectly clear.

The rubber produced by the washing process is apparently as clean as could be desired, and although it must necessarily contain some water, it has not been found to hold sufficient to cause decomposition.

It is fairly clear that the latex of Castilloa lends itself readily to this method of separation, and it is therefore quite possible that if due advantage is taken of the fact, that the specific gravity of the rubber globules is lighter than water, methods will soon be in use by which it can be quickly and cheaply coagulated without the assistance of either acids, alkalies or smoke.

A process by which clean sheet rubber can be easily produced is now being worked out in Trinidad and from the foregoing it is evident we think, that it has a considerable prospect of success.

August 9th, 1898. J. H. HART, F.L.S.

METHODS OF PREPARING RUBBER.

By R. H. Biffen.

So much has been written within the last few years on the subject of India-rubber, the sources of our supply, and the possibility of acclimatizing the best-yielding trees in our colonies, that at first sight it may appear that there is little more to be said. A study of the methods in use for preparing rubber from the latex, or milk may however be of use to many interested in the formation of plantations, especially if some attention is paid at the same time to the inaccurate statements made in some recent publications, which apparently have disregarded the valuable series of papers on the subject contained in our one journal devoted to economic botany, the "Kew Bulletin."

The methods in use at present are either the out-come of the limited experience of uncivilised people, or the application of experiments made without paying due attention to what is known of the chemical constitution and physical properties of latex. As a good example of the latter we may take the experiments of Morisse,* who found that coagulation was brought about in the latex of *Hevea* by the addition of alcohol, pheno, hydrochloric acid, nitric acid, sulphuric acid, calcium chloride, ferric chloride, corrosive sublimate, &c.

As the out-come of these experiments, a mixture of phenolin alcoholic solution, and dilute sulphuric acid, was recommended as a coagulating agent.

The latex is, as a general rule, a thick, white fluid, composed of small particles of rubber in suspension in a clear watery solution of various substances. Unfortunately, only the latex of a few trees has, as yet, been chemically examined when fresh.

The analysis of the latex of *Hevea brasiliensis* shows that it contains :—

Rubber	32 per cent.
Proteid matter	2·3 ,,
Calcium and sodium salts	9·7 ,,
Resin	traces
Water	55 to 56 ,,

It is slightly alkaline to litmus paper.†

The presence of albumin, globulin, and other proteids, has been demonstrated by Green‡ in some other rubber-yielding latices.

As a general rule all these substances are to be found in rubber as it is at present prepared, often with others added to bring about coagulation of the latex, and accidentally or intentionally added impurities such as bark and clay. In all cases the percentage of impurities is large, how large we shall see later, and when it is remembered that some cause a rapid deterioration of the rubber, it is obviously much to the interest of

* Seeligman, Lamy, et Falconnet; "Le Caoutchouc et a Gutta-percha." Paris, 1896. p. 68.

† "Le Caoutchouc," &c., p. 94.

‡ Green, "Proc. Roy. Soc.," 1886, p. 28.

those connected with the industry that a method of preparation should be adopted which would minimize them or ensure their absence.

I propose now to consider a few of the better-known varieties of rubber.

Para Rubber is the product of *Hevea brasiliensis*, a tree which thrives in many parts of the Amazon valley, British Guiana, &c. As pointed out by Churchill* in his consular report, there is no danger of this source of supplying becoming exhausted, though this is the frequent cry of companies formed for rubber-planting, usually fated for an ephemeral existence. The tapping is done with considerable care by the natives, and even should a district become exhausted, in a few years a fresh supply of trees springs up. From the planters' point of view Brazil is hardly a suitable country, for the climate is bad, it is difficult to obtain labour, and the exchange is *liable* to endless variations. The trees have, however, been introduced into Ceylon, where small plantations exist, and into other colonies†. The method of preparing the rubber has been so frequently described that repetition is needless; "transalation of a valuable article on rubber of the Orinoco"‡ has received so much attention of late that it requires some examination. One of its most striking errors is the following:—"As the juice contains a considerable quantity of water, the preparation of rubber consists essentially in separating the former from the latter, which is performed by evaporating the water by means of a heating process or obtaining its coagulation by certain chemical process. Although the last system is more rapid they prefer the former, as they pretend that the rubber thus obtained is of a superior quality —a supposition devoid of all reason."

As I have already had occasion to show,§ this statement is incorrect, for the heating continues for too short a time; ("the rubber" *is not* "dried in a few minutes") to evaporate off some 50 per cent. of water, and further there is no loss of all reason," for it is a well-known fact that the smoked rubber is far preferable to that obtained by chemical process. A comparison of the prices of "Parà fine" "and sernamby" should be sufficient proof of this. Why it is so may be made clearer from the following experiment. At the end of a day's work I had several litres of latex left, to which an equal volume of water had been added, which would not keep over night without coagulating. To this a small quantity of acetic acid was added, and in a short time the *whole of it* had formed a stiff curd. On pressing and drying, a portion of the water exuded from this mass of sernamby, but it still remained full of cavities, and the proteid matter in it quickly decomposed, so that ultimately a stinking, inflated mass was obtained.

If this latex had been coagulated by smoking it would have yielded a wet rubber, but the subsequent decomposition of proteids would not have set in, for the creosote contained in the smoke would have acted as an antiseptic land prevented decomposition, as it does when meat is preserved by smoking.

Then again we find, "the rubber thus prepared (by smoking) acquires a darkish colour, due to the particles of coal which adhere to the outer skin. Some people believe that this tends to improve it, but such is not the case, for it is thus impregnated with impurity."‖ Now when these "bottles" of rubber are cut across, the fresh, laminated surfaces are a silvery grey colour, as each layer is exposed to the same extent to the action of the smoke it is difficult to account for the outer layers only being so coloured. The freshly cut surfaces however soon darken and become black in turn, so that the explanation of oxidation seems far more probable, especially when taken in conjunction with the fact that smoke is white¶ and not black,** for the nuts are simply dry-distilled and not actually burnt. If the smoke of these heated urucuri nuts is condensed it forms two layers of liquid in the receiver, one a clear limpid solution consisting mainly of acetic acid, the other, darker in colour, of creosote.

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* "Kew Bulletin," 1898, p. 241.
† "Kew Bulletin," 1893, p. 159.
‡ "Trinidad Bulletin." 1893, No. 18, and 1897, p. 36.
§ "Biffen, "Anns. Bot." 1898, p, 165.
‖ "Trinidad Bulletin," 1897, p. 38.
¶ Compare the plate on page 757 of the "Journ. Soc. Arts," 1898.
** "Trinidad Bulletin," 1897, p. 37.

The hot vapour of acetic acid brings about the coagulation of the proteids of the latex, as may easily be proved by direct experiment.

A solution of alum is said to be in use for preparing rubber in some parts of the Amazon valley. Morisse* states that alum solution has no effect upon the latex of Hevea species however.

The loss in the factories on making up Para rubber is as follows†;—(1) Para fine, 10 to 15 per cent.; (2) Entre-fine, the carelessly smoked pieces, 15 to 20 per cent.; (3) Sernamby, rubber pulled from the cuts on the tree and cups, coagulated by being allowed to stand, &c., 20 to 40 per cent. From these data we may safely conclude that the smoking method of preparation is by far the best in use at present, a view which will be further strengthened when we compare the losses on making up other sorts of rubber.

Ceara Rubber is the product of *Manihot Glaziovii*, a tree growing chiefly in the highlands of the State of Ceara, Brazil. Cross is responsible for most of the descriptions of the locality in which it grows, but as his experience of it appears to have been limited to Pacatuba, in which place its habitat is far from typical, they are not very accurate. He records it as growing at an elevation of 200 feet above sea level, among granite boulders, in a country whose dryness was indicated by the fact that "ferns, weeds, grasses, and mosses" were absent. True, it does grow among granite boulders, in the scantiest of soil in such localities, but it is more at home in the mountains, up to a height of 3,500 feet, and even more, where there is an abundant rainfall. These facts will serve to show the wide range of conditions the tree will put up with, and were it not for the smallness of its yield (1 to 3 lb. per annum) it would be invaluable for introducing into many of our colonies. Coagulation is brought about either by smoking, as on the Amazons, or by simply allowing the latex to dry on the tree-trunks or soil.

The latter methods are objectionable, as the rubber invariably contains pieces of bark or grit.

It may also be prepared by churning the latex, and pressing the resulting clots. The method is not to be recommended though, for even if the clots are cut into thin slices and exposed to the heavy pressure of a mandiocca press, a considerable percentage of water remains in its cavities, and decomposition sets in, but not to the same extent as in "Ceara scrap."

Although so impure it commands a price usually second only to "Para fine." The loss is from 20 to 25 per cent., which, in inferior qualities, may even amount to 55 per cent.

Mangabeira rubber also comes from Ceara. It is the product of *Hancornia speciosa*, a dwarf tree with somewhat the habit of a birch. The rubber is prepared by the addition of an excess of salt to the latex, or by Strauss' method of adding alum. Even after thirty days' drying in the sun it is spongy and full of cavities of liquid. As might be expected, the loss on purification is enormous, amounting to from 40 to 60 per cent.

By this method of coagulating with chemical re-agents it is impossible to get rid of the coagulated proteid matter, to say nothing of the greater part of the water. Morellet's‡ remark that "le procedé Strauss est ingenieux, mais les resultats de son application sont mauvais" may well be applied to all these chemical methods, and the sooner the search for coagulating agents is abandoned the better.

The only other American rubber of importance, at present, is yielded by *Castilloa elastica*. It appears on the market in a number of different forms under the names of Mexican, Nicaraguan, &c. As far as we know *C. elastica* is the only species of the genus yielding rubber, for the *C. Markhamia* of Collins turns out to be a *Perebea* species.§

The latex is obtained in a rough and ready fashion by hacking a spiral channel from the crown of the tree to the ground, or by making great gashes with a machete.

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* "Le Caoutchouc," &c., p. 67.
† "Le Caoutchouc," &c., p., 75.
‡ "Le Caoutchouc," &c., p. 64.
§ "Kew Bulletin," 1887, p. 13. *c.f.* "Trinidad Bulletin," 1898, p. 21.

Collins* has recommended a timber-scoring knife for tapping, and since then most writers have followed his lead. On experimenting with one, I found it was practically useless, as little latex exuded, possibly owing to the closure of the vessels by the drag of its edge. Stabbing with a broad-bladed knife, or with a chisel, as practised in Ceylon,† gives good results without much damage to the tree. In the previously-mentioned article in the "Trinidad Bulletin" (1848), there is some slight confusion as to the localities suitable for the growth of *Castilloa*. In one place (p. 122), "it will scarcely thrive in regions that are not equally suited to *Hevea spp*," which (p. 130) grow "on land which is periodically inundated even to a depth of five feet." Then (p. 121), "the tree (*Castilloa*) avoids marshy or boggy land, and manifests a preference for warm, deep loam, or sandy soil." The latter statement is the correct one.

The most general method of preparation in Mexico is to add an extract of the leaves and stem of the moon-flower (*Ipomoea bona-nox*), and allowed the mixture to stand over-night. The floating clot which forms is then pressed to remove some of the water.‡ As in all these cases of preparation by "wet" methods the rubber contains large quantities of water, it loses from twelve to thirty per cent. on drying. Another method is in use in Nicaragua.§ The latex is mixed with about three parts of water, and allowed to stand over-night, when the rubber comes to the surface in particles are mixed with a fresh supply of water, and the process is again repeated. The particles are then brought into a solid mass by pressure. The latest account of this method is apparently given by Hart, in an article on the "Coagulation of rubber."‖ who appears to have re-discovered it. I quote it in full as I may be mistaken. "After the addition of water, the mixture is well shaken; the globules of rubber (having a lighter specific gravity than the albumenoids and proteids [*sic*] contained in the latex) will float quickly to the surface. It is found moreover that on the removal of albumenoid liquors from below the floating rubber, the globules rise much more quickly to the surface."

The following criticism of this "creaming" process is given in "Le Caoutchouc et la Gutta Percha":—"Ce mode de préparation est bien rudimentaire et ne peut fournir qu'un produit de qualitè infèrieure, qui perd souvent plus de 50 per cent. surtour lorsqu'il fraichement prèparé. "¶

Recently there has been some talk of extracting rubber from leaves and twigs by means of solvents, as has been done in the case of gutta-percha. A description of this latter process may therefore be of interest. It originated in the smallness of the yield of the *Isonandra gutta* trees, a tree from 25 to 30 years old, only giving 1·3 lb. of gutta-percha when felled. The explanation of this fact is to be found in the work of De Bary,** who showed that the laticiferous system of the tree consisted of short, closed sacs. This being the case, a great many would remain unopened, and thus a considerable per-centage of the gutta-percha would remain in the bark. As the demand for gutta-percha has been large, and the supply has been obtained by felling the trees, they have become almost extinct.††

Serullas proposes to utilise the leaves and twigs of the shoots from the old butts to extract the gum from. They are dried, treated with caustic potash to destroy colouring matters, and treated with a solvent for gutta-percha. The solvent is then distilled off and may be used again and again.
Rather more than 1 lb. of gutta-percha is said to be yielded by 30 lb. of chopped up fresh leaves and twigs.‡‡

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* Collins, "Report on Caoutchouc."
† "Royal Botanical Gardens, Ceylon," 1898; Ser. I., No. 4, p. 30.
‡ Belt, "Naturalist in Nicaragua." p. 33. Morris, "Colony of British Honduras," p. 76.
§ "Le Caoutchoue," &c., p. 62. "Kew Bulletin," 1887, xxviii., p. 16.
‖ "Trinidad Bulletin," 1898, p. 131.
¶ "Le Caoutchouc," &c., p. 62.
** "Comp. Anrt. Phan. ana Ferns," p. 151.
†† "Serullas," "Kew Bulletin," 1891, ccxiii., p. 230.
‡‡ "Kew Bulletin," ccxiv., p. 231

For several reasons I do not think this process could profitably be applied to the preparation of rubber. The most important of these are (1) on gathering the leaves and twigs there would be an immense loss of latex, and (2) stripping trees of their foliage (the part which builds up their food supply) invariably kills them.

The direction in which research work should tend, I venture to think, is to prepare rubber free from the other constituents of latex, so that among other things, freight and customs charges on these impurities may be avoided.

Now it has been shown conclusively that the chemical constitution of latex varies with its source, so that it is improbable that any one re-agent can be found capable of coagulating any given latex. Thus from the fact that acetic acid coagulates the latex of certain Hevea species, it cannot be argued that it will coagulate the latex of a Kicksia species.

Then expert opinions, as we have seen, show that the preparation of rubber by these chemical means is not satisfactory, for the product is far from pure.

I have recently succeeded, however, in preparing pure rubber by a physical process, and so demonstrated that chemical methods are not necessary. This is effected by centrifugalizing the latex in a special form of separating machine, when the rubber particles, which have a smaller specific gravity than the medium in which they are suspended, are thrown out of the bowl in an almost dry state. They may then be converted into a solid mass by slight pressure, or by draining off the small quantity of water which remains with a porous tile. So prepared, the rubber forms a translucent mass, free from its usual smell and from all danger of decomposition.

The merits and demerits of this mode of preparation must rest entirely with me, but I cannot be responsible for any statements made in Trinidad, where a copy of my experimental machine was recently exhibited without my consent or knowledge.—*Journal of the Society of Arts.*

RUBBER—ITS CULTURE AND PREPARATION IN TRINIDAD, &c.

Botanical Department, Trinidad, April 24.

To Editors "Tropical Agriculturist."

GENTLEMEN,—I note a reprint in *T.A.* which would probably have escaped notice, had I not been a reader of your periodical. As it was noted in your publication, it is due to you that I should send my reply to you also, and I trust therefore you will give the enclosed insertion, and Mr. Biffen is, I know, a friend of your Mr. Willis.

Yours faithfully,

J. H. HART.

RUBBER COAGULATION AND SEPARATION, &c., &c.

SIR,—In the *Tropical Agriculturist* for March 9th, I find an article by Mr. R. H. Biffen, copied from the "Journal of the Society of Arts," treating on the above subjects.

The writer exhibits a tendency to decry similar efforts as his own, and he uses extracts from the *Trinidad Bulletin* in a way to mislead those who have not that publication in hand; as he refrains from quoting the authorship of the articles. He should have told his readers that Dr. Ernst of Caracas was responsible for the statement he quotes as being "incorrect," and not the editor of the *T.B.* as he leaves it to be inferred for reasons of his own.

After discussing the value of rubber prepared in various ways, Mr. B. jumps to the conclusion that Dr. Ernst is wrong in stating that "smoked rubber is impregnated with impurity," and decides the fact by the prices realised by certain qualities on the larger markets for this class of produce. Now! I happen to have an estimate of rubber prepared without smoking *(Hevea)* given by respectable dealers on those same markets, who valued it as being quite equal to the best smoked rubber, so that a reliance upon this method of estimating quality is proved unsafe, and it may well be that, later on, when buyers have become accustomed to it, pure rubber will sell at higher prices than the smoked product.

Equally unsafe is Mr. Biffen's statement that the juice of the Moon-flower is "alkaline," for I have a qualified analyst's certificate that fresh juice sent by me was found "slightly acid." Equally fortunate is Mr. B.'s assertion that Castilloa *latex* will not coagulate by the addition of acid, as it has been found to coagulate by the addition of acetic acid (Biffen in Ann. Bot. pp. 165 et seq).

The point of Mr. Biffen's conclusions in his article in the Annals of Botany is "that the cause of coagulation must be looked for in the medium in which the rubber particles are suspended," but unfortunately for this theory it has been abundantly proved that not only can rubber be coagulated when the albumenoids are removed, but a better class of rubber produced.

An attempt follows to ridicule the statements as to the character of land suitable for various rubbers, and accuses us of "slight confusion" in the *Trinidad Bulletin.* As a matter of fact the statements are quite sound, and the confusion only exists in the writer's brain. *Hevea* will grow well in places never inundated, notwithstanding the fact that it is found in places regularly flooded, and this can be proved by trees growing in Trinidad, which have been found to stand drought with impunity, and have never been flooded.

I can well afford to pass without irritation the remark made on my supposed "re-discovery" of a method, for the method differs so much from that described by older writers, that it cannot be placed in the same category. It is a method of washing, it is true, but a very different method to any formerly described, in fact may well be compared to the washing of the steam laundry as contrasted with that of the peasant at the river side.

Notwithstanding what is said by "Le Caoutchouc" (p. 6) rubber prepared by this process is of the highest quality, as it is found possible to rash it quite free from *corps étrangers.*

Mr. Biffen claims that his machine separates the rubber particles by centrifugal action, but the real fact is, they are brought to the surface by *centripetal,* not centrifugal action.

The insertion of the word (*sic*) might also have been readily avoided by the writer, had he noted that the word "or" should have been substituted for the word "and."

I now come to a remarkable statement where Mr. Biffen says that research work should tend "to prepare rubber free from the other constituents of the latex." How this is to be reconciled with the previous *dictum* of the Annals of Botany is not quite clear. It there says "The action of centrifugal force effects the separation of the rubber, and from the failure of the processes usually employed, involving the use of chemical re-agents to bring about the clotting of the separated and washed rubber particles, we must infer that *the cause of the coagulation must be looked for in the medium in which they are suspended.*" Again we are told that "the coagula in forming gather up the rubber particles" . . . . "in the same way as the white-of-egg gathers up particles in suspension when clotted for the purpose of clearing jellies."

It must be concluded therefore that Mr. Biffen has abandoned the position he formerly took up, and is now devoted to the task of removing those very constituents he formerly stated were essential to coagulation, but which he at the same time proved could be dispensed with, for he told us that they could be "brought into a solid mass by pressure, by heating and by evaporation (Ann. Bot. p 168). Why does he use the words "brought into a solid mass"? and not the word coagulation?

Mr. Biffen records his success in preparing rubber by a physical process. He started by requiring albumenoids for coagulation, but now he is recommending separation by a physical process; and has adopted what is actually the basis of the hydro process, which he facetiously accuses me of having rediscovered. I might with equal propriety ask him whether he re-discovered the Babcock machine. If I re-discovered! so has he. I separate by water, he by physical methods, but I dry by evaporation! so does he. His rubber is free from impurities! so is mine. His method requires a machine, so does mine. Again his rubber is free from smell, so is mine, and large quantities can be prepared in a day by simple apparatus, while it would take a powerful engine to drive the machine to get through a similar quantity by centrifugal action. The quality of my rubber is equal to that prepared by other physical processes, as a voucher for which I am quite prepared to submit samples for test and the "*merits or demerits of the system*" do not rest with me, but with those who can judge of its value by actual practice; Mr. Biffen states the contrary.

Mr. Biffen repudiates statements made in Trinidad, but no one has asked him to be sponsor for them. He must however allow me also to repudiate the points conveyed by his remark that "a copy of his machine was exhibited without his consent or knowledge." As a matter of fact the machine was no "copy," any more than his primary effort was a "copy" of the Babcock ; but was of different construction, and a vast improvement upon his model, as he knows, for drawings of the improvements were placed in his hands. The "Babcock" machine was never patented, and there are consequently many modifications of it, among which are the forms under discussion which can hardly be called inventions, for such adaptations are being made daily all over the world, for the separation of materials of different densities.

I may be liable to a protest from Lefebre for pirating his ancient washing method, I may perhaps expect a raid from Central American Indians for having improved on their use of the juice of the Moon-flower ; or I may be called to account for using a modified form of butcher knife for sticking a rubber tree ; but I hardly thought I should be held responsible for having with others used the principle of the "Babcock" machine.

There is a point which I would commend to Mr. Biffen's attention, and this is the special character of the Rubber globules of *Castilloa.* Perhaps if he examines them he may find the cause of the rupture which is evidently the real cause of coagulation. This rupture can be caused in various ways, and he who succeeds in causing it in the simplest and most economical way will have solved the question of the preparation of Castilloa rubber, be it by a physical or *non*-physical process.

April 21st, 1899. J. H. HART, F.L.S.

PARA RUBBER.

(*Hevea brasiliensis*, Muell. Arg.)

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 Euphorbiaceæ, 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 are elucidated (t.t. 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 ascertained. 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 fores 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 familiar 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.
From River Purus	3,500 Tons.
,, ,, 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 valley 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:—

United Kingdom	8,843 tons.
France	2,010 ,,
Italy	65 ,,
U.S. 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 grearest 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 coconut 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 there from 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 foot paths 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 *scrnamby*, 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 a 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 overtapping, 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 twelve 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 be always 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 principal, 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 borders 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 foot paths, 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 onefourth 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 ceased 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). 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 pirarucu (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 coner 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 lb.—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 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 "negro-head"—the latter from the fancied resemblance of the mass to the head of a negro.

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 lb. 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 determind 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 3¾ 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.		ft.	in.		ft.	in.
End of 1880	1	4	End of 1885	3	7	End of 1890	5	9¾
,, 1881	1	9	,, 1886	4	1	,, 1891	6	1
,, 1882	2	1½	,, 1887	4	5½	,, 1892	6	5
,, 1883	2	6	,, 1888	5	0	,, 1893	6	7¼
,, 1884	3	0	,, 1889	5	0	,, 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 seeds 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.		seeds.
1889	8,000	1893	90,000
1891	15,000	1894	86,000
1892	16,000		

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 rain-fall 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 3 feet from the ground :—

At Edangoda	(4 years old)	average of 100 trees	.. ..	12.96 ins.
,,	(3 ,,)	,, 50 ,,	.. ..	8.75 ,,
,,	(2 ,,)	,, 20 ,,	.. ..	4.96 ,,
At Yattipowa	(3 ,,)	,, 108 ,,	on western slope	9.37 ,,
,,	(,,)	,, 108 ,,	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 2½ 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. 2½ 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 ¾-inch chisel in the inner bark. The milk mostly dried on the tree in tears, thick strings and small sheets, and that which ran down the trunk was prevented from reaching the ground by little cups of coconut-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. 12¾ 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. 11¾ oz.; in 1890 gave 2 lb. 10 oz.; in 1892 gave 2 lb. 13 oz.; in 1894 gave 3 lb. 3 oz., being a total of 10 lb. 7¾ oz. 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 10½ lb. 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
,, ,,	,,	..	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.
,, (,, ,, 1893)	200 seeds.

We have also supplied seeds to the Botanic Gardens at Buitenzorg, Java, and to the German East African 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 Heneratgoda Garden are now very fine trees, with an average height of about 60 ft. and 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 150 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 also has 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 coconuts.

"*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 ½ inch.

"*Tapping.*—The yield of rubber from very young or slender trees is too small to make their tapping worth while, and it is 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 a 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 three 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 $\frac{3}{4}$-inch chisel, a wooden mallet, a number of clean coconut-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 around 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 coconut-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, and forming the channel against the bark by 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 aimed at is 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 ten or twelve 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 ft. mean girth, the average yield per tree of the successive weekly tappings was as follows:—

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

"*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 25 and Febuary 15, yielding 17¼ oz., of rubber on six days between July 20 and August 29, yielding 7 oz., and on four days between December 6 and 20, 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.		lb.	oz.
1888	1	12¾	1894	3	3
1890	2	10	1896	3	0¼
1892	2	13			
			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, 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, six inches less than the mean girth of the whole plantation. From six consecutive weekly tapppings 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 Plantation.—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:—

	R
Felling and clearing at R12 per acre ...	3,600
Lining 10 ft. by 10 ft. at R2 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 battacola roof, at R30 per room	300
Roads for inspection, 2 miles	160
Plant nursery, including watering	150
Weeding, at R1 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 firewoood 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 R20 per 1,000). These items will probably bring up the total cost for the first year to at least R125 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 R12, R8, and R5, respectively. Assuming that the expenditure in the years following is at the rate of R5 per acre, the cost of the plantation up to and including the tenth year, might work out as follows:—

	R.
Cost of land, 300 acres at R75	22,500
Cost of seed, say	3,600
First year's cost, as above	11,927
Weeding and supplying, second year	3,600
Do third year	2,400
Do fourth year	1,500
Do 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 R100,000 or R366·66 per acre.

"*Return.*—The value of Para rubber in the London market varies between two and four shillings 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 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 R150 per acre. The cost of harvesting should not be more than R50 per acre, including carriage to London. This leaves a margin of R100 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 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 latter 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 1¾ mile 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	29½	Forked into two branches 4 feet from ground.
2	43½	37	Clean bole of 9 feet.
3	40	38	,, ,, 8 ,,
4	34½	40½	,, ,, 12 ,,
5	36½	39½	Forked at 3 feet from ground.
6	38½	27½	Clean bole of 8 feet.
7	36¾	31	,, ,, 10 ,,
8	30	18	,, ,, 6 ,,
9	31	27	,, ,, 6 ,,
10	21½	18½	,, ,, 8 ,,

Propagation with cuttings.—In the rains of 1879, 24 cuttings 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
	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 acclimatization 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., 26th April 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,—Secy.

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 Bokchaungale 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 during 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 Bokchaungale.

The method of tapping was the same as that followed previously; but the yield from each incision being small (less in fact than was the case in the rains), the several trees were tapped to their utmost extent, and, by constantly collecting the milk before it had time to dry, the quantity now forwarded was obtained, *viz.*, 3 oz. from the 5 trees to the west, and 9 oz. from the 37 trees 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 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 morning, 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 affect 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 as 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 appear to be better than either No 1 or No. 2, and it approaches very near to No. 4. Except as regards the diffi-

culty of coagulating the rubber their appears from these experiments to be difference between the specimens collected during the rainy season and those collected "when the rains 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 twelve 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 resume 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 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 trees 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 lb., 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 been 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 per acre, 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 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 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 been distributed, 3,000 going to the Jebong Estate, and 11,000 to the Sam Sing Estate.

At 15 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 by 20 feet, an annual crop worth £10 16*s.*, and if planted at 15 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 been 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 seeds 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 not of *H. Braziliensis*. 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.—Seeding 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 ½ 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 to 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 & 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 & Kahn.

BRITISH GUIANA.

Hevea brasiliensis does not appear to have taken well in this colony. According to Mr. Hemsley there are at last two species of *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. 1,332), and is now under cultivation at the Trinidad Botanic Gardens (Hart, No. 3,554).

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. Latter information on the same subject is included in a Report on "the Balata Industry of British Guiana," published in 1885.

The following brief accounts of the rubber-yielding plants of British Guiana appeared in 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 Mazaruni rivers, and probably yields some of the crude rubber sometimes received from that region. It is also found in some districts on the Pomeroom 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).

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.

MANICOBA, THE NEW RUBBER OF CEARA.

To the Editor of the *India Rubber World*.

Informati on continues to each Para of a development in the rubber inte rest in the states South of us, and particularly those in which the "maniçoba" or Ceara rubber thrives. The *Diario do Maranhao* reports an expedition in search of rubber forests up the river Jury-assu. The quality of the rubber obtained, and which was sent to England, though it was not well prepared, encourages the belief that the state possesses in this commodity a great source of wealth. The *Diario* refers also to the exploration of the river Caru or Pindare, in search of rubber. The bark *Codo* had returned with 1,320 pounds of rubber, and 150 *estradas* had been opened. Rubber forests have been discovered on almost all the affluents of the Pindare. The climate is salubrious, and on this river fish and game abound, while *farinha* can be bought for less than in the Amazon valley. A manufacturing and agricultural company at Codo have sent to Ceara to buy manicoba rubber seeds for planting.

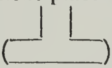
This new rubber field, understood to be very large in extent, may be reached in ten or twelve days, by canoe, from Sao Luiz, the capital of Maranham state, depending upon the state of the water. The *estradas* (paths) already opened are about six miles from the outer boundaries of the forest. It is expected that other *estradas* will be opened in July and August, and that the rubber prepared there will be shipped in September. The work will then be suspended, as the rubber-trees will have begun to shed their leaves, and until new leaves have grown the sap is watery and contains less rubber than at other times. But this promising prospect has its dark side. The journal *Federalista* gives an account of an attack upon a rubber camp in the new district by savage Indians, armed with poisoned arrows. They killed or wounded the rubber-gatherers and committed all sorts of depredations.

A state commission has been appointed in Maranham to study and report upon the best methods of cultivating the maniçoba rubber and preparing the product for market. *A Pacotilha*, a Maranham journal, gives the following instructions for planting the maniçoba rubber: "Leave the seeds in water for three days; plant them at a distance of three meters one from another. The land for the planting should be high, but not too dry. The holes where the seeds are planted should be about 2 inches in depth—about the same as for corn. The growth is spontaneous, and in a short space of time will compensate the planter." The same instructions, it is said, will apply to the seeds of other varieties of rubber, except that the *Hevea* should be planted somewhat deeper.

An important commercial firm of Pernambuco have written to *A Provincia do Para:*

"Maniçoba rubber should be planted at the beginning of the rainy season, in rows, at regular distances. The trees should be at least five meters (=15½ feet) apart. It requires four or five years to develop sufficiently to yield rubber. The maniçoba is unlike the Amazon rubber-tree in that it does not, in general, require a marshy soil, but it does require an even temperature—neither very damp nor very dry. The manner of gathering this rubber is as follows:

"Cut lightly with the axe into the bark, taking care not to injure the wood. Cut at several different places, always vertically, placing cups beneath the incisions. The milk will soon commence to flow and continue about three hours. The milk is next placed in a large vessel for smoking, constructed in about this form,



under which is built a fire of some wood that produces smoke liberally. Then dip into the milk a round piece of wood, not too large, to which the milk will adhere, and hold this in the smoke until the rubber solidifies, repeating the dipping and smoking operations until the resulting rubber ball is as large as can be handled conveniently. A tree of the diameter of 1 decimeter will yield two cups of milk yearly, and larger ones in proportion.

"A new grade of maniçoba rubber has appeared in the market, under the name of 'charo.' It is produced by making long vertical incisions in the bark of the tree with a knife, from which the milk drops from the trunk in the form of tears; hence the name *charo*, which means literally 'to cry.' The milk solidifies in the sun and the rubber thus produced is ready for sale without farther treatment."

Dr. Barreto, of Sao Paulo, a recognized authority on India-rubber, has written a letter, published in *Le Bresil*, recommending maniçoba for the French colonies and for cultivation in hot climates. He claims that its yield of rubber is larger than that of the *Hevea* species. In Ceara two or three years sometimes pass without a drop of rain, but notwithstanding such persistent drought, the maniçoba yields the precious sap. Dr. Barreto adds: "It is a beautiful tree, of gigantic height, with a pretty foliage, being also remarkable for its rapid growth and unexigent demands upon the soil."

The *Journal de Recife*, of Pernambuco, states that the maniçoba rubber abounds in that state, also, though without having received any attention thus far—probably, the editor says—owing to ignorance of its value. A newspaper published in the state of Sao Paulo, one of the more southern portions of this republic, notes that interest is beginning to be shown in maniçoba rubber, and that seeds have been sent for to Ceara. Finally, I may mention that a Dr. Pó is beginning to cultivate the Ceara rubber at Cametá, in the state of Para and near the Amazon. He is reported to have planted a very large number of trees.

Para, Brazil April, 14, 1898. GRAO PARA.

Ceara rubber has been exported of late in larger volume than in any former year, one member of the trade in New York being of the opinion that the outturn for the season will reach 1,000 tons. The Ceara rubber proper is produced from the tree known as *Manihot Glaziovii*, which has been planted with success in Ceylon and appears to be adapted to every portion of the African rubber belt into which it has been introduced by experimenters. Locally it is known as "maniçoba" rubber, differing from the "mangabeira," which is the product of another tree—the *Hancornia speciosa.* The maniçoba trees are more plentiful, and the product is of a better quality. The exportation of rubber from Ceara began as long ago as 1846, since which it has fluctuated greatly. In 1855 the exports reached 505,447 pounds, although as late as 1885 the average output for several years had not exceeded 277,664 pounds. There was a period in the history of the industry " when it declined with the general disaster which reduced the province to misery." Since that time there has been an annual exodus of the Cearense to the upper Amazon regions, where their labor is in great demand for rubber-gathering. The fact that the current output of Ceara rubber is larger than for any season in the past, has given rise to the suggestion that more of the natives have remained at home this year to gather their own rubber, and that this may have helped to keep down the yield of Para rubber below the figures for last year.

Here is a specimen item from the Brazilian press : " Messrs. Silva Mattos & Irmao shipped last year from Ceara 164,722 kilograms of maniçoba rubber, valued at 875,516 milreis, on which they paid duties to the amount of 51,887 milreis." These figures would suggest an average value for the year of 5$315 per kilogram. During the same period the average value of coarse Island's rubber at Para was 4$987 and of coarse Upriver, 5$788. It would appear, also, that the export duties amount to about 6 per cent. *ad valorem.* The sales of " Ceara and Maniçoba " rubber in Liverpool in January reached 80 tons and in February 60 tons, the highest price reached being 3*s* 4½*d* for " Fine." The rubber here referred to has never met with any favor among American manufacturers, and few lots have appeared in the New York market.

An official report from Togoland, one of the German colonies in west Africa, says : " Attention is being paid to the cultivation of India-rubber trees and it is anticipated that the imported *Manihot Glaziovii* will do better than the native sorts." One plantation is mentioned which contains 6,000 of these trees, grown from the seed. When only ten months old the plants begin to yield seeds, which germinated in three or four weeks more. Seeds from this plantation had been distributed to twenty-two villages, for forming new plantations.

Seeds of the Ceara rubber-tree sown in Madagascar in July, 1896, produced plants over feet high within four months.

FIJI INDIARUBBER.

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 Meseum. 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 *Tabernæmontana* (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 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-wounded 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 Vanna 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 vicid, on the outside, with little or no elasticity, and practically without value."

A letter specimen, received in June last, was not so vicid, 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 received 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 Khan as suitable for mixing purposes, and its value today was placed 1*s* to 1*s* 3*d* per pound.

A substance obtained from the "Ban" tree, possibly a member of the *Sapotaceæ*, 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.

NOTES ON RUBBER-CULTIVATION IN MEXICO.

By J. C. Harvey.

Being connected with an enterprise, contemplating the cultivation of rubber in Mexico, the article by Mr. Francis Child Nicholas on this subject in the September issue of The India Rubber World, is of especial interest to the writer, as it in a great degree confirms an opinion formed relative to the question of adopting the forest system of planting rubber, as against the clearing of the virgin forest and replacing with rubber seedlings at equal distances apart.

Nearly two years' study of the *Castilloa elastica*, as found growing indigenously on the Isthmus of Tehuantepec, and particularly in that region lying near the Trinidad and Colorado rivers in the southeastern portion of the states of Vera Cruz and Oaxaca, has led the writer to form important conclusions.

Rubber cultivation, on a thoroughly practical and scientific basis, may be considered to be in its infancy. The greatest difficulty was met with in attempting to gather definite information upon the most important points, such as the age of the trees, time of tapping, quantity of rubber produced per tree, percentage of gum, the proper age before tapping could be commenced with safty, methods of planting, such as with seed in the position the tree is to occupy permanently, or with seedlings from the seed bed, and the best time for transplanting, as well as the most suitable age in the seed beds before such transplanting should be attempted; also the most suitable soils, likely to produce good, healthy, trees, yielding a profitable percentage of gum. These considerations are obviously of the greatest importance to the intending planter.

A brief account of the writer's observations may, therefore, be opportune. The *Castilloa* tree is found in the district above mentioned growing under varying conditions, though within certain limitations—for example: from sea-level to an elevation of 1500 feet. In some localities there are, doubtless, exceptions, where tree may ascend the mountains 1000 feet higher. Careful observation during the period mentioned and within an area covering many hundreds of miles, justifies the belief that the zone wherein the tree attains its best development, lies between sea level and 1500 feet altitude and within a virgin forest district, with a mean annual temperature, approximating 80° F., or a range of from 60° minimum to 95° maximum ; also a well distributed rain fall, approximating 100 inches per annum. These are the meteorological and climatic conditions, existing in the district under consideration.

The trees are found growing in various soils, seldom in arid, gravelly districts, and when so found, presenting a stunted appearance, while in swampy or inundated districts, I have failed to find them at all. I have observed them growing in reddish clay soil where drainage was good, in black or raddish sandy loam, occasionally in rocky soil, with deep deposits of leafmould; in such conditions, only, where there is much humidity and shade, and lastly,—and in the writer's opinion—in the finest state of development in alluvial soils, mixed or overlaid with dark forest loam, and in company with a fine growth of other trees, and more especially when the lands are somewhat rolling in character, insuring proper drainage. In such land the wild trees exist in grater number near the sides of arroyos or streams, which rarely overflow their banks, though the trees near and on the summits of these rolling hills are quite as fine in development. Probably the greater number in the former case is owing to the fact that the seeds falling from trees above, are washed down and find lodgment in the more level places. Experiments in planting have demonstrated equally as good growth away from the margins of streams, as upon them.

The seed matures the early part of June, just about the beginning of the rainy season, and soon falls from the trees; in fact, it would be difficult to find much seed after the 15th of July. The seeds are about the size of pease, and are covered with a soft pulp, scarlet in color when mature, and dropping quickly thereafter. Good-sized trees produce from 5,000 to 10,000 seeds, or more annually, being so conspicuous in color and the pulpy covering of a sweetish taste, are much sought for by various birds, while others, which fall to the ground are immediately attacked by various grubs.

Germination takes place very quickly in about ten days or two weeks, and as the great majority fail to find a suitable medium to continue growth in are lost, while many are destroyed, as above explained, so that we do not find the number of seedlings about the forest that might be expected.

The vitality of the seeds is very short, and much disappointment will be met mith by those planting seeds a few months old. The seeds should be gathered daily when they commence to ripen, placed in a barrell with a gallon of water to say, a peck of seed, as proportions. In eighteen hours fermentation will have sufficiently loosened the pulp, without injury to the germ, so that it can be washed off. The seeds should then be laid upon mats in a dry, but not too sunny position, for not longer than a week; they are then ready for planting. Under this plan I have procured 90 per cent. of seedlings. If gathered and allowed to remain in a mass for a week or more, with the pulp on them, they generate a fierce heat, which utterly destroys the germ, while if washed and dried, as above, stated, but not planted for two or three months, the yield of seedlings will be insignificant, if not a complete failure. The cotyledons undergo a rapid chemical change, leaving no nourishment for the germ. It is thus easy to see how a whole season may be lost in starting an enterprise of this kind.

Seeds planted on the 25th of June. a year ago, were transplanted the end of August the same year in certain places on the isthumas and attained the height of three feet the following June. These trees were planted in full sunshine, without forest surroundings. Those allowed to remain a few months longer in the seed beds and then transplanted, received a severe check and do not appear to rally so quickly; in any case, the seedlings are somewhat impatient of disturbance and wilt almost immediately when the the roots are cut.

Our plans, as first decided upon, contemplated the complete clearing of the land and planting in regular orchard form. From the experience gained the forest system appears to be the most rational, entailing less labor and expense and affording the natural conditions of partial shade and a greater degree of humidity. These conditions do appear to be essential to the highest development of the tree and the greatest yield of sap. Hence, this system involves simply the clearing of the under-growth and planting the seedlings at as nearly uniform distances as the standing forest will permit, only destroying such forest trees as are unnecessary to the fulfilment of the demands of shade and humidity, thus increasing the number of rubber trees per acre.

Los Angeles, Cal., September 16, 1898.

IS THE CAUCHO TRADE IN PERU DECLINING?

By Fred. J. Hessel.

Most people connected with the crude rubber business will have heard of Dr. Antonio Vaca Diez's expedition, which started from Bordeaux toward the end of 1896 and proved such a disastrous failure.* The Doctor's original idea was to conduct his party, consisting of about 500 men and women, over the waterfalls of the Madeira river to his rubber estates in Bolivia, but subsequent events, and the hope of establishing a better connection between the Beni and the Atlantic, made him choose the longer, but apparently less dangerous, route up the Amazon through Peru, by way of the river Ucayali and its affluents, to the Mànu and Madre de Dios, which latter joins the Beni about twenty-five miles above the headquarters of Dr. Diez, called Orton.

During his last stay in London and Paris the Doctor succeeded in forming a private company *ad referendum*, and having been asked by the directors to go out and investigate the titles and value of the property, I joined the expedition in Para and, journeying with it, gained an insight into the Caucho trade carried on along the route we travelled. According to my experience, comparatively few known exactly how this class of rubber, called also "Grossa"

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* *The India Rubber World* has printed a number of articles in reference to Dr. Diez. In the issue of December 10, 1897, appeared a letter from Major J. Orton Kerby, who is also referred to by the present writer, narrating some particulars in connection with the death of Dr. Diez—*The Editor.*

and "Peruvian," is collected and prepared. Hence it may interest the readers of *The India Rubber World* to learn something about it rom one who has had an opportunity of studying the matter.

The way in which the Caucho business has been done n Iquitos for many years past is well known, and the statistics, compiled with much care by various firms of Para, show how much of this article is brought down and exported to Europe and the United States in every year. It may, however, be as well to mention that, for reasons which I will try to explain, a falling off is sure to take place, if it has not already set in*

The river Ucayali itself, through which we travelled slowly and looking well about us, seems to be getting played out as regards the Caucho tree, and although some of its affluents will yield fair quantities, yet the shippers of Iquitos do not appear to be as busy as they have been ; in fact, I understand from a letter received some time ago that the regular steamboat service, introduced about two years ago between that port and Para, has already been suspended for want of freight. In some of the larger villages of the Ucayali, such as Nazareth, Contamáno, Masiséa, and Cumaria, we found plenty of people who would have been quite willing to follow us to Bolivia with a view to finding a wider and more remunerative field of labour. Of course, there may be plenty of Caucho trees yet, especially east of the Ucayali, in the vast and partly unexplored regions between the Javary and Jurua, and around the upper Purús and Acre, but as the *Siphonia elastica*† is sure to exist there also, it will pay the gatherers better to go in for "fine Para." Here, for instance, in the Beni and its affluents, I have come across many Caucho trees in the forests, but no one thinks of touching them as long as "Fine" is found in sufficient quantities for working.

The Tambo and the Urubamba rivers, which together form the Ucayali, were neither of them being worked when we passed, and during our thirteen days' canoe journey from the mouth of the Tambo up the Urubamba, to Mishagua, we never saw a human being, or a hut. Don Carlos Fiscarrald who opened up this part of Peru not very many years ago, and with whom I spent the last few days of his prematurely ended life, told me that some distance away from the river side Caucho was yet to be found, but too far away and not in sufficient quantity to make it pay.

In the Sepaua, an affluent of the Urubamba not much below Mishagua (or Puerto Fiscarrald as it was renamed during my stay there), Mr. Fiscarrald's Piro Indians were then collecting Couch in fair quantities, but it was dangerous work, as this river is infested by the savage tribe of the Amahuacas. Precisely while we were there, a party of about a dozen Piros arrived with two wounded. One of their men had been shot through the thigh and a woman through both breasts, the latter thus showing four wounds inflicted by one shot. According to the report given by these Piros—who, by the way, handle their Winchesters with great skill—they had shot several of their assailants and put them to flight, but had thought it wise to retire, fearing that a larger party would soon be down upon them. The Amahuacas, like all the other savage Indians in these parts, have only bows and arrows to shoot with, but even these are dangerous weapons in an experienced hand. We were practising one day, to while away the time, and found it extremely difficult to hit the target, when I called a friendly Campa India who was looking on and asked him to show us what he could do. He grinned, took the bow, and without as much as aiming sent the seven-foot arrow straight into the very bull's eye from a distance of fully forty yards, for which feat, worthy of William Tell, I gave him a drop

* Some further information relating to this point appeared in an article on "The Peruvian Caucho Tree and its Product," in *The India Rubber World* for December 10, 1897 [pages 65-66], written with much care, though not by one who had visited the Caucho country in person.—*The Editor.*

† The generic term *Siphonia* is now little applied to the South American rubber trees in America and the Europe, but the older designation of *Hevea*. The tree referred to here is referred to habitually in *The India Rubber World* as the *Hevea Brasiliensis*. Some points of interest in this connection appear in a lecture by Dr. J. Huber, of Para, reported in our issue of January 10, 1898 [page 98]—*The Editor.*

of liquor, more to his satisfaction. He gave me to understand that, at the same price, he would do it again, for a few times more, if I liked, but liquor was precious then, so I sent him about his business.

While in Mishagua, I made the acquaintance of Major J. Orton Kerbey, of Washington, who had come from Cuzco, also in connection with some rubber scheme, and got shipwrecked in the waterfalls of the Pongo de Mairique. A friend of mine picked him up near the mouth of the Huepaya, where he found him on a raft with two other young Americans, in an exhausted condition, having had nothing to eat for three or four days. Some letters which I have since received from Major Kerbey show that he is grateful for the little we were able to do for him then, of which I am glad. Precious little it was, for we, too, were on the brink of starvation ; we also had suffered a shipwreck in the Urubamba and Mr. Fiscarrald having been drowned, together with Dr. Vaca Diez, found it difficult to get assistance from the house of Suarez and Fiscarrald—the only one for hundreds of miles around—of which Mr. Fiscarrald was a partner.

But I am straying. From Mishagua we followed the course of the river of the same name for seven days in canoes and then turned into an affluent called Serjali (muddy river), reaching the narrow strip of high land (*varadero*) which divides the waters of the Ucayali from those of the Madre de Dios, about a week later. Along this route, and on the high plateau itself, I observed several Caucho trees, but they were few and far between, most of them yielding no milk worth having, which is but natural considering the height of the land above the level of the sea. There are, however, some yielding trees yet, and the representative of Suarez and Fiscarrald stationed there generally uses their milk, mixed with sulphur or gunpowder, to make waterproof tents and mackintoshes for the *caucheros* who pass through, to and from the Mánu.

From the other side of this hilly, marshy and about fifteen miles broad *varadero* the descent to the Mánu river is effected by the Cahspajali (sandy river) in about a day. At its confluence with the Mánu, the house of Suarez & Fiscarrald has another branch establishment, named Bella Vista, for the purpose of receiving and shipping the Caucho delivered by the collectors in the Mánu. There used to be another *varadero*, also opened up by Mr. Fiscarrald and his Piros, which connected the Camisea river with the Mánu, but since the Caucho in the upper Mánu has given out, the one by which we crossed was found shorter and more convenient.

According to the information which I was able to gather in the Mánu, the Caucho export from the river to Iquitos had, when the tree was still plentiful near the riverside, reached about 8,000 arrobas (of 25 pounds Spanish) in one season, but as the tree is felled in order to get at its sap, the collectors had to go further and further inland, or higher up the affluents, and I do not think the last crop can have exceeded 4,000 arrobas. It is not surprising, therefore, that the 400 workers, who were there when we passed, were considering the advisability of shifting down to the Madre de Dios, where not only Caucho tree, but also the *Siphonia elastica* are yet to be found in great numbers. Fear of the savages, with whom Mr. Fiscarrald had many a tussle in his exploring trips, and the indebtedness to the house of Suarez and Fiscarrald, had so far kept them in the Mánu, but since the beginning of the year, about half of them have come down to the Imambari, Carmen, and Sena, in Bolivian territory, and the remainder will no doubt follow soon, so that the Mishagua business, which depended on these people, will in all probability have to be liquidated, if not already done. The Peruvian Caucho export will suffer a reduction in consequence, as all the rubber gathered in the Madre de Dios and its lower tributaries will naturally be shipped by way of the Madeira and Acre—*i. e.*, through Bolivia.

Plenty of rubber of both descriptions is sure to exist in the lower Imambari, but the tappers can only advance slowly on account of the hostile Indian tribes. We ourselves were witnesses to various raids made on Peruvian settlers who had pushed on in front.

As to the manner in which the Caucho is collected, I have already mentioned that the tree is felled in order to secure its milk ; that is to say, the sap is first extracted from the broad wings at its base by making vertical incisions of the V-shape and placing receptacles underneath; then the tree is cut down just above the wings, which are generally from four to six feet high, and circular incisions are made round the fallen trunk, at a distance of about a yard from one another, up to the crown and the receptacles, or tubes of thick bamboo, placed under them on each side to catch the milk which oozes out from between the bark and the wood. The sap is then passed through a sieve, to free it from any bits of stick and bark, into a large basin, into which a rope, creeper, or strap has previously been placed, so as to be able to pull out the block of rubber after coagulation. The *caucheros* in the Mánu usually cut a hole in a fallen tree, 3×4 feet square, by 2×3 feet deep, for want of suitable basins. If the milk is then left to dry, covered with large leaves, it will take from ten to fifteen days to coagulate; if a small basin of soap lather is added, it will be ready in two or three days, and if mixed with the juice of a creeper called *vetilla*, diluted with tepid water and soap, six to ten hours will be found enough. The juice of the black *vetilla* is preferred to the white. When sufficiently coagulated, the square block is lifted out, and through its own weight flattens down into what is brought to market as Caucho, Grossa, or Peruvian Slab.

The so-called Strips are the slabs cut in slices; this proceeding is not resorted to by the *cauchero* himself, but by the shippers of Iquitos. The Caucho Ball, known here only by the name of "sernamby," consists of the bits of dried rubber string left in the incisions of the tree and collected about a fortnight after the tree has been bled. By sprinkling the fresh milk on a well cleaned piece of ground, the same bits of rubber string are obtained in about the same time and the whole is collected and rolled up in Ball, Roll, or Sausage.

The tree itself is from 50 to 90 feet high, has from three to five wings (*aletas*), coarse bark with small warts, bare stem of from two to four feet diameter, and at its crown thick egg-shaped leaves from five to eight inches long. Its roots, which yield no milk, run out a long way, and a good *cauchero* can by their means, follow up a tree from a distance of 40 to 70 yards, which is worth something in a virgin forest. There are many similar trees, and it wants an experienced eye to discover the right specimen. They grow singly, often at great distances from each other, rarely in clusters of from ten to twenty trees, called *manchales*. The yield of a tree is from eight to twenty pints, according to size.

I have made a point of going through the process of the Caucho collecting myself and found it very rough work indeed, but in spite of that the *cauchero* generally does not wish to take to cutting "Fine," probably because he believes the old tale that the latter can, at times, only be done by going up to the waist into the water, an idea which is far from being correct. Here at least, in these parts, there is no such thing. Certain it is, however, that many of those who offered their services to me on the road, did so on condition that I should let them work Caucho, and not fine Para.

In conclusion, and referring to what I said at the beginning, I would like to mention that out of the 500 people who left Europe as stated, only fourteen reached Orton in my company. Most of them stopped in Para and Iquitos, and some in the Ucayali. The death rate was comparatively small, and after leaving Iquitos we had no fevers to speak of. The illnesses which, outside of a little intermittent fever, prevail in the Caucho districts are chiefly anemia and dysentery, rheumatism and liver complaints coming next.

Orton, Bolivia, October 12, 1898.

AN ANALYSIS OF SUN-DRIED BALATA LATEX.

DURING last year opportunity was taken to dry a small quantity of the milk or latex of *Minusops globosa, Gaertn* by the heat of the sun. The sample when dried was sent on to the Director of the Royal Gardens, Kew, who was good enough to obtain and forward to us the analysis together with observations made by Siemen's Brothers. The common method of preparation is by boiling th latex until coagulation occurs.

MESSRS. SIEMENS BROS. & CO., LTD., TO ROYAL GARDENS, KEW.

12, Queen Anne's Gate, Westminster, S.W., *19th October, 1898.*

DEAR SIR,—With reference to your favour of July 22nd last, we now have the pleasure of subjoining the analytical result obtained in examining the sample of Trinidad Balata which you have sent to us with the above-mentioned letter. The Balata was described as having been dried in the sun in the bottom of a shallow basin instead of being obtained by boiling the latex until the water is evaporated. The results obtained are as follows:—

Specimen as received.				Balata Proper.	
Percentage.		*Composition.*		*Percent.*	*Composition.*
Gutta.	Resin.	Dirt.	Water.	Gutta.	Resin.
39.6	37·0	16·5	6·9	51·7	48·3

On comparing the foregoing results with those obtained in a former sample of Trinidad Balata—also received from the Museum and analysed in 1886—we find that the composition of the Balata proper, *i.e.*, when freed from dirt and water is exactly the same as before (*vide* Dr. Obach's Cantor lecture on gutta percha, pp. 52—53).

As regards the durability of the sun-dried material, we are at present unable to form an opinion on that point as it has only been a few months under observation, while at least twelve months must elapse before anything definite can be ascertained.

The Gutta derived from this Balata is still in good condition and shows no signs of decomposition.

Since we do not use Balata for making core or for similar work we cannot judge of the value of the material under consideration. The market price for good Balata is about 1s. 9d. per lb. at present.

In compliance with your request we beg to return you the remnant of the sample submitted for examination.

We remain, etc.
(Signed) For Siemens Bros. & Co. Ltd.
A. STRAUBE.

THE RUBBER SITUATION IN MADAGASCAR.

Madagascar as a source of India-rubber is destined no doubt to become largely more important. The exports of rubber from that island have fluctuated from year to year, sometimes declining so far as to induce fears of the early extinction of the yield, which were strengthened by reports of the destructive methods of the rubber-gathers. But again the output has increased, while each successive traveller returning from Madagascar has thrown new light upon the extent of the rubber forests. Some facts of interest in this connection have been supplied to The India Rubber World by Mr. John L. Waller, some time United States consul at Tamatave, who has lately returned to America after his release from a French military prison, his troubles having grown primarily out of a concession to him of valuable rubber lands by the Malagasy government without consultation with the French authorities.

This large island is covered, for the greater part, by virgin forests throughout which, so far as foreigners have made their way, India-rubber vines and trees abound. By the way, most authorities have attributed the Madagascar rubber to vines of the genus *vahea* (similar to if not indentical with the *Landolphia* vines of continental Africa), but, according to Mr. Waller, a more important source of rubber is a large tree which he has not been able to indentify botanically. This tree often grows to a diameter of twelve to eighteen inches and in such numbers as to make the ground seem almost bare after the reckless rubber gatherers have gone over a strip of forest with their axes. A pecpeculiarity of the tree which Mr. Waller reports to have seen personally is that the rooots are not killed by the felling of the trunks, but that new shoots invariably spring up, becoming large enough in a few years to yield rubber. Thus the extinction of the supply is provided against by nature, which is not true of the Para rubbers or the *Landolphia* climbers. The tree likewise grows readily from the seed.

The usual practice of the native rubber-gatherers is to proceed to the forest in gangs, armed with axes for felling trees and galvanized iron buckets for catching the sap. The fallen trunks are chopped or sawn into lengths of three or four feet and supported over the buckets until all the rubber sap has drained from the bark. Mr. Waller reports having seen two quarts or more of sap yielded by a single stick of wood. Coagulation is effected by stirring a few drops of acid into a bucketful of sap and allowing it to stand in the sun for several hours. There is as yet practically no proprietorship in the lands, and the rubber gatherers have been free to wander at will in the forests. But the governor of the province in whieh Mr. Waller's concession is located has orders from Antananarivo to prohibit trespasssing upon it after the limits shall have been surveyed, and the next step will be to put an end to the destruction of the trees.

The concesssion covers 144,000 acres of forest lands, to be located in the best rubber district in Madagascar, which is in the south-eastern portion including the old French station, Fort Dauphin. This has been the chief place for working rubber on the island, and, as it is distant from any consulate, and, as the English and French traders are secretive about the extent of their business doubtless not a little rubber has been exported to which no record ever reached the various consuls stationed at Tamatave. Rubber near the coast began to be scarce several years ago, but the natives asserted that more was to be found farther inland, and now the seat of the industry has been removed to a district about three days distant from Fort Dauphin. Twenty-two dollars are paid there for a hundred-weight of rubber. Fort Dauphin has been styled a halfway house between Europe and the Orient, and it is now a port of call for the Castle Mail Packet Co., Limited, and another line of steamers. There are from two to four ships and sometimes more per month in the harbour. The climatic conditions at this point are good, the lands are fertile, the cost of living is low, and a consideration which induced the Hovas to grant this concession was that it might lead to immigration from Mauritius and elsewhere and the development of various industries at Fort Dauphin.

It is the belief of the *concessionaire* that the district would be well fitted for colonization by Afro-Americans, who would find there better advantages for trading than they enjoy in the United States. The Hovas are an educated race, and foreigners from several countries have made fortunes in trading with them. Mr. Waller will attempt to find means in this conntry for developing his concession, the status of which, he claims, has not been changed by his troubles with the French authorities. In what light it will be viewed by the latter, however remains, to be seen. He believes that a field exists for a much wider direct trade between the United States and Madagascar. While the foreign traders have been mainly English and French. the American house of Ropes, Emerton & Co., of Salem, Mass, long and had a successful career at Tamatave, retiring from the trade during the troubles growing out of the late French war. The house of George Ropes, of Boston, entering the trade later, is now established at Tamatave, Vatromandry, Antananarivo (the capital of the island) and Finanarosa. A large business is done in the selling of American cotton goods to the natives.

The British and American imports of Madagascar rnbber, which presumably include almost the entire output of the island, have been of late years as follows:—

United States.			Great Britain.		
		Pounds.			Pounds.
1891-92	...	174,919	1890	...	624,848
1892-93	...	275,331	1891	...	729,232
1893-94	...	265,411	1892	...	996,240
1894-95	...	31,003	1893	...	1,040,920
			1894	...	984,816

There must also be taken into account the British imports of rubber from Mauritius which are mainly derived from Madagascar, and which amounted in 1894 to 168,336 pounds. Altogether, the official figures available point to an average annual output of Madagascar rubber in recent years of 1,162,000 pounds. If it be true that the supply is practically unlimited, the ever-growing commercial spirit of the age, the increasing means of transportation, and the utilitarian spirit which must inevitably stop the waste of trees, will, without doubt, combine in largely and permanently increasing the yield.

Madagascar rubber is classed in the markets as "pinky" and "black," the former being the more valuable. When asked whether one kind was probably yielded by trees, and the other by vines, Mr. Waller replied that he could not say.—*India Rubber World,* May 10.

GATHERING RUBBER IN THE FRENCH CONGO.

By Mrs. Martha Nehne.*

In the months of March and April, during the rainy season, one sees busy life in the native towns of the French Congo. The men are preparing to go to the bush to cut rubber. Every woman and child seem to have something to do, and even the men do not lounge about as usual, but are sharpening their knives and *machetes* and putting their guns into proper trim. The women are digging *cassava* and some of them are washing it and preparing *chiguanga*, or native bread. Others are cleaning the *cassava* with knives and tying it into *mattets* made from palm leaves. This kind of *cassava* is roasted over the fire and eaten warm, while the bread is eaten cold and is mostly used on the road. The men carry their guns so that they may be prepared to kill the game which abounds in the forest.

When all is ready a drunken carousal and dance are given the night before the start by way of saying farewell to the villagers left at home. Sometimes a good place with plenty of rubber plants is found after a march of two or three days, but oftener the journey takes a week or more. In this case the men keep carriers on the road with food for them because there is nothing to be had in these parts with the exception of game.

The rubber in central Africa is not a tree, but a vine, often three or four inches in diameter. This vine generally climbs up the tallest trees, and the natives often use one of the vines to ascend the tree. After the branches are reached, which in most cases are at least fifty feet from the ground, the men proceed to cut the vines away at the top, leaving only one for their descent, and this one, if possible, not a rubber vine. It seems strange that the natives cut away the rubber plants and so destroy them instead of tapping them, but they are too lazy to learn any other way.

After the vines have fallen they are cut into lengths of three or four feet, and the juice is collected into iron pots. This is a tedious job. The piece of the vine is held over the pot, first by one end, then by the other until the juice ceases running. Then the piece is cut again to get at any juice which may have been left in the middle. After a pot is nearly full a rest is taken, and this juice is boiled for nearly two hours, and, during the boiling process, is mixed with the juice of other vines and some lime juice, so that the mixture is more sticky and easier formed into balls.

As soon as it cools down sufficiently to be handled the hardening rubber is shaped by winding it at first around a stick. After a bit the stick is pulled out and the ball is re-wound to finish it off. In some places these balls weigh three pounds or more each: in others, five of them make a pound. The purity of the rubber depends much upon how much other juice has been added. The best and purest is that obtained from the juice without boiling. This is only found in the shape of bracelets, because the natives wind the juice as it runs out around their wrist and let it dry there. When perfectly dry it slips off easier. This would be transparent rubber if the skin and fingers of the native were not so very dirty.

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* The writer of the information printed here is an American lady who for the past nine years has been a missionary in the Mayumba district of the French Congo.—The Editor.

The natives often used to put foregin subtances, such as small stones, palm-nuts, and little balls of grass into the rubber ball to make it heavy. They were soon found out, and every ball is now cut through the center to reveal its mixture. Often the rubber is buried for some days because it draws the moisture from the ground, which adds to the weight. Cheating is resorted to because the pay is so poor. It takes a party of eight or ten men and boys six to eight weeks to gather from eighty to one hundred pounds of rubber. The value of this, if all is first-class, is from 200 to 250 yards of cotton cloth or forty gallons of rum or three or four flintlock guns. Surely this is poor pay for this kind of work.

Still, the natives rejoice greatly if the men from one town return with 100 pounds. It seems like a fortune to them, because they need so little that civilized people crave and pay for. When this little fortune is spent and the weather permits, another trip is undertaken to the rubber region.—*India Rubber World.*

NICARAGUA:—OUT WITH THE INDIA-RUBBER GATHERERS.

INDIA-RUBBER: ITS COLLECTION AND CULTIVATION IN NICARAGUA.

By Rowland W. Cater.

At or near the mouth of all the large rivers on the Mosquito Coast will be found the bungalow of a trader, generally English or American, fitted up as a shop, and stocked with cloth, tinned and other provisions, rope, tobacco, rum, gunpowder and similar necessaries. When the unsophisticated Indian from the interior has collected a canoe-load of Jungle-produce, such as rubber, vanilla beans, sarasparilla, herons' feathers, gold, deer, Jaguar, and puma skins, &c. he pays a visit to the trader, and an exchange of commodities is promptly effected. Hard cash plays a very small part in these transactions. In due course the merchant ships the produce to New York or London reaping a profit of—I am almost afraid to say how much per cent.—two or three hundred perhaps. At any rate the trader speedily makes a fortune large enough to recompense him for his banishment for some more civilised country.

Many of these merchants are large employers of labour in the shape of mahogany cutters and rubber collectors. The men, Indians and Craibs mostly, bind themselves to a patron for a certain period and become practically serfs. The laws regulating these 'mozos matriculados" as they are called, are very severe and strictly enforced. The patron or master supplies provisions, implements and perhaps a small sum of money in advance, and each mozo is constrained to be diligent, and to return with the fruits of his labour at the expiration of the term. Rubber gatherers (huleros) are obliged to deliver one half of their caucho to their employer and to sell him the remainder at the current market price, less the value of the provisions, &c., previously advanced. But the patron almost invariably keeps a shop. He does not pay for the huléros' share of the rubber in cash, but mostly in goods. Consequently all the evils of the truck system are rampant.

A large proportion of the rubber exported from Nicaragua comes from the Prinzapulea district. At the mouth of the Prinzapulca River—called Apulca in some maps—there is a village where scarcely a week passes without the arrival or departure of huléros, and these I found myself during my travels on the Mosquito Coast. My host was one of the principal traders, an American, whom I will call Hayes. In his employ were many rubber collectors, so that I experienced no diffiulty in making arrangements to accompany a gang into the interior. This comprised six men, four Mosquito Indians of pure blood and two Caribs of negro type.

We started at daybreak in the usual frail dug-out, and at nine o'clock the following morning reached the point from which the huléros intended to take to the woods. Disembarking, we concealed the cance in a sedge thicket, and after a meal of boiled rice and salmon, set out across a sandy plain in the direction of a cone-shaped hill. Jose, one of the Caribs, informed me that the rubber trees are usually found in groups of twenty or thirty, and that he had often travelled for days together without discovering a single one.

'Dis time, sah,' he added, 'we go straight to big lot. See dem long time ago.'

But Jose was unaware of what the elements had in store for us. A belt of forest intervened between the plain and the hill which was our landmark. I noticed pine trees cedar, oak, and mahogany, interspersed with wild cherries and cacao, ceibas, or silk-cotton trees, and here and there a guava, not unlike an apple tree, but with more foliage. This is the white guava, from the fruit of which the famous jelly is made. It grows to a height of twenty feet, and is to be found in many dry jungles as well as in almost every garden or patio. The apple-shaped fruit is a little larger than a hen's egg, smooth, and somewhat resembling a small lemon when ripe. Inside is an aromatic pulp full of small white seeds. The red guava of the West Indies is more acid and less agreeable.

We had cut our way through some miles of this forest, and had just reached a part where the undergrowth and creepers were less dense, when one of the Indians stopped suddenly and uttered an exclamation. A peculiar sound, between a moan and a sigh, was creeping through the woods; the tops of the trees were in motion.

'Huracan, señor!' shouted the Indian in a tone of alarm, and all set off running as fast as they could.

I followed, buffeted by branches and climbing plants, and torn by thorns at every step. It was a desperate race to get into the open and out of danger before the dreaded hurricane should overtake us. In speed I was no match for those practised woodmen. They left me behind. The forest swallowed them up. But I could hear their shouts and the crashing of bushes as they tore their way and I struggled on until I could run no longer. In a cleft of a big rock on the outskirts of the wood I crouched and waited for the storm to pass.

It came quickly. The murmur swelled to a roar.

The sky grew black almost as night. Branches and twigs fell in showers. Great trees bent and swayed as reeds, groaning like giants in torture. Soon crash followed swiftly on crash as the older monarchs of the forest were swept down. Some, stripped of every branch, defied the fearful blast, comparatively safe in their nakedness. Others were torn up entire, and carried yards away from the great pit their roots had left behind. But while the tornado raged, even if I had dared to look out from my place of refuge, it would have been impossible to distinguish anything, except perhaps when a flash of lightning revealed the hurtling mass of leaves and branches overhead and all around.

As suddenly almost as it came, the hurricane swept onward and passed, followed in its course by myriads of twigs and small boughs, drawn forward it seemed by suction. For long afterwards these floated in the direction taken by the storm, resting apparently on the thick cloud of dust which seemed to reach from the ground to the tops of those trees that had withstood the storm.

No hurricane so terrific had visited Central America for many years, but luckily it was confined to the coast. Adjectives are of small use to describe its effects. These provided the Indians with a topic of conversation for months, and very marvellous were some of their stories.

An old man walking beside a river was said to have been lifted up and deposited on the opposite bank. An Indian who had lost his horse discovered it in the fork of a tree thirty feet from the ground, and was compelled to fell the tree to recover it. Whether it remained sound in wind and limb the more or less veracious chronicler omitted to state. Another found in his garden a row of banana trees which he had not possessed before. Great was the mystery until the owner of an hacienda many miles away identified them as his property. Some of the tales might be true—*Quien sabe?* Nobody is obliged to believe them. But I can testify that the hurricane was a very bad one, as also do the many wrecks remaining to this day on the beach near the mouth of the Prinzapulca and other rivers.

Pushing on over the debris, I eventually reached the hill, and there found the huleros, who had sheltered in a cave with which they were acquainted.

From the hill-top the keen-sighted fellows marked down several clumps of rubber trees not in the track of the hurricane and set out in couples to tap them. I accompanied Jose and Pete, the Caribs, both of whom spoke English after a fashion of their own.

Here I should observe that the best and purest rubber comes from the great forests intersected by the Amazon and its many branches. It is known as Para rubber, and is obtained from several species of Hevea. The India-rubber plant of our green-houses is *Ficus elastica* of India, generally epiphytic, the seeds germinating at the top of forest trees, whence are sent down numerous aerial roots. Rubber, or caoutchouc as it is called commercially, is also obtained from species of Manihot, Landolphia, Willugbeia, &c., in addition to the subject of this paper, the *Castilloa elastica* of Mexico and Central America.

The Castilloa grows to an average height of sixty feet, and throws out its huge branches, many of them a yard in diameter, at a considerable elevation. The bark is of a dark slate or ash colour ; the leaves measure from ten to eighteen inches long, are elliptical, glossy, closely veined, and paler beneath than above. They usually grow at the end of the boughs in compact groups of trees. The fruit consists of a capsule comprising three divisions, each containing a large seed, white, irregularly marked with black.

The best season for tapping is from August to February and the operation should be performed early in the morning, before the daily rain, or in the evening after the rain has fallen. In the latter case the milk should be coagulated as soon after sunrise as possible next morning.

The milk, or sap, is white and of the consistency of cream. The tree thrives best in moist but not marshy forests on a warm sandy clay. It seeds in the tenth year, and ought not to be tapped before its eighth year, or its growth may be much retarded.

On reaching the group of trees, which numbered seventeen of various sizes, my Carib friends first cut away the twining creepers that almost hid the trunks and then carefully removed a couple of buruchas, natural ropes of rubber formed in the following manner. From incisions in the bark, possibly caused by woodpeckers or some insect, the juice often exudes, trickling down the trunk, in and out of the encircling creepers, and sometimes reaching the ground. The milky stream coagulates and turns black as it runs, forming a long strip or card, with which the huleros often tie up their bales.

The parasites removed, Pete and Jose strapped on their aspuelaa (climbing spurs) fastened at the knee and ankle, and having dug a small pit or basin at the foot of each of a couple of trees, passed a ring of stout rope round the trunks and their own waists, and walked up with their machetes between their teeth. By lifting the rope at every step they were enabled to stand almost erect, and when lying back in the ring both hands were at liberty.

Jose, whom I watched closely, commenced operations immediately before the first branch. With his broad-bladed sword he cut in the bark a horizontal canal which almost encircled the trunk and terminated in a V-shaped angle. From the point of the V-downwards he next cut a perpendicular canal about two feet in length, which joined another horizontal channel ending in a V, and so on to the ground. In the last cut he inserted a large green leaf to serve as a funnel and guide the milk into the basin.

The Brazilian rubber collectors always place a receptacle of tin or earthenware in the hole at the foot of the tree to prevent the admixture of grit or other foreign matters ; they also strain the milk through coarse muslin ; hence the greater value of Para rubber. But Nicaraguan methods are primitive.

The sap runs down the incisions to the basin, where the water evaporates. Artificial heat is employed to hasten this evaporation in Brazil, but happy-go-lucky Nicaraguans leave the process to nature. When the hulero is of opinion that no water remains, he makes a decoction of liana vines, or of a kind of convolvulus, and adds it to the juice in the proportion of one pint of the former to a gallon of the latter, when the sap immediately coagulates and forms india-rubber.

When the sap had ceased to run, my Carib companions ought to have filled up the canals carefully with mud or clay. There was a stream close at hand, but they did nothing of the kind. Consequently, when next they passed that way, the trees would probably be dried up and sapless. It is said that a kind of wood-leech attacks the tapped Castilloa, introducing itself through the channels, and so injures the tree as to cause its eventual decay. This the clay would prevent, and at the expiration of six months the tree might be again tapped, with as much profit as on the first occasion. I took José to task on the matter.

'Plenty hulé heah, sah,' he answered, grinning. 'Me find ten—twenty mo' trees while 'um doin' dat. An' what good? Perhaps I neber come heah no mo.'

To that I had nothing to say. The forests are no Man's Land, and another hulèro would probably have reaped the fruit of his labour.

The heated air speedily evaporated the water from our rubber milk, and the necessary coagulation did not occupy much time, though the process appeared to me very wasteful. With this I will deal presently, however. While the evaporation was taking place other trees were being tapped. When the sun sank the Caribs left off work. We slept beneath the rubber trees, as is the huleros' custom. All the day following the Caribs toiled, and at sunset we returned to the dug-out, José and Pete carrying about forty pounds of rubber each. The Indians, who had been less successful, were awaiting us. Next morning we ascended the river still farther and again entered the forest, leaving two men with the boat to take care of the rubber and pack it in bales.

Dishonest huleros frequently put stones and pieces of heavy wood in the middle of the bales to increase the weight. But the merchant usually pierces every package with a sharp-pointed steel rod, so the rogues seldom escape detection.

At the expiration of ten days, being then four days from the mouth of the river, we commenced the return journey, towing the bales of rubber behind the dug-out. We did not escape the usual capsize; but as each man had a lifebuoy in the shape of a waterproof bag, and besides, could swim like a fish, nothing more serious than a wetting resulted, and that we could not avoid on land.

These rubber bags, which a native of this coast is seldom seen without, are made by the huleros as they go along, so to say. A sack of unbleached calico is stretched on the ground, and painted over with rubber milk, a coconut husk serving for a brush. When the first coat is dry the operation is repeated, three coats being necessary before the bag is fit for use. The result is a waterproof article, rather heavy, but in every other respect far superior to any manufactured in Europe. Before setting out in their trail canoes, the natives take care to inflate their bags and tie up the mouth. Thus the sack forms a receptacle for clothes, a pillow on land, and a life-buoy in the event of an accident upon the water.

On arriving at what was left of Mr. Hayes' bungalow, for the hurricane had not spared it, I had several discussions with that gentleman in reference to the practical cultivation of *Castilloa elastica*. The result of my inquiries on the Mosquito Coast and in other parts of Nicaragua are here summarised.

The subject has been ventilated by many private persons in addition to the various Central American Governments, and in Nicaragua a bounty of ten cents native currency is paid for every tree planted. As the world's supply is rapidly diminishing, while the demand is increasing by leaps and bounds, there appears to be a magnificent field for Englishmen with capital. Certainly, unless the output is soon increased, manufacturers of rubber goods may have to fall back upon substitutes. In Mexico there are English and American Companies already at work, but, except two plantations in the Chontales district, I am not aware of anything of the kind in Nicaragua. That the industry would be exceedingly profitable has been demonstrated by the results of many experiments; and when I say that neither coffee, tea, cocoa, sugar, bananas, indigo, nor hemp growing would pay so well as the cultivation of india-rubber trees, I speak on the authority of Mr. Hart, F.L.S., of the Botanical Gardens, Trinidad.

In March of last year I visited a plantation in Chontales, which, strange to say, is the result of native enterprise. It then comprised one thousand trees, well developed, of hardy appearance, and as large as a good sized apple tree. An early maturity seemed assured.

Señor Romero, Mexican Minister to the United States, in an article published in the *India-rubber World* (New York) for April 1892, estimates that each sixty-year-old tree, planted at intervals of fifteen feet, will have cost eight cents U.S. currency, and will yield six pounds of rubber. Other authorities fix the yield at maturity as high as fourteen pounds of rubber. It depends on whether the season has been wet or dry, and whether the trees are well or badly cultivated.

In order to be on the safe side, I propose to estimate the cost to the end of the eighth year at 18 cents U.S. currency, or 9d. per tree, and the eighth year's average yield at five pound of rubber. The market price of good Central American rubber is 2s. 4d per lb. Para rubber fetches from 2s. 3d. to 3s. 6d. per lb. ; and if gathered and coagulated in the same cleanly manner, rubber produced in Nicaragua should be worth as much. Nevertheless, I prefer to estimate on a selling-price basis of 2s. per lb. only. The result at the end of the eighth year of an acre plantation comprising 193 trees planted fifteen feet apart would be as under, including the premium of 10 cents native currency—say 3d.—per tree paid by the Nicaraguan Government.

Dr.	£	s.	d.	Cr.	£	s.	d.
Cost of cultivation for the term of eight years, with seed, &c., of 193 trees at 9d. each ...	£7	4	9	Government premium of 3d. per treee... ...	£2	8	3
Cost of tapping or harvesting	3	0	0	Yield of 193 trees at the end of the eighth year—965 lb. at 2s. per lb. ...	96	10	0
To balance ...	88	13	6				
	£98	18	3		£98	18	3

Profit ... £88 13 6

I arrive at the cost of tapping, or harvesting, in the following manner. A huléro, working in the dense, overcrowded forest, can tap four wild, creeper-grown trees in a day ; therefore it stands to reason that, in a plantation where the trees are weeded and cleaned of all superfluous growth, he could tap five at least, and also plaster up the cuts with mud. Thus the 193 trees would occupy him 39 days. A mozo in Nicaragua is well paid if he earns fifty cents native currency, or say 1s. 3d. per day, but I have calculated his daily wage at rather over 1s. 6d.

Supposing that the plantation comprises five hundred acres, then, on the above figures, the eighth year's profit would amount to the enormous sum of £44,337, 10s. And the yield increases every year, with no outlay except for weeding and harvesting.

The gross capital expenditure for the eight years I estimate as under :

	£	s.	d.
Cost of 500 acres of land at 5s. per acre ...	£125	0	0
Surveying and procuring titles thereto ...	100	0	0
Clearing land for planting	1,000	0	0
Collecting seed and planting	500	0	0
Eight yearly weedings at £200 each ...	1,600	0	0
Extras, implements, &c.	300	0	0
	£3,625	0	0
Interest on £3,625 for eight years at five per cent. per annum	£1,450	0	0
Planter's expenses, cost of living, &c., for eight years at £200 per annum	1,600	0	0
Cost of gathering the eighth year's crop ...	1,500	0	0
	£8,175	0	0

I have included in the above the cost of maintaining the planter during the eight years that should elapse before the Castilloas are tapped but it should be borne in mind that when the trees are planted fifteen feet apart, coffee, sugar-cane, cotton, cacao, and other shade-loving plants, yielding yearly crops, may be grown between them, and their produce should maintain the planter. But adding five per cent. interest, the planter's expenses, and the cost of harvesting, there still remains a net profit of £36,162 10s. Estimating the value of the ninth year's yield at £50,000, and deducting £200 for the annual weeding, £1,500 for the cost of harvesting, £180 for interest, and £500 for the planter's expenses, the net profit for that year will amount to £47,620, which is a pretty good return for a net capital outlay of £3,625. Of course it will be necessary to maintain a nursery of young plants to fill vacancies caused by accidents and replace trees when their rubber-bearing life is over; but the cost of such a nursery would not be great. And one must not count on the Government premium being paid in perpetuity.

In reference to the life of a rubber tree and its increasing productiveness, the following extract from *The World* (New York) of 21st August, 1892, will be of interest.

'Three young trees transplanted from the forest to a cultivated field in Soconusco, Mexico, are now said to be seven feet in diameter, and have yielded rubber for more than thirty five-years; the present product averaging more than fifty pounds of gum per year.' The average increase is generally estimated at one pound of rubber for each year of the tree's life up to a certain age, which, however, I am unable to fix.

On the eastern side of Nicaragua, and especially in the Mosquito territory, there are immense tracts of land suitable for the cultivation of *Castilloa clastica*. In choosing land, shelter from strong winds, the greatest enemy of young Castilloa, should be kept well in view. The seeds should be sown in a nursery bed shaded from the mid-day sun, and the young plants transferred to the hacienda when twelve months old. For each plant a hole should be dug three feet in diameter and one foot deep, and filled with fine loamy soil to which a little sand has been added. The mixture should be well-trodden down and watered night and morning for two days, when it is ready for the young Castilloa, which must be placed in its new bed at exactly the same depth as in the nursery; if it is weak, a stake support is very desirable.

Trees tapped in the wet season are estimated to yield five times as much milk as in the dry. The quantity of rubber produced therefrom depends to a great extent on the coagulating agent employed. Sixty per cent. of the milk ought to be turned into rubber. A very good agent is one ounce of alum dissolved in sixteen ounces of water. But a weak alcoholic solution will give even better results, for the process is immediate, and the solution may be used many times. In my own experiments I never lost more than forty per cent. of the bulk, and often only thirty-five per cent.

That the cultivation of *Castilloa elastica* is worth the attention of the thousands who are seeking really remunerative investments there cannot be the slightest doubt, and this the author intends to show in a work on the whole subject of India-rubber which he hopes to publish shortly. For success careful study and inquiry is imperative.—*Chamber's Journal.*

THE CULTIVATION OF INDIA-RUBBER IN NICARAGUA.

There has been a revival of interest in Nicaragua in the future of the India-rubber industry there, due to the decreasing yield and the resulting fear that the methods practised by the gatherers hitherto will lead to the extinction of the trees. The government has manifested its interest by means of the decree, published lately in The India Rubber World, prohibiting the exportation of other than cultivated rubber for the next ten years. This decree was preceded by laws for the encouragement of rubber-planting, and something has been done in this direction. But how far any law can prevent the exportation of native rubber remains to be seen. The United States consul at San Juan del Norte reported recently that, "notwithstanding the law made in Costa Rica some years ago prohibiting the cutting of rubber, much of the rubber shipped from San Juan del Norte comes from Costa Rica. It is estimated that Costa Rica has contributed between 35 and 60 per cent. of all the rubber shipped from San Juan del Norte."

Recently many persons in western Nicaragua—the Pacific-coast section—have declared their intention to plant and cultivate India-rubber in the eastern portion of the republic, investing some of the money which they have accumulated during several years past from their profitable coffee estates. Likewise many requests for information have been received in Nicaragua from citizens of the United States, bearing upon the whole subject of rubber cultivation, the impression evidently existing in many minds that India-rubber is becoming a scarce commodity. These circumstances have led to the preparation of some reports of interest published recently by the department of state, at Washington—one by Thomas O'Hara, the efficient consul at San Juan del Norte, and one by J. Crawfords, of Managua, the author of a paper, included in the volume of special consular reports prepared at the instigation of The India Rubber World in 1890, which forms the most valuable contribution to our knowledge of Nicaragua rubber.

Consul O'Hara first calls attention to an extract from the Bluefields *Recorder* of June, 6th, 1896, as follows:—

"On this subject of agriculture, we may add that a great deal of attention is being given to the cultivation of the India-rubber tree. Several of our banana growers on the river, while cultivating the product of the more rapid growth (the banana), devote some of their time to the India-rubber tree, which has the advantage of being a product full of staying qualities, yielding handsome profits after it has attained its full development, and which has not that baneful influence on the soil which is the peculiarity of the banana. We do not believe that we are beyond the mark when we say that there are to be found on several plantations on the Escondido more than 75,000 rubber plants, vigorous and promising ready for transplantation. Ten or twelve years after these shall have been planted, bananas will be nowhere; the very places where they are now grown will be exhausted and allowed to lie fallow for the subsequent cultivation of other and less ephemeral products."

The consul has undertaken an inquiry respecting the details of such plantations, and he reports having learned through Vice-Consul Henry E. Low, at Managua, of two rubber plantations in western Nicaragua, with a producing capacity not to exceed 5,000 pounds a year. Further information on this head is promised to the department.

Mr. Crawfords writes in his report that localities in Nicaragua south of latitude 15° north and between longtitudes 84° 10' and 85° 35', in low valleys where the soil is deep alluvial or deep vegetable humus and sand and capable of being rapidly drained and in a climate that is almost uniformly warm and humid, are best suited to the rubber tree. Many such valleys in central and north eastern Nicaragua supported groves of large-sized trees yielding rubber until about fifteen years ago, when nearly all the trees had been killed by too frequent tapping, or by being cut down by irresponsible collectors. There are by the way, several species of rubber trees in Nicaragua, some of which are indigenous to a higher, drier climate and soil. Mr. Crawfords uses the term "elastic rubber" throughout his report, because some varieties, as the "tuno," for instance, are but slightly elastic.

"Next to the *Castilloa elastica*, the second best rubber producers, in quality and quantity, are of the *Ficus* family, a variety locally known as 'matapala,' an epiphyte having numerous bodies from aerial roots (like the banyan tree). It is also an inhabitant of low, fertile, well-drained lands. By cultivation, this tree would, most probably, fully equal the other low-valley varieties in quality and annual output of rubber. It has the advantage that if one of its trunks or bodies is deadened by excessive bleeding or drainage of the sap, it has several other live trunks from which to obtain supplies of rubber." Evidently the tree thus described by Mr. Crawfords is not unlike the rubber tree of Assam and Burma.

"The quantity of the annual yield of elastic material depends," says Mr. Crawfords, "the soil and climate being suitable, on the bulk of the bast or lactiferous tissues that exist or that can be developed in the tree or vine. Some trees of two to three feet diameter and thirty-five to fifty feet tall will give annually twenty to forty pounds of good rubber. The quality of the rubber depends largely upon the shape or form of the cells and spaces composing the bast, or lactiferous tissue, and in part in the process used to separate the elastic material from the emulsion-like sap. Quality and quantity, therefore, are responsive to cultivation—to be increased or, decreased."

Cultivation begins with sowing the seeds in beds and transplanting to a nursery at the end of the first year, and to the permanent plantation at two and a half or three years. The planting is at such distances apart as to allow sixty-four "matapala" or 100 *Castilloa* trees to the acre. "Cultivation consists in ditching the land so as to drain it slowly or rapidly at will, keeping it moist without permitting water to stand in pools or low places. During the the rainy season, drain rapidly. Keep all undergrowth cut down and the land 'hilled up" around the trees in cone shape to about six inches higher than the general level within five feet of each tree. Deaden or fell other varieties of trees and vines until they shade but a very small part of the surface of the land."

Tapping may begin during the sixth or seventh year of the tree's age. If the tree has matured properly it should yield from eight to twelve pounds of rubber every second year until it is twelve years old, after which ten to fifteen pounds of rubber should be obtained annually. "The coagulation of the milk and the separation from it of the elastic material can be effected by heating to 167° to 175° F. and stirring in a hot decoction or hot, strong tea of the leaves and twigs from some species of *Convolvulacœ*—as morning glory or bindweed, or, stirring into the emulsion, when fresh and hot, the smoke from burning palm-nuts or other oleaginous nuts—all of which are abundant in districts where the rubber trees grow."

Secondary crops which may be grown profitably between the rows of rubber trees until they reach a productive age are Liberian coffee and bananas, the latter of which would afford a large percentage of the food required by all the animals on the estate.

As for profits, Mr. Crawfords estimates that sixty-four trees to an acre, at nine years of age and thereafter, should yield an average of ten pounds of rubber, or 640 pounds to the acre. At 30 cents net per pound, this would yield $192 per acre, which should give considerable profit, the cost of cultivation being so slight. The net profit from an acre of coffee trees in Nicaragua is given at $65.

Consul O'Hara's attempt to compile statistics of the production of India-rubber in Nicaragua has not been entirely successful. For example, the customs recorded at San Juan del Norte extend back only to 1874, and the invoices on file since that date do not, for most of the years, specify the quantities of India-rubber shipped, but only the values. He is now trying to collect the figures for the other ports, but even if these can be obtained, it will be impossible to say how much of the total represented the product of neighbouring states.

"The India Rubber World" happens to have at hand the details of Central American rubber imported by Great Britain and the United States for the years 1870 to 1885, inclusive, the greater part of which was the product of Nicaragua. The larger share was taken by great Britain, until 1878, when the United States took the lead in the importation of Nicaragua rubber, which it has since maintained.

		Pounds.
Taken by Great Britain ..	..	6,654,780
Taken by the United States	..	13,789,499
Total for sixteen years	..	20,444,279

This without doubt practically embraces the whole production of Central American rubber for the years named, though a small amount may have gone direct to Germany. More than half this rubber was exported during the last four years (1882-85), and by far the greater part of this half was taken by the United States.

Nicaragua rubber then began to be entered separately in the United

States customs returns, and the imports from that country alone have since been as follows, by fiscal years ending June 30 :—

Year.			Pounds.
In 1885-86	...	...	1,552,574
In 1886-87	...	...	1,575,837
In 1887-88	...	...	1,545,121
In 1888-89	...	...	1,573,331
In 1889-90	...	...	1,209,730
In 1890-91	...	...	1,146,727
In 1891-92	...	...	1,027,232
In 1892-93	...	...	958,703
In 1893-94	...	...	892,908
In 1894-95	...	...	907,243

Meanwhile Great Britain has begun to record imports from Nicaragua separately, with this result, for calendar years: In 1892—7,952 pounds; in 1893—37,072 pounds; 1894—75,936 pounds; in 1895—33,264 pounds. There have also been unimportant shipments from Nicaragua to France, Germany, and Holland.

Just what has been the rate of decline in the output of Nicaragua rubber can only be conjectured, but that it has been great is proved by the following table showing the receipts of all Central American rubbers by the two great importing countries :—

		United States [a]	Great Britain [b]	Total Pounds.
In 1885	...	2,079,278	237,552	2,316,830
In 1895	...	1,300,802	33,264	1,334,066
Decrease	...	778,476	204,288	982,764

a, fiscal year ; *b*, calendar year.]

Nicaragua has not so long been a producer of India-rubber as many other countries. Its output suddenly more than doubled about 1880, continued at the figure then reached for a few years, and then began to decline at a rate which justifies the fears of the trade and the government that without protective measures the rubber tree will soon disappear from Nicaragua.—*The India Rubber World.*

INDIARUBBER IN ASSAM.

A brief account of how rubber trees (*Ficus elastica*) are grown in Assam. By Mr. D. P. Copeland, Deputy Conservator of Forests, Darrang Division.

1. *Ficus elastica.*—The Indian rubber fig or caoutchouc tree, is indigenous to Assam, where it is found a dominant tree in the evergreen forests. It requires an exceedingly damp atmosphere, and the best natural rubber trees are met with in the forests at the foot of the hills, or on the hills themselves up to an elevatson of 2,500 feet.

2. *Natural germination.*—In its natural state the rubber tree starts from seed dropped by birds in the forks of other trees, often 20 or 30 feet or even more from the ground, where it germinates, and the young plant remains an epiphyte for years until its aerial roots touch the ground ; as soon as this takes place the little epipyte changes rapidly into a vigorous tree, throwing out numerous aerial roots which gradually envelope the tree on which it first began life and often kills it out.

Having started life so high up it soon throws out branches which overtop the surrounding trees, and the numerous aerial roots which fall from these and establish connection with the ground, in a few years, enable it to dominate the forest growth around it.

3. *Seed.*—The seed of this tree is contained in a fig-shaped fruit about 75 seeds being found in one good sound fig. The fruit first begins to form on the trees in March and ripens from May onward to December. On some trees the whole crop ripens and falls off by June, but as a rule the rubber tree has fruit on it from April right up to December, the figs forming, ripening and falling off the whole of the rains.

After collection the figs have to be carefully dried and mixed with pounded charcoal, which preserves the seed for several months.

4. *Seed beds.*—In the Charduar rubber plantation nursery, for a seed bed $40' \times 3\frac{1}{2}'$, two to three seers of pulverized rubber seed, 10 seers ash and 20 seers of vegetable loam or good soil, are well mixed in a half cask and spread evenly over the bed, and then lightly stamped down and watered. Such a bed should yield with good germination 2,000 seedlings and should be sufficient for putting out 100 acres of rubber planted $70' \times 35'$. The beds must be well raised and drained, the soil being prepared in the same way as for vegetable or flower seed. If sown in boxes these should be put under the leaves of a house: if in beds light removable shades must be put up to keep off the direct rays of the sun. The shades should be removed during rainy or cloudy weather and at night.

Light sandy loam is most suitable for seed-beds; if the soil is stiff, charcoal dust should be mixed with it to make porous and prevent caking. The beds or boxes must never be allowed to get dry.

5. *Sowing.*—This should be done exactly in the same way as for vegetable or flower seed which requires transplanting after germination. The figs are broken between the hands. As the seed is very minute the particles of the fruit are left with the seed and sown with it, no attempt being made to clean or separate the pulverized figs. In order to distribute these minute seeds evenly over the seed-beds or boxes, a certain quantity of ash and soil is mixed with them.

6. *Germination.*—Germination takes place from the end of April to the the end of rains. Seed sown between October and January requires daily watering and screening from the sun, and will not germinate before end of April or the beginning of May, but seed sown any time during the rains will germinate in a few days (from five days to a fortnight). It follows the best time for sowing seed is during the rains, that is from June to September.

The embryo appears on the germination of the seed as a seedling having a pair of opposite cotyledons with an entire margin destitute of incisions or appendage of any kind, with the exception of the notched or emarginate apex, oval in general outline, green in colour and of a glassy smoothness. The second pair of leaves shew a tendency to the alternate arrangement on the stem but appear at the same time. Their shape and venation are very different from those of the primary leaves for they have a central midrib and a distinctly coarsely crenate margin. The third pair of leaves do not appear simultaneously, and are distinctly alternate with a marked reddish colour. After this the plant is easily recognized.

7. *Pricking out.*—When the seedlings are two inches high in the seed-beds or boxes they should be transplanted into nursery beds, and put out in lines about a foot from each other. The nursery beds should be well raised and drained, but the soil need not be so carefully prepared as for the seed beds. Here the plants are kept till the following rains when they are dug up and taken to stockaded nurseries in the forests and put out $5' \times 5'$ on raised well-drained beds; where they remain for two years till they are required for planting operations.

8. *Forest Nurseries.*—Almost every animal will eat the young rubber plants; it is therefore impossible to plant out small seedlings in the forest owing to the destruction by wild elephants and game, unless each individual plant is carefully fenced in. As this is too costly and the rubber after it is one to two feet in height is very hardy and can be transplanted with ordinary care, at any time of the year (the best time in Assam is between May and July), the seedlings are kept in stockaded nurseries in the forest where planting operations are to take place, and remain there till they are 10 or 12 feet high, that is about three years after germination, when they are dug out and the roots are cut back 18 inches right around the plant and planted on the mounds in the forests.

9. *Planting operations.*—In artificial planting it is found that the rubber grows best on mounds. Lines are cut through forest 20 feet wide and 70 feet apart from centre to centre; in these lines 15 foot stakes are put up 35 feet apart. Round each stake a mound is thrown up 4 feet high. The base of the mound is about 10 feet in diameter and tapers to

4 feet on the top ; on this mound the rubber tree is planted, care being taken that the roots are carefully spread out before they are covered up with earth. To prevent animals pulling the plant and wind blowing them down they are tied to the stakes.

10. *Cutting.*—The rubber tree can readily be propagated from cuttings, if only perfectly ripe young branches or shoots are used, but the tree raised from cuttings does not appear to throw out aerial roots, and as the future yield of the tree probably depends on its aerial root system it is questionable whether trees raised from cuttings ought to be used except where required only as shade givers, such as in an avenue. In the Charduar rubber plantation propagation by cuttings were given up very early, that is about 1876, the plantation having been commenced in 1879. The best time to take cuttings is May and June.

11. *General.*—The rubber grows equally well on high land or low land, in forest land or grass land, so long as it is planted on a mound and its roots are not exposed to the sun. It is a surface feeder, but as soon as its roots appear above ground they must be covered with fresh earth until such time as the tree has formed sufficient leaf canopy to protect itself.—*The Indian Forester.*

THE EXTRACTION OF GUTTA-PERCHA FROM THE LEAVES OF THE ISONANDRA GUTTA-PERCHA TREE.

Mr. Bourdillon has sent us a copy of an interesting report on the above subject by Professor W. Ramsay, Ph. D., F.R.S., of University College, London, from which we make the extracts given below. Could not a somewhat similar process be applied for extracting Indiarubber from the leaves of *Ficus elastica?* Perhaps some of our readers who are in charge of rubber forests would make experiments in this direction and let us know the results.

"The existence of a gum of a plastic nature in certain of the trees found in the Malayan Archipelago was first indicated by Montgomery, in 1832; but it was not until 1847 that Mr. Thomas Lobb sent specimens to Sir William Hooker. The material extracted from this tree was named "Gutta-percha"—or the "Rag Gum," to translate the word literally. The word "rag" refers to the appearance of the gum before it has been kneaded into the usual compact form in which it is known in commerce. In 1848 the material was patented as an insulator for telegraphic wires by Messrs. W. H. Barlow and T. Forster, and in the following year by Dr. Siemens ; so that its value for the purpose for which it is now in ever increasing demand was early recognised. In 1849 Mr. Walker Breit laid the first cable, two miles in length, in the English Channel. It consisted of wire, insulated with Gutta-percha ; and at the present date, with the exception of a small consumption for bottles and stop-cocks to resist the action of strong acids almost all the Gutta-percha produced is used to cover the wires of submarine cables. But the supply is far behind the demand. There is in existence today no less than 162,000 nautical miles of cable, and in 1884 over 3,000 tons were exported to England, involving the destruction of 12,000,000 trees of thirty years old. Owing to this great destruction of trees, the quantity of Gutta percha in the market has been greatly diminished, and the price has risen accordingly, while the material is no longer of such good quality as it used to be. Indeed, it is stated ("Le Caoutchouc et le Gutta-percha," by E. Chapel, Paris, 1892) that the Chinese merchants are so much in the habit of adulterating the pure gum with resins from other species of trees, that it is not possible to find a pure specimen of Gutta in the market. The gums from species of Euphorbia are frequently used for this fradulent purpose."

"There is great need to increase the supply of genuine Gutta-percha ; and there is every prospect that a rich reward would recompense a successful effort to do so."

"The present process of producing Gutta-percha is, as has already been indicated, wasteful in the extreme, and very costly. The trees are either ringed, so as to cause a flow of sap, or felled, and in either case the tree is destroyed. Moreover the gum is mixed with impurities of vegetable matter, such as pieces of bark, and even with mineral matter like sand and earth; to say nothing of the adulterations fraudulently added by the Chinese merchants. This necessitates a costly purification, which is achieved by softening and kneading the gum, or by squeezing it through wire gauze or some similar process, the results of which are, at the best, not very satisfactory. Solution in bisulphide of carbon, or in benzine, has also been tried as a means of removing these impurities, but the quality is thereby deteriorated. After the impurities have been mechanically removed, the gum is rolled between grooved or spiral rollers to expel water and air."

"The yield from a single tree, too, is by no means great. A tree of fifteen to twenty years old gives only three to three and three-quarter ozs. of Gutta, one of thirty years old gives some nine ozs., according to Serullas; and Burck gives about ten ozs. as the yield of a dichopsis tree twenty-six years old."

"The juice as it flows from the tree is white; on standing, it solidifies spontaneously, forming a sort of pellicle on the surface. On boiling or heating the juice, the Gutta collects into a more or less coherent lump."

"The Gutta as it comes into the market has usually a brown colour, which, however, does not belong to the pure gum, but is due to a trace of colouring derived from the bark; in some specimens the colour is dirty-white or pinkish, but the pure gum is really colourless. After being kept in the air for some time, the gum changes spontaneously to a brittle resin; this change does not occur if light be excluded, nor is the gum changed by light if air be excluded. Under water it is quite stable, whether the water be fresh or salt. It is found, too, that specimens differ in their power of withstanding the action of the air, and it is belived that the purer the Gutta the better it will resist the action of the air. It is found, indeed, that pure Gutta is only slightly attacked even after a very long exposure to light and air."

In what is usually termed "Gutta percha" three distinct chemical substances are to be found. On boiling the gum with absolute alcohol a quantity of resinous matter is dissolved, varying with the specimen of Gutta employed. Even the purest gum in the market yields some 18 to 20 per cent. of its weight to boiling alcohol; and only what is left can be considered to be the chemically pure compound. Of worse vatieties of gum, 40 or even 50 per cent. may be thus dissolved. These dissolved resins, although possessed of good insulating properties, cause the Gutta to deteriorate very rapidly if they are in present large amount; it becomes friable and easily disintegrated owing to oxidation. It is their presence in poor qualities of Gutta which renders them unsuitable for telegraphic purposes. But up to 18 or 20 per cent., they do not appear to act injuriously. The resins are named "albane" and "fluavile" respectively; the former, when quite pure, forms white crystals, the latter is a yellow gum. Both appear to be products of oxidation of the pure Gutta, albane containing twice as much oxygen as fluavile. Oudemans gives the formula of albane as $C_{20}H_{22}O_2$, and that of fluavile as $C_{20}H_{22}O$. But the chemical nature of these bodies, including Gutta-percha, has hardly been explored."

"M. Serullas has been led to devise a method of extracting these mixed gums from the leaves; instead of from the trunk of the Isonandra Gutta-percha. This tree used formerly to flourish in the Malay Peninsula in the neighbourhood of Singapore, but until it was re-discovered in 1887 by M. Serullas, it had not been utilised as a source of Gutta for thirty years, and it was supposed to have become extinct. It is the product of this tree which M. Serullas says is best adapted for telegraphic purposes, for it yields gums containing the highest percentage of pure Gutta, mixed with the smallest propotion of albane and fluavile."

In the best Gutta, the following are the proportions of these constituents:—

Pure Gutta-percha.. ..	75 to 82 per cent
Albane	19 ,, 14 ,,
Fluavile	6 ,, 4 ,,

"The process of extracting Gutta-percha from the leaves is an exceedingly advantageous one. To quote from the *Sarawak Gazette*, of the month of April, 1895:—"A tree of twenty-five to thirty years old yields one catty (one and one-third lb.) of pure dry Gutta, the same amount can be obtained by two pluckings of the leaves." The *Gazette* goes on to say that the stumps of trees which have previously been felled have now become covered with shoots, bearing rich crops of leaves; and that M. Hourant has induced the natives to collect these leaves, and that they are now exported in considerable quantity."

"M. Serullas states that a tree thirty years old yields 25 to 30 kilograms (55 to 66 lb.) of green leaves, or about 11 kilograms of dried leaves (24 lb.), from which it is possible to extract, by methods to be described, no less than 1,000 to 1,100 grams (over 2 lb.) of Gutta-percha, while the felled tree yields only 365 grams as a maximum. It would thus require that a tree should yield only 7 kilograms of fresh leaves per annum in order to give as large a supply as the whole tree felled and with much less expenditure of labour."

"It now remains to describe the method of extracting the Gutta-percha from the leaves. The process is due to M. Serullas.

"The leaves, either fresh or dry, contain Gutta-percha. The process of drying, whether artificial or natural makes no difference to the percentage of Gutta, if the latter be reckoned on the dry leaves. The leaves, after being dried, are ground to a fine powder, and then mixed with one-tenth of their weight of caustic soda dissolved in water, and heated to boiling or indeed digested under a slightly increased pressure. The liquor turns dark brown in colour, owing to the solution of a brown colouring matter, to which the Gutta-percha which usually comes into commerce owes its colour. The weight of the leaves, and also their bulk, is materially decreased by this process. The power is then dried by heating to 212° F.; a solvent is added, in a closed vessel, so as to hinder loss by evaporation. The mixture is heated so as to effect the solution of the Gutta-percha more quickly. The mixture is placed in a filter press, and the solvent is separated as completely as possible. The residue of leaves is washed with fresh solvent so as to extract the whole of the Gutta. The solution is of a greenish-brown colour, owing to the solvent dissolving out some chlorophyll--the colouring matter of leaves. As some solvent remains adhering to the powdered leaves, a current of steam is driven through this residue, which carries off the solvent and permits of its recovery. The extract is next placed in a still, and the solvent is partly removed by distillation, the pressure being somewhat reduced, so as to cause its boil at a temperature lower than that of boiling water. The concentrated extract is then run into a tank and mixed with twice its bulk of a volatile liquid. On mixing this liquid, which is done in a closed tank, there is produced a flaky or "raggy" precipitate of Gutta-percha. This precipitate is filtered off again by means of a filter press and the mixed liquids are run into a retort where they are submitted to distillation and are thus separated.

"The cakes of Gutta-percha from the filter-press are dried at a low temperature; they are then heated so as to soften them, and in presence of water they are moulded into lumps."

"The process is thus seen to be a very simple one. The products are easily prepared, and there is no loss except the unavoidable one, which always occurs when any substance is put through a round, and which is unlikely to be considerable."

"The next question is as regards the yield of Gutta-percha from the leaves and twigs. The following table is extracted from the valuable work on "Caoutchouc and Gutta-percha," by Seeligmann, Lamy, Torrilhon, and Falconnet, published by Britach, of Paris, 1896:—

"Old dry wood	..	10	per cent
" ..	..	9·15	,,
'Dry twigs ..	..	10·20	,,
,, ..	...	10·50	,,
'Dry leaves ..	...	10·02	,,
,, imperfectly dried		9·06	,,
,, imported in water		10·05	,,
,, ,, ,,		9·00	,,

"I have myself extracted Gutta from the leaves of the tree, by the process of Serullas, some six or seven times. Even on a small scale, where the difficulties of extraction, filteration, &c., are much more considerable than on a larger, I have obtained a theoretical yield. The following is a typical analysis of a sample of leaves, chosen at random from among many:—

Water in the naturally dried leaves ..	19·92	per cent.
Extractive matter removed by caustic soda ..	55·00	,,
Gutta, reckoned on the thoroughly dried leaves	9·61	,,

"The statements made by M. Serullas are therefore thoroughly borne out."

The following letter from the Director, Gardens and Forest Department, Straits Settlement, to the Director, Royal Gardens, Kew, which is printed in the Kew Bulletin for May and June 1897, gives a somewhat different account of the process. "I have just been to inspect the little factory where Mr. Arnaud makes his Gutta-percha. Serullas has gone back to Paris with endless patents of different kinds, and Mr. Arnaud alone keeps up the business. The leaves are imported in sacks dry, from Borneo and Johore. Most of the trees are overcut in Singapore, and there are no more leaves left, I hear. The leaves and twigs cost four dollars and half a picul (133 lb). They are then put, damped with hot water, into a rolling machine, two rollers working against each other, which grind them to powder. The powder is thrown into tanks of water and shaken about. The gutta floats in the form of a green mealy-looking stuff, is lifted out by fine copper gauze nets, put in warm water and pressed into moulds. I have samples of the gutta as it comes from the leaves, and the pressed out finished article. It is really a very curious little manufactory. I do not know how long it will last, on account of the difficulty of procuring leaves, which must I think, sooner or latter stop the trade—*The Indian Forester.*

RUBBER CULTURE.

A POSSIBLE AUSTRALIAN INDUSTRY.

An age of stone, of bronze, of iron, and also, say the scoffers, one of brass, has the world passed through in turn ; is it too much to claim that we are now in the rubber era, considering to-day the multitudinons articles in common use, the manufacture of which is impossible minus the indispensable inspissated juice known as caoutchouc. Indiarubber comes from many countries, but the principal supplies have been secured heretofore from tropcial South America, West and East Africa, Burmah, Assam, &c. Over extensive areas of these countries the different species of rubber trees are to be found, yet, although nature in the past has been so generous for man's wants in *re* the present pneumatic tyres, &c., so great is the demand and so wasteful the usual process of rubber collections—left as it mostly is to either ignorant, savage, or semi-civilised savages, taking little heed for the to-morrow of manufacturers—that specialists are casting around for fresh fields of exploitation ; their prognostications being that nothing is more sure than a half response, or less, to the future cry for raw material. And this is owing to the exhaustion of the known forests, thanks to rutbless destruction of trees and lack of forethought in the matter of replanting.

Not so many years age the Amazon valley with its Hevea Braziliensis yielded more than enough rubber for the world's use—and the real rubber trade may be said to have commenced less than thirty years ago—to-day this supply has been supplemented from the Hencornias of Pernambuco, the Manihots of Ceara, the Landolphias and Kickxias of West and East Africa, not to speak of the Ficus Elastica of the East and the celebrated Castilloa of central America. And yet the prices are slowly rising! Needless to say the manufacturing outlook is viewed with some uneasiness. Accordingly in other climes certain far-seeing people have started plantations, more particularly of the Castilloa, the Hevea, and the Manihot, whilst the Germans, with their usual thoroughness, in their West African possessions are making systematic attempts to propagate the Landolphias. And that the harvest to be reaped will be satisfactory is assured. The profits, based on present prices, at the expiration of the eighth year can be reckoned on at 300 per cent.

The parts of the world above mentioned are tropical, with a minimum average temperature of 66° F., combined with a heavy rainfall (though the Manihots and Hancornias do not require too much moisture), and it has always been laid down as a botanical postulate that Rubber and Rain, Miasma and Monkeys, are an indivisible quartette. But the knowledge of the earth's good things increases always. For example in 1893 the output of caoutchouc from Lagos, West Africa, was practically nil. Comes along one Kicks, who discovers a hitherto unknown tree. Its product is sent to Kew Gardens, London, for report, which being satisfactory, by 1895 nearly 4,000,000 lb. of rubber had been exported from that British Possession. But this by way of illustration only of what fresh discovery has done for the rubber market, for Lagos is an equatorial province. What is of far greater import to us is whether there is any possibility of the cultivation of any known tree in New South Wales. And considering what immense advantages would accrue to the farmer and planter by so doing no research for such a valuable kind of tree could be too comprehensive and no experiments too exhaustive, for the successful introduction of rubber-growing into New South Wales would mean an additional £1,000,000 to our annual export schedule. Surely an attempt to acquire such an increase is worth more than academic scepticism.

Twenty years ago that distinguished savant, the late Baron Von Mueller, stated emphatically that the Ficus-elastica (E. Indies), being so closely allied to the Ficus species known here, would grow in the Gippsland valleys and gullies. Nothing so far has been done towards founding such an industry. However, opinions differ as to the speed of growth of this tree, for though experience elsewhere, in Ceylon, &c., quotes an average of eight years ere maturity is attained, it is at least likely in a fair cooler climate that the wait would have to be at least 25 per cent. longer. The deceased Baron spoke, too, of the well-known Port Jackson fig (F. Rubiginosa) which on analysis gives—Resinous sycoretin, 73; Acetate sycoceryl, 14; Caoutchouc, 13—100.

And the Apocynaceous "bitter bark," akin to the West African variety, is also reported to yield a fair percentage of commercial rubber when leaf and stalk-crushing are resorted to. Beyond these Lactaria Calocarpa and and Lactaria Moorei have been suggested by some writers as possible caoutchouc givers.

So much for the known Australian trees themselves.

Remains now to be seen whether there are any quick-growing varieties obtainable from other countries which are suitable to the climate, say, of the Tweed, Richmond, and Clerance rivers. And, it appears, while the Castilloa might possibly meet the case, it is more than probable that the Sapium Biglanduksum would do so.

NOTES ON RUBBER GROWING IN PERAK.

MEMORANDUM BY MR. L. WRAY, CURATOR AND STATE GEOLOGIST, PERAK.

The first seed of the Para rubber *(Hevea braziliensis)* was introduced into Perak in the year 1882 by Sir Hugh Low, the then British Resident. It was sent to me to plant, but did not germinate, having been kept too long after picking. A second lot was received a short time after and was planted at Kula Kangsar: so that the larger trees there are now about 14 years old. 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. Finding that they grew so well I ventured, in 1891, to write to Sir F. A. Swettenham, the then British Resident of Perak, suggesting that they should be planted on waste lands, and, as a result, Mr. O. Marks, then Superintendent, Government Plantations, put out a number of trees at Kuala Kangsar, which are now about six years old and are doing very well.

It may 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.

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 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 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 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 some of those in the Museum grounds. These trees, it is to be remembered, are 10 years old and are planted on mined land of the poorest quality.

For 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 greatest difficulty in planting Para is the very short time which the seed remains good after it falls from the trees. The time which elapses before they are planted should not under any circumstances be longer than a week, and if they can be planted before this so much the better. Sown at once nearly all germinate, but each day which intervenes increases the number of failures till, at the expiration of ten days or so, none grow. The trees are very prolific seed bearers. Those in the Museum grounds have this year yielded nearly 14,000 seed—or, to speak more correctly, that number have been collected. At 15 by 15 feet, 14,000 seed 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. In the first few years a little judicious pruning would prevent this tendency to throw up more than one stem. In other respects they do not require any pruning, nor after the first few years any attention at all except a little cleaning with a parang. The trees are vigorous growing and, have such thick foliage that they would soon cover the ground and effectually keep out all weeds and scrub. Many methods have been suggested and tried for tapping the trees, but what may be called the herring-bone method appears to have advantages over the others. This is the way the Ipoh trees are tapped by the wild tribes of Perak and it is also used by the Malays for tapping trees yielding bird-lime, etc. The American rubber collectors also adopt the same method for tapping Castilloa. In 1888-9 the trees, Para and Castilloa, at Kuala Kangsar were tapped by herring-bone cuts by Malays.

On 5th July, a rubber tree in the Museum grounds was tapped by a herring-bone incision in the bark of the trunk about ¼ inch wide and reaching down to the wood. The cuts were widened several times to ultimately about ½ an inch. By the 7th October, the cuts were closed up with a new growth of bark. Three months is therefore sufficient for the covering over of ½ inch wide cuts made right down to the wood. The last places to heal over were those where the side cuts met the vertical one. Here, of course, the width of exposed wood was considerably more than half an inch. The best way of carrying out the herring-bone method of tapping is a matter of much importance, as on it depends the cost of the collection of the rubber. Common knives, chisels, chopping knives, pruning knives, etc, are quite unsuited to the work, so I devised an implement for scoring the bark which apparently answer the purpose in a satisfactory manner. The handles are made like a boat-builder's draw knife but the cutting blade is shaped like the letter U and fixed by a suitable set screw or wedge in the bar joining the handles and in the same line with them. In cutting a herring-bone incision the knife is taken in both hands by the handles and a long vertical cut made in the bark, but not so deep as to reach the sap layer. The blade ploughs out a furrow having the same section as itself and of a depth corresponding to the inclination at which the instrument is held in relation to the surface of the bark ; the set of the handles giving complete control over the direction of the blade. The side cuts may then be made to the same depth. Having gone so far and having cleaned away all the loose cuttings of outler bark, the receptacle for catching the sap may be fixed at the lower end of the vertical score, and then beginning from the top of the cut it may by a second application of the tool be deepened to the proper extent. By following this procedure waste of rubber may be avoided to a large extent and cleaner product obtained. The same instrument can of course be used to enlarge the scores for the subsequent tappings. The scoring knife will, I think, be found to quite halve the time in tapping the trees and do the work in a much better fashion as well. The receptacles for catching the sap can conveniently be made as follows. A tin can is fitted with a sort of sharp straight-edge lip at one side and a hinged lid to keep out fragments of bark, rain water, etc., and it is best and quickest hung on to the tree by a couple of attached wires furnished with sharpened hook points. In this way there is nothing required by the collector but his scoring knife and tins. He wants neither nails, hammers, wet clay, knives, chisels, all the other things now is use. Mr. J. C. Willis, Director of the Royal Botanical Gardens, is trying a method of tapping; with small detached V-shaped incisions, made with two cuts of a chisel having a wide blade of about an inch in breadth. These cuts I fined heal up in a very short time and do little damage to the tree, but it is doubtful if they will yield as much rubber as the native herring-bone shaped cuts. Mr. Willis informs me his experiments are not yet complete.

Some years back an instrument for tapping was recommended of the following description. A piece of wood about an inch broad and a foot or more long had the central portion set with sharp steel spikes like the hair of a brush. It was to be taken in both hands by the ends, which served as handles, and the spikes pressed into the bark, producing a series af punctures through to the wood. On trail in Perak, on the Kuala Kangsar trees, it was found that although the sap flowed when it was applied in fair quantities, it stopped almost at once, as the holes quickly became sealed up by the coagulation of the sap within them.—*Malay Mail*, Jan. 19.

TAIPING 4th Dec. 1897.

PARA RUBBER GROWING IN STRAITS SETTLEMENTS.

Government Plantations Office.
Taiping 24th Nov., 1897.

To the Secretary to Government, Perak,

SIR,—In reply to S.G. 61 64-97, I have the honour to forward the following report on the work done in connection with Para rubber trees at Kuala Kangsar.

2. Some months ago the Director of Kew wrote to me. He had heard from Sir Hugh Law that the Kuala Kangsar trees did not exude when tapped, and asked, with a view to information, for the reason.

3. It will be seen from this report that the work for the year is not yet completed, and I would particularly point out that the experiments have not been conducted to test how much each tree will yield, for the reason that these trees are of much greater value to the Government at the present time as seed-bearers than rubber-producers: as an instance of this, I would mention that applications for 70,000 seeds have been received for the current year (of which 25,000 have been supplied) and an application filed for 1,000,000 seeds next year.

4. The Para-rubber trees (*Hevea Braziliensis*) at Kuala Kangsar were first tapped during the month of August, and the work has been proceeding up to the present time. The frequent wet days have delayed the work considerably. At the end of October, 60 trees had been tapped and 88, of dry marketable rubber prepared. Most of the trees tapped were six years old, and from these trees an average of 10 ozs. of dry rubber has been obtained. A few trees, 12 years old, produced 3 lb. each, but in no instance were the tappings exhaustive. Two samples have been sent to Mincing Lane for opinion and valuation.

5. Tapping.—The trees were tapped with almost V-shaped cuts, a few inches apart, with a channel down the centre from the lower branches to the base. An ordinary pruning knife was used to make the first cuts, and about a quarter of the outer bark removed, care being taken not to cut too deeply. So soon as this commenced to callous—which varies from two to several days—the edges of the cuts were lightly shaved with a very sharp chisel every day with an occasional interval until the decided quantity has been exuded. The rubber was collected in locally-made tin boxes, 6″ × 4″ × 2″, nailed at the base of the tree, with the lid partially opened so as to prevent wet or dirt from falling in. When full, this was allowed to dry and the water pressed out (a pinch of salt appears to expedite the coagulation) and then kept in smoke for about a week to prevent mildew.

6. Time of Tapping.—Para rubber has a short resting season when most of the leaves fall off. The flowers usually appear first, and when the tree is in full foliage tapping can be commenced and carried on with different trees—until again deciduous. The first cuts can be made at any time of the day and may be left for weeks in the event of exceptionally wet whether, but the subsequent tappings should always be done in the evenings as the rubber soon ceased to exude with the influence of the sun.

7. Planting.—Most of the teers, at Kuala Kangsar are planted on wet land, subject to be flooded every year. Some, however, are on high dry land, but my experiments are not sufficiently complete to say if there is any difference in the yield of rubber on dry, against wet, land.

8. The tree appears to be the most adaptable of any rubber tree, growing from swampy lands to an elevation of several hundred feet, and seems to thrive on any ordinary soil. The material point in its cultivation is close planting. I recommend not more than 15 feet apart.

9. Remarks.—I am of opinion that a tree 5-6 years old is capable of producing 1¼ lb. and a tree 13 years old 5 lb. of rubber without injury. The cost of tapping, drying and preparing, I should estimate, working on a large scale, about 30 cents per lb. The present London value for dry rubber is from 3s 6d to 3s 8d (sterling) per lb. I would add that I shall be able to offer some further remarks when my experiments are completed, and when I receive an opinion on the samples sent home.

I have, etc.,

R. Derry,
Superintendent of Government Gardens.

38, Mincing Lane, E.C., 19th Nov. 1897.

To R. Derry, Dear Sir,—I have received your samples of Para rubber and beg to report on same as follows:—

No. 1. Matta Grossa in character, fairly clear, imperfectly smoked, but apparently good strong rubber.

* No. 2. Do. do. do. slightly preferable ,Value 2s 9d to 3s per lb.

The market is very good and you should ship all you can, try and smoke it a little more and keep the bulk up to the standard you sent me. As a rule the rubber from the Straits is much inferior to that coming from South America, but your samples are quite equal to Para. You seem to have more carefully prepared it, ordinary Straits rubber, imperfectly collected and prepared, is worth about 1s per lb. less than the samples you have sent.

I hope to do fairly well for you in the pepper, the market keeps good.—Yours, etc.,

W. Figg, for W. J. & H. Thompson.

NYASSA RUBBER—A NEW AFRICAN SORT.

Among the lots of rubber offered at the Antwerp India-rubber sales in February was one of 3,360 pounds described thus: "Nyassa —generally small and medium-size ball, hard good quality, Upper Congo red ball quality." The brokers' estimation was 7·35 francs per kilogram, while prime Lagos silk strips were put down at 7 francs. Nyassa rubber comes from the new protectorate of

* Prepared with a pinch of salt.

British Centrat Africa, and in regard to it we quote from the *British Central Africa Gazette*, published at Zomba, in the issue for November 8th, 1897.

"Considerable quantities of rubber are now being collected on Lake Nyassa, and it appears not improbable that this may become an article of extensive export from the protectorate. Rubber is being sent down from Bandawe at the rate of about tow tons per month at present. It is collected from the *Landolphia* vine, This creeper does not grow all over the country, but it is found solely along the banks of streams. In the country west of Nkata and Bandawe all the numerous stream valleys contain *Landolphia*."

This rubber is shipped by the steamears of the African Lakes Corporation, Limited, across Lake Nyassa, down the river Shire to the Zambesi, and thence to the mouth of the latter, on the East African coast. The amount of such shipments, during the year ended March 31st, 1897, was 5,667 pounds valued at the point of export at £277. The value of the rubber shipped during the preceding year was £28—*India Rubber World*, March 10.

THE OLDEST INDIA-RUBBER PLANTATION IN THE WORLD.

For the following translation of a Dutch Report on a Java Rubber plantation, we are indebted to *The Indian Forester* for May. Its contents are specially interesting to Ceylon planters at this time :—

The oldest Caoutchouc plantation in the world is perhaps one existing in the west of Java, in the province of Kranong. A former proprietor of the Pamanockan Tijiassan Estate which is the biggest private property in Java, containing 540,000 Dutch acres, had most of his land under coffee until 187?. Finding the cultivation of this plant was no longer lucrative, he planted some of the land up with *Ficus elastica*. The coffee plantations had already been more or less cleared of forest growth, so that the planting of *Ficus elastica* cost less than thirty shillings per acre. The soil of these coffee gardens had become useless for other agricultural purposes ; and had not *Ficus elastica* (Karet) been planted in time, would only have become covered with poor forest growth. The trees were planted 8¼ yards apart, or 72 trees to the acre. The area planted was 72½ acres, containing 5,200 stems. The trees were first tapped when the plantation was 14 years old, and the yield for that and the six following years was :—

Year.			lb.	Average oz. per stem.	Value. £.
1886	...	...	5,512	17	600
1887	...	...	4,954	15	540
1888	...	...	1,514	4	165
1890	...	...	3,307	10	*360
1891	...	...	6,113	18	387
1892	...	...	5,992	18	256
1895	...	...	3,197	10	411
	Total	...	30,589	Average per year per stem 6oz.	2,719

72½ acres thus, it is said, yielded in 7 years a surplus of £2,719, or per acre per annum £5-8 0. The yield was 71 lb. per acre per annum during this period. During the 23 years from the establishment of the plantation in 1872 till 1875 the net yield per acre per annum amounted £1-12-10. A. H. BERKHOUT, late Consr. of Java Forests.

Wageningen, Holland, 6th Jan., 1898.

We cannot regard the above as a favourable yield from trees 14 years old ; closer planting would probably give a better return per acre. It is noteworthy that the harvest fell off rather than increased during the 7 years recorded above. Far better and earlier returns can be got from Para rubber trees in Ceylon.

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* This note is taken from a report of the Netherland Indian Commercial Bank, in which the money results are called "net income," presumably after deducting the original cost of the planting operations.—*Translator.*

for making up substances as nearly identical with the natural product as possible, which are used to adulterate the rubber and Gutta percha used in the factory. No one has yet, however, succeeded in discovering a perfect substitute for either rubber or Gu ta percha. The history of chemistry contains many instances where natural products have been supplanted by artificial compounds possessing the same properties and characteristics. One of the most notable of those is the substance known as alizarine, the colouring matter extracted from the madder root. This, like India rubber, is a hydrocarbon. Prior to 1869 all calico-printing was done with the colouring matter derived from the madder root, and its cultivation was a leading industry in the eastern and southern portions of Europe. In 1869 alizarine was successfully produced from the refuse coal tar of gas works and the calico-printing business was revolutionized. The essence of vanilla, made from the vanilla bean, and used as a flavouring extract, has been supplanted by the substance christened vanilla by chemists, which possesses the same characteristics and is made from sawdust, Isoprene, from which Dr. Tilden produced India rubber, is comparatively a new product, as derived from oil of turpentine. It yet remains to be seen whether rubber can be synthetically produced certainly and cheaply. The results of further experiments will be awaited with interest, as the production of artificial rubber at moderate cost would be an event of enormous importance.—*Scientifi American.*

HOW RUBBER TREES (FICUS ELASTICA) ARE GROWN IN ASSAM:

By D. P. Copeland, Deputy Conservator of Forests, Darrang Division.

Ficus Elastica.—1. The India rubber fig or Caoutchouc tree is indigenous in Assam where it is found a dominant tree in the evergreen forests. It requires an exceedingly damp atmosphere, and the best natural rubber trees are met with in the forests at the foot of the hills, or on the hills themselves up to an elevation of 2,500 feet.

Natural Germination.—2. In its natural state, the rubber starts from seed dropped by birds in the forks of other trees, often 20 or 30 feet or even more from the ground, where it germinates, and the young plant remains an epiphyte for years until its aerial roots touch the ground; as soon as this takes place, the little epiphyte changes rapidly into a vigorous tree, throwing out numerous aerial roots which gradually envelope the tree on which it first began life and often kill it out.

Having started life so high up, it soon throws out branches which overtop the surrounding trees, and the numerous aerial roots, which fall from these and establish connection with the ground, in a few years enable it to dominate the forest growth around it.

Seed.—3. The seed of this tree is contained in fig-shaped fruit, about 75 seeds being found in one good sound fig. The first fruit begins to from on the trees in March and ripens from May onward to December. On some trees the whole crop ripens and falls off by June, but, as a rule, the rubber tree has fruit on it from April right up to December, the figs forming, ripening and falling off, the whole of the rains.

After collection the figs have to be carefully dried and mixed with pounded charcoal, which preserves the seed for several months.

Seed Beds,—4. In the Chardur rubber plantation nursery, for a seed bed 40′ × 3½′, two to three seers of pulverized rubber seed, 10 seers ash and 20 seers of vegetable loam or good soil, is well mixed in a half cask and spread evenly over the bed, and then lightly stamped down and water. Such a bed should yield, with good germination, 2,000 seedlings and should be sufficient for putting out 100 acres of rubber planted 70′ × 35′. The beds must be well-raised and drained, the soil being prepared in the same way as for vegetable or flower seed. If sown in boxes, these should be put under the eaves of a house; it in beds, light removable shades must be put up to keep off the direct rays of the sun. The shades should be removed during rainy or cloudy weather and at night. Light sandy loam is most suitable for seed beds; if the soil is stiff, charcoal dust should be mixed with it to make it porous and prevent caking. The bed or boxes must never be allowed to get dry.

SOWING.—5. This should be done exactly in the same way as for vegetable or flower seed which requires transplanting after germination. The figs are broken between the hand. As the seed is very minute, the particles of the fruit are left with the seed and sown with it, no attempt being made to clean or separate the pulverized figs. In order to distribute these minute seeds evenly over the seed beds, or boxes, a certain quantity of ash and soil is mixed with them.

GERMINATION.—6. Germination takes place from the end of April to the end of the rains. Seed sown between October and January, requires daily watering and screening from the sun, and will not germinate before the end of April or the beginning of May, but seed sown any time during the rains will germinate in a few days (from five days to a fortnight). It follows that the best time for sowing seed is during the rains—that is from June to September.

The embryo appears on the germination of the seed as a seedling having a pair of opposite cotyledons with an entire margin destitute of incisions or appendage of any kind, with the exception of the notched or emarginate apex, oval in general outline, green in colour and of a glassy smoothness. The second pair of leaves shows a tendency to the alternate arrangement on the stem but apperas at the same time. Their shape and venation are very different from those of the primary leaves for they have a central midrib and a distinctly coarselycrenated margin. The third pair of leaves do not appear simultaneously, and are distinctly alternate, with a marked reddish colour after this the plant is easily recognized.

PRICKING OUT.—7. When the seedlings are one to two inches high in the seed beds or boxes, they should be transplanted into nursery beds, and put out in lines about a foot from each other. The nursery beds should be well-raised and drained, but the soil need not be so carefully prepared as for the seed beds, Here the plants are kept till the following rains, when they are dug up and taken to stockaded nurseries in the forest, and put out 5+5' on raised well-drained beds, where they remain for two years till they are required for planting operations.

FOREST NURSERIES.—8. Almost every animal will eat the youn rubber plants ; it is, therefore, impossible to plant out small seedlings in the forest, owing to the destruction by the wild elephants and game, unless each, individual plant is carefully fenced in. As this is too costly, and the rubber after it is 1—2 feet in hight is very hardy and can be transplanted, with ordinary care, at any time of the year (the best time in Assam is between May and July), the seedlings are kept in stockaded nurseries in the forest where platnting operations are to take place, and remain there till they are 10 or 12 feet high that is about three years after germination when they are dug out and the roots are cut back 18 inches right around the plant and planted on the mounds in the forests.

PLANTING OPERATIONS.—9. In artificial planting it is found that the rubber grows best on mounds Lines. are cut through the forest 20 feet wide and 70 feet apart from centre to centre; in these lines 15 feet stakes are put up 35 feet apart. Round each stake a mound is thrown up four feet high. The base of the mound is about ten feet in diameter and they taper to four feet on the top; on this mound the rubber tree is planted, care being taken that the roots are carefully spread out before they are covered up with earth. To prevent animals pulling the ptants and wind blowing them down, they are tied to stakes.

CUTTINGS.—10. The rubber tree can readily be propagated from the cuttings, if only perfectly ripe young branches or shoots are used, but the tree raised from cuttings does not appear to throw out aerial roots, and, as the future yield of the tree probably depends on its aerial root system, it is questionable whether trees raised from cuttings ought to be used except where required only as shade givers, such as in an avenue. In the Charduar rubber plantation, propagation by cuttings was given up very early, that is about 1876, the plantation having been commenced in 1873.

The best time to take cuttings is May and June.

GENERAL.—11. The rubber grows equally well on high land or low land, in forest land or grass land, so long as it is planted on a mound and its roots are not exposed to the sun. It is a surface feeder, but, as soons as its roots appear above ground, they must be covered with fresh earth until such time as the tree has formed a sufficient leaf canopy to protect itself.—(Assam Forest Report 1896-97).—*Indian Forester.*

RUBBER:

SOME RECENT DEVELOPMENTS IN RUBBER-CULTIVATION.

During a trip of several months through the old rubber-producing regions of Central America and the northern states of South America I found a great interest in rubber cultivation, and preparations were being made to start very considerable undertakings, particularly in the British West Indies, where the fact that rubber never has been indigenous to those islands is not considered in the enthusiasm of the people. On the island of Trinidad I found this enthusiasm increased to a substantial boom. Rubber seeds were selling at five cents each, and young trees were wanted at fifty cents, though owners were refusing to sell year-old trees about two feet high for less than a dollar a piece. It was reported that two English companies were about to begin operations in Trinidad and were proposing to invest a combined capital $5,000,000, while private enterprise would probably bring $2,000,000 more to the island making a total of $7.000,000 prospective capital to be invested in that one locality. Other islands were becoming interested. In Grenada seeds were in demand, with the prospect that a very considerableacreage will be set out.

The most interesting point under discussion in relation to rubber-planting in the British West Indies is a series of experiments now being carried on in London and Trinidad, by which it is proposed to secure rubber from year-old trees of the *Castilloa elastica.* It has been found that seeds sown broad-cast over a prepared field will field an abundant crop of young trees, which at about a year old can be cut and sent to a factory where, with ordinary machinery operating a simple process, 8 per cent. of fine rubber can be extracted from the young shoots. This can be done in the laboratory. It is claimed that the process is a simple one, that but little machinery is necessary, and that in future the world's rubber supply will be secured from an annual crop of young trees sown on cultivated estates, and not from remote forests as at present. A series of experiments has shown that the young tree contains about 8 per cent. of rubber, which would at present prices return an estimated profit of $200 to $400 per acre. The extraction of rubber from young shoots has been accomplished chemically in the laboratory, but whether it can be applied to the economic production of rubber on a large scale remains to be seen.

Castilloa elastica will grow almost anywhere, but it will yield a profitable flow of milk only under favourable conditions, and these conditions are dependent on the geological formations and topographical features surrounding the trees. To form an opinion in regard to these matters requires an economic geologist of some skill, and because of the fact the greatest losses will be made, for, as it is in mining and kindred enterprises requiring technical skill, uninformed people always considered themselves competent to judge and most of them will have no use for the trained observer. As rubber trees will grow almost anywhere, and as the period of waiting before a crop can be expected is a long one, the successes that some will make afford an example on which to secure money and lose it to the profit of promoters and their associates who will claim to be thoroughly posted and to control lands that fulfill every requirement.

Opinions in regard to suitable rubber lands vary to an unusual extent. This is because many observers have noted one species of rubber-producing tree and its special surroundings, but have never noted all the conditions common to the several species. In America rubber is mostly produced from *Castilloa elastica*, and several species of *Hevea*, each of which is found under quite distinctive surroundings. As a result, general opinions on rubber lands, are three times differently expressed. One man will feel assured that rubber to be successful must be planted on land that is inundated a few feet at least once a year, another will say that low ground near a wet swampy country is the only available locality; while still another will talk of the midium upland country as the most promising.

These are widely different opinions, yet each is correct. Some species of *Hevea* do best on low ground that is subject to slight annual floods. Other species of the tree thrive over low, rich woodlands just beyond the reach of floods. *Castilloa elastica* does well on the foot hills wherever there is a rich, clean soil and abundant water. It is also found in low, swampy ground, but amid such surroundings does not yield as fine rubber as in the healthier localities.

Rubber is taken from a number of trees and vines, but the species that I have noted yield the commercial supplies of America; of these *Castilloa elastica* is of the most interest to people who think of planting, because it does well on healthy ground where a man from the temperate regions can expect to live and see his trees develop.

The proper land should be clean, rich, and abundantly watered, with a good drainage. Such lands give the best returns. The trees grow abundantly on low unhealthy lands, but do not yield so good a quality of rubber, for which reason if one proposes to cultivate it is well to have the best, and on this much will depend, for it will have an important bearing on results. Of the two methods of cultivation that are being tried little has been done with forestry, as yet. but the few experiments that have been almost universally successful and promise important developments for the future. Husbandry so far has not been a great success, and in many places rubber-trees have been carefully planted and tended for a long term of years but have not given any returns, though it is claimed that some of the trees are twenty to forty years old.

The claims in favour of husbandry are that a great number of trees can be planted on one acre, and that all are within easy reach, while better returns can be expected from cultivation than from the natural conditions of the forest. It must be borne in mind, however, that *Castilloa elastica* is a tree of the shade, and that the flow of sap, and not beautiful proportions or an abundant yield of fruit is the object sought. Another important point is that the tree has a comparatively tender bark in the shady woods, which in an open cultivation becomes much heavier as a protection against the sun and dry air at the expense of the flow of sap, and the provisions of nature which permit the tree to grow anywhere defeat the objects of the planter and makes rubber cultivation a doubtful undertaking. Hence in many cases the thousands of dollars that are being invested in such enterprises will be the source of grievous disappointment. On the other hand, a careful selection of a run of forest property where rubber-trees reproduce themselves naturally, must yield returns that will surprise even the most sanguine expectations.

Castilloa elastica reproduces itself freely. It has been compared to the pine—a slow-growing tree which does not propagate itself rapidly. It should, however, be compared with the chestnut of our northern forests. If a stretch of well-situated land were allowed to grow up wild here at the north, it is certain there would be a fair proportion of chestnut-trees that would probably come up on the property. If, besides these natural results one or two camps were established on the place and a few men were kept working about through the woods planting chestnuts and looking after the trees, it is certain that the care and attention would result in a heavy percentage in favour of the planter. Similar results can be expected in the trophical forest using the same methods but substituting the care of rubber-trees for the chestnut-trees that I have taken as an illustration.

MANICOBA RUBBER IN BRAZIL.

The official report of Consul Benjamin F. Clark of Pernambuco to the United States government has just reached us :

He says : The manicoba plant is grown in the north of Brazil especially in Ceará and Rio Grande de Norte and Parahyba. In price the rubber from those states is second to the seringueira or Pará rubber, and for certain classes of work is preferred to the latter.

The interest in the growth of the plant is steadily increasing through the three states mentioned above, and is also extending rapidly throughout Pernambuco, Alagoas, and Bahia, giving better sesults with less labour than almost any other agricultural pursuit.

The seed should be planted at the beginning of winter, red or brown soil giving the best results. At the time of planting the soil should be neither excessively dry or wet ; once the tree has reached the age of two years it can resist any weather, but, of course the amount of milk will always more or less depend on the climatic influence.

At six years the plant will have reached its maturity, which is the time best suited for tapping, though this may be begun at the age of two years. After six years the tree will produce annually, until the age of thirty years from 2 to 5 kilograms (4·4 to 11 pounds) of rubber, if in good condition. After thirty years the yield will slightly decrease, the life being at least a century; under fair conditions.

The sap is prepared in exactly the same manner as the seringueira of Para, but is of a deeper brown color after smoking.

The way the greater part of the manicoba rubber is produced in the states above mentioned is to simply cut the bark of the tree, letting the sap run in drops to the base, where by the action of the sun's rays it coagulates and forms an irregular solid mass, which is gathered by the natives and sold to the middlemen, by whom it is shipped to America and Europe.

The prices per kilogram range, in the states from 2 to 5 milreis (28 to 70 cents per 22,046 pounds), according to quality.

Besides the manicoba, these states produce a great quantity of mangabeira rubber, which is of an inferior grade to the manicoba and is used for covering cables, &c.

Below is given a table of the rubber export from Ceara for the years 1893 to 1897, inclusive :—

		Quantity. * Kilos	Value. † Milreis	Value. $
1893	...	135,569	1,129,742	359,840·66
1894	...	146s627	1,221,892	242,378·30
1895	...	146,627	1,529,567	302,587·73
1896	...	324,327	2,702,725	486,490·50
1897	...	475,663	3,964,108	594,616·20

—*The Rio News*, Jan. 24.

RUBBER MACHINES.

With regard to machines for the preparation of rubber from the raw state, of which few if any are, we believe, at present in use in Ceylon, it is of interest to learn that the local School of Agriculture are to receive a supply in the course of a few weeks from Messrs. Thomas Christy and Co. the well know exports of Lime Street, E. C. A large quantity are being made, the machine having been carefully tested in several rubber countries. The price will be somewhere about £7, the exact figure not having been fixed yet.

* 1 kilogram equals 22,046 pounds.

† The paper milreis is estimated as follows: 1893, 23 cents; 1894, 20 cents; 1895, 19 cents; 1896 18 cents; 1897, 15 cents.

PARA RUBBER IN SELANGOR.

EXTRACT FROM ANNUAL REPORT OF SELANGOR PLANTERS' ASSOCIATION FOR 1899.

(*b*) PARA RUBBER.—Probably no more important evidence, that planters are at last realizing the futility of risking their all on any one product, has been afforded during the past year than the energy with which large areas have been planted up with para rubber. Had it not been for the shipments of seed which were received form Ceylon, operations would have been considerably restricted, as the local supply was no hing like sufficient to meet the demand. The vitality of Para seed is so dependent upon immediate planting that it was feared the long journey from Ceylon would prevent a large proportion of the seeds from germinating; happily, however, where proper precautions were taken, from 50 to 60 per cent. of plants resulted on an average from the Ceylon seed, and in consequence this product, which does so well here, and which has to all appearance so prosperous a future before it, has become established in the State with every prospect of large extensions in the coming season. The young plants are reported on all sides to be growing satisfactorily, but on most places heavy losses have been occasioned by rats, lizards, moles, crickets' and other pests, and the problem now to be solved is how to best stave off such attacks until the plants are able to take care of themselves. Your Committee, therefore, hope that members will communicate to the Association particulars of any experiments that have been attended with successful result. 389,500 Para Rubber trees have been planted in Selangor during 1898.

WEST AFRICAN RUBBER.

THE "KICKXIA AFRICANA."

THE THREATENED DESTRUCTION OF A VALUABLE INDUSTRY.

(*By an Occasional Correspondent.*)

Kickxia Africana is the botanical name of a rubber-yielding tree, erroneously known to many, even in West Africa, as the Lagos Rubber Tree, although its commercial utility was first recognised on the Gold Coast where it was regarded as an important source of trade long before energetic little Lagos rubbed its half-opened, sleepy commercial eyes, and fortunately for itself rediscovered it when the cycling craze set the world a wheel and created a demand for rubber which has always overlapped the supply and will always continue to do so, considering the number of dormant industries involving its use that will leap into activity and outpace any additional supply.

I am almost tempted to digress into describing the marvels of the West African bush, where trees yielding rubber, incredibly long bark fibre, valuable timber, gums, and various sorts of oil, &c., flourish side by side with others carrying lurking death in their wood, bark, flowers, leaves, and fruit—all joined together, as it were, in weird comradeship by interlacing creepers, including the world-famed *Strophanthus*, whose seeds are almost worth their weight in gold.

It is, I think, generally admitted that the coagulated milk of the Kickxia forms the principal rubber supply of West Africa. The economic value of this supply has progressed by leaps and bounds for a few years in each of our East African Colonies, Protectorates, etc., and declined as rapidly after reaching an unexpected climax that has puzzled colonial officials, particularly those immediately connected with revenue and financial departments. The diminution in the output has been brought about not by the diversion of this particular branch of trade industry to French or German spheres of commercial, competitive activity, but by

IGNORANT, WASTEFUL, AND DEPLORABLY SUICIDAL METHOD

adopted by the Aborigines in tapping the milk from the lactiferous inner bark in such a destructive way, and at such unreasonable times, that thousands of trees have died from exhaustion, deprivation of the chance of bark healing and recuperation by unseasonable tapping, and unnecessarily deep scorings through the barks into the wood of the tree, rendering it an invitingly easy prey to a destructive grub or maggot with a predilection for the wood of the Kickxia, and a prolific fecundity that is simply astounding. Whether the maggot is the progeny of a beetle in an entomologically transitional state like the coffee borer, palm weevil, &c., I have not determined from lack of opportunity for scrutinous observation; but that it attacks the exposed wood of the Kickxia with fatal results is a certainty, preventable by judicious tapping, as I shall subsequently show.

Besides the supply from the Kickxia,

RUBBER IS ALSO OBTAINED FROM THREE SPECIES OF VINE,

principally Landolphia, forming, however, only a sixth or seventh of the total rubber output of West Africa. Three kinds of Ficus also yield a commercially unimportant supply of what is called paste rubber. This is capable, however, of vast improvement while in a milky state, by the use of the proper coagulating fluid. The rubber from the vines and ficus being comparatively unimportant, I shall confine my descriptive attention to the Kickxia, which is, must be, and is easily capable of being, not only the prop but the buttress of the fast declining West African Rubber Trade Industry. It is, moreover, an easily cultivable plantation rubber, and being indigenous, possesses reproductive advantages it would be fatuously suicidal to overlook. There are certainly excellent species like the four kinds of *Heavea* of Brazil, the *Castilloa Elastica* of South America and Mexico, and the *Ficus Elastica* of Assam and India that imbue hopes of prosperous alternatives, but, alas, delusive hopes, because the seeds lose their vitality with such disappointing rapidity. Hence what is really urgently needed in West Africa is an indigenous, easily propagable rubber that will give bushmen the minimum of trouble in planting and growing from seed *in the bush* to continually supply substitutes, growing and mature, to replace trees killed by destructive tapping.

It will thus be seen that the aboriginal bushman, the tapping producer, cannot be depended upon to conserve Kickxia from the destructive effects of bad tapping. It will be conclusively seen under the heading *Seed* that the Kickxia is easily and inexpensively propagable, although the peculiarity of its comparative isolation seems to militate against the fact.

Dr. Stapf's amplification of Bentham's description under the heading Apocynaceæ in the "Flora of Tropical of Africa," is in the main, accurate. The lithographed illustration of a pair of follicles forming a supplement to the Kew Bulletin No. 106 for October, 1895, is slightly misleading. The follicles I have plucked from the tree are on an average 8 inches long and planoconvex. They split open when perfectly mature in a straight line, equidistant from the longitudinal ridges, *on the plane face*.

SEED.

The Kickxia flowers in the dry or Harmattan season, simultaneously shedding its seed from mature follicles developed from the previous year's flowering. Having often donned climbing spurs and a circumferential supporting rope, I have climbed the Kickxia, remaining amongst the branches for hours watching the seed fall. This they cannot possibly do till the follicle has entirely split from base to tip; even then they float down singly to the rhythmic movement of the tree's gigantic arms in the breeze, leaving the pod first in the centre. The follicles are tightly packed with seed pointing tipwards, the reversed silky hairs attached with the basal awn pointing in the same direction. On a slightly breezy day I have seen thousands parachute down—none perpendicularly; all point downwards with the basal awn and supporting silky hairs keeping the seed in an upright position for some time, as if nature desired the radicle point to penetrate the soil. Unfortunately this interesting provision of nature to assist germination is counteracted in the dense bush by preventing under-growth and the equally deterring carpet of leaves, on which the seed invariably alights to quickly rot or abortively germinate, *out of soil*, assisted by the warm, humid, equable temperature of the dense bush. This being so, it is quite evident that hardly one seed in many million has even the soupcon of a chance of germinating to some purpose. For these reasons the Kickxia grows in singular isolation like all trees in dense forests with winged, light, delicate seed. Its capacity for reproduction, however, is great, and easily convertible into an accomplished fact if follicles were collected from trees, the seed taken from them and planted in the bush. If the different Colonial and Protectorate Governments of West Africa would only encourage the gathering of the seed, which is simple enough, and persuade the natives to give them the ghost of a chance of germinating *in soil in the bush* I am fully persuaded that within seven years from the initiation of this precautionary measure, they will have

RE-CREATED A RUBBER INDUSTRY.

that will not only prove a reliably constant source of reactive revenue, but will soon outrival the everlasting palm oil and palm kernels that have reached and declined from the zenith of remuneration owing to cheaper substitutes and the volition of industry requiring their reduced use to Belgium, Germany and America.

The Gold Coast colony, with tracts, paths, and roads into the interior, has special facilities for coming in contact with rubber-gathering bushmen, and being handicapped for want of waterways, bulky produce like palm-oil and palm-kernels are with extreme difficulty conveyed to the coast. Rubber, on the contrary, is extremely valuable for bulk, and easily transportable, and short of present or prospective demand must form the keystone of the industrial arch of this colony—a suggestive arch, pregnant with pathetic meaning; an arch whose stones have been cemented together by the life-blood of Englishmen who have sweated in the world's valley of Death pursuing various careers in trade and in Government service. It is to be hoped that this colony in particular will be successful and avail itself of the hopeful prospect of inducing bushmen to sow the seed of the Kickxia, which flourishes in the interior. The process is simplicity itself, as it involves only clearing the bed of leaves, loosening the soil for a foot in circumference to the depth of a couple of inches, and dropping two or three seeds on the loosened bed, The seed will germinate rapidly, the seedling grow quickly, and take care of itself in the bush,

The seeds, if carefully kept, preserve their vitality for a considerable time, thus possessing an incalculable advantage over the short-lived seed of other good rubbers, particularly for plantation purposes. Being only six to seven inches long and delicately spindled, they pack into a conveniently small compass, rendering it possible to send tens of thousands by parcel post ridiculously cheap. I know for a fact that the soil and climate conditions are eminently favourable in the Straits Settlements and over vast areas in Ceylon, Lower Burmah, Assam, and other places in India, it is possible to utilise the services of splendidly-trained, efficiently-equipped, and thoroughly-organised forest departments.

SOIL.

The Kickxia thrives best in a sandy clay, with a subsoil of clay. I have seen it flourishing in stiff clay, but with feeders only partially buried. Of course, under the latter condition the damp, dark shade of the bush is a necessity. In quite a number of clearings in West Africa I have seen it growing luxuriantly as a sapling in loose, friable, sandy loam, although I must admit it had a tendency to be rather branchy, remediable, however, by judicious pruning. I should say the ideal soil for a plantation would be a loose sandy clay, with more sand than clay, and a subsoil of clay, so that during the warm dry season the latter would act as a reservoir, supplying requisite moisture by capillary attraction.

PRUNING.

In the bush, the growing sapling sheds its primaries till it practically overtops the closely surrounding forest growth, 70 and often 80 feet from its base. At this elevation I have seen quite a number of trees throw out their gigantic arms. Nature, more by surroundings than by heredity, if I may say so, seems to prune it in the bush in her own incompar able way to ensure a splendid trunk surface for tapping. When it grows in the open, artificial pruning becomes necessary. As the desideratum is to have a good trunk height or tapable surface, unnecessary primaries should be pruned away close to the stem, leaving a sufficient number with concomitant leafage to form new wood. The Kickxia is also capable of being stumped even when pretty old. Should the tree be hopelessly irregular, stumping should be resorted to but only in the rainy season, when its roots, with the assistance of moisture, adequately help in the preservation of old and the formation of new wood. All but the best sucker or shoot should be pruned away, care being taken to tar the exposed wood, to prevent the destructive incursion of the grub or maggot.

TAPPING.

Assuming that the tree has reached maturity, systematic tapping is necessary or rather essential to get a reliable annual supply of rubber; the best way to do this is to make a longitudinal conducting channel up the trunk from the base. It must be recollected that this is only a conducting channel to capture the milk from oblique, transverse scorings in the bark. The scorings into the bark resemble the letter V, forming angles where they meet the conducting channel of approximately 45°. Rectangular scorings would facilitate the milk flowing down the trunk irregularly instead of all into the conducting channel and straight down the trunk into the receptacle placed at the base of the tree to collect the milk for coagulation. It stands to reason that the oblique transverse scorings and conducting channel should be respectively continuous, otherwise there would be a diversion and consequent waste of milk flowing away at the points where they are disjointed. For this reason a *machete*, even in the hands of a skilful European craftsman, would be almost useless, leading to independent cuts and not continuous scorings, considering that the operator must be in an unstable, wobbly position, like Mahomed's mythical coffin. Anyway, he must be above *terra firma* where his *machete* or knife strokes cannot produce continuous and conterminous scorings, but must necessarily be disjointed and fluky. The inner bark should never be cut deeper than a quarter of an inch, as this is amply sufficient to drain away enough milk from the tree and facilitate the healing of the bark which may be safely accelerated by the application of what I may call, with every apology to the medical profession, an antiseptic plaster, composed of one part of quicklime, two parts wood-ashes, and five parts clay. This not only excludes the oxygenic, deteriorative action of the atmosphere, but, what is more important, precludes the depredatory entry of the dreaded grub or maggot. If this system be adopted an annual supply is certain, and the conservation of the tree ensured. Moreover, oblique scorings could be made less than a foot apart, without in any way retarding the complete recovery of the bark or hindering recuperation, which would be so rapid as to enable the tree being tapped again the following year. It is advisable, however, that the scorings should be fully a foot apart, tapping being done a month or so after the commencement of the rainy season. This would leave a good wet period for rapid, healthy convalescence, and complete recovery before the advent of the ensuing dry season.

YIELD.

The Kickxia, when treated judiciously, yields between three-quarters and a pound of rubber for every year of its age—that is, a tree twelve years old could be safely depended upon to yield nine pounds of rubber

VALUE.

A pound of Kickxia rubber, properly coagulated, should realise at least 2s 9d. auctioned in open market in London. The milk, when procured clean and allowed to coagulate itself, realise 2s a pound.

Trade rubber, adulterated by the bushmen to mendaciously increase its weight, and soaked in water by traders for the same reason, fluctuates in value from 1s 6d to 1s 9d a pound. When the proper coagulating fluid is used condensation is more homogeneous, so to say, that the result a compactly welded mass of rubber, with no air chambers and holes full of uncoagulated milk. By soaking the bales or cakes as they are brought to his factory, in water, the trade generally converts the uncoagulated milk into a putrid-smelling liquid.

I am positive it is well worth the while of all West Afrcan Governments to interest themselves in the easy bush culture of the Kickxia, as trees are being destroy d very rapidly by unavoidable, deplorable, primitive tapping, which cannot possibly be avoided, as I have shown, but can be remedied as indicated by providing growing substitutes to replace fast dying trees Moreover, the manner of replacement is simplicity itself. I strongly advise sticking to the Kickxia in West Africa. It must be borne in mind that seven-eighths of the rubber exported comes from the Kickxia, the growth of which it is imperative to encourage as a means of reviving a remunerative and, consequently, revenue yielding branch of trade.—*Commercial Intelligence*, Feb. 25.

MANGABEIRA RUBBER.

In the review of rubber plants, which Professor V. Warburg is contributing to the "Tropenpflanzer," he prophesies a great future to the hancornia speciosa, a tree which occurs in the central belt of Brazil, principally in the States of Bahia and Pernambuco, also in Goyaz and Minas-Geraes, San Paulo, and other Southern and Western States, and has indeed been found in Paraguay. The trees attain a height of 20 ft., and may in general appearance be likened to apple trees. In some districts they are so common that they give the characteristic stamp to the landscape. The fruit has the size of a plum, and is valued both raw and preserved. The rubber trees are on the whole very useful, and their fruits are often appreciated. When the tree has attained an age of five or six years, it may be tapped. The milk has a characteristic pinkish colour, and the rubber, the coagulation of which is brought about by an addition of alum, is distinguished by the same colour. Originally the lumps were kneaded by hand and dried in the sun. The mass, which keeps its pink colour inside, while the outside turns brown, retained too much water, however, so that the rubber is now dried in thin sheets. These sheets command a good price; but the Professor is hardly correct in stating, as the *Gummi Zeitung* points out, that it is valued as highly as Para rubber. Perhaps Warburg's account is a little optimistic; at any rate, the state of S. Paulo is encouraging the cultivation of the hancornia and it may be quite right to introduce the tree in Togoland, although the climatic conditions of the South American continent and of the Gulf of Benin may differ widely. As there is little known about the habits of the tree, a further study in the home of the hancornia may be more advisable than experimenting.

Professor K Schumann announces the identification of a new rubber tree of East Africa. It concerns the moga rubber tree of the Zanzibar trade. So far as branches and blossoms allow to determine, this product forms the mascarenhasia elastica, the special variety having been named after K. Schumann.

RUBBER CULTIVATION IN THE STRAITS SETTLEMENTS.

Consequent upon the great demand that at present exists for good rubber, experiments have been made with various rubber producing plants in most of the tropical botanic gardens and stations. At Singapore and Penang experiments have been conducted almost entirely with Para rubber (*Hevea braziliensis*), and at the latter garden success obtained has been so considerable that in Penang and the Wellesley Province large areas have been placed under rubber cultivation. During 1898 there were distributed from the Singapore Botanic Gardens 98,650 seeds and 10,650 plants of Hevea braziliensis as follows: Selangor, 76,7000; Johore, 21,300. Borneo, 5,500 Pahang, 3,550; Penang, 1,400; Dinings, 400; Negri Sembilan, 600; Madras, 500. This amount did not nearly meet the demand. As showing the enormous growth the trees make, it has been stated that at fourteen years after planting Para rubber trees will have a girth at five feet from the ground of from four feet to six feet. At the Penang Botanic Gardens Mr. Curtis tapped a thirteen-year-old tree. On the morning the incisions were first made only $\frac{1}{4}$ oz. of wet rubber was obtained, but by taking a thin shaving off the lower surface of the oblique cuts on fourteen subsequent occasions the following quantities were obtained at each operation in ounces: $\frac{3}{4}$, $1\frac{3}{4}$ $3\frac{1}{4}$, $3\frac{1}{2}$, $3\frac{1}{4}$, 6, 9, [illegible]$\frac{1}{2}$, $8\frac{1}{2}$, 6, [illegible]$\frac{1}{2}$ 10, $8\frac{1}{2}$, 8. Total 5 lb. $1\frac{1}{2}$ oz. of wet rubber, which weighed when dry exactly 3 lb. As will be seen from this, the last three tappings gave a better result than any previous three, but operations were then suspended because it was not advisable to make the cuts any wider. The time occupied in affixing the tins and renewing the cuts average half an hour on each occasion, or seven and a-half hours in all. It may therefore be taken that a man at, say, 30 cents per day could attend to at least fifteen trees per day, and that the cost of collecting will not exceed 10 cents (a little less than $2\frac{1}{2}$d.) per lb. This same tree yielded 1lb. of rubber in 1897, and it had a girth of three feet five inches at three feet from the ground in December, 1898. There appears to be little doubt about the profitableness of rubber cultivation, if one can afford to wait a dozen years or so for returns.

RUBBER IN TRINIDAD.

The annual report of Mr. J H Hart, Superintendent of the Royal Botanic Gardens in Trinidad, for the year 1898, is as follows:—Rubber.—(Castilloa elastica, Cerv.) Rubber cultivation has been taken up with considerable energy during the year 1898. The principal kind used for planting was Castilloa elastica, Cerv. Auction sales of seeds and plants of this rubber were well attended and good prices were realised, as there was considerable competition.

At the experimental station a small area was planted in July. Among the Castilloa has been planted at wide intervals the larger and slower growing Hevea brasiliensis with the view to their becoming the permanent occupants of the ground; it being the intention to bleed the Castilloa trees very hard for certain experiments, under which many may succumb. Another area has been planted out under the shade of standing trees, in what is called the old cottage grounds. It has been found that where Castilloa is well shaded their growth is much more rapid and vigorous than in the open. To grow Castilloa without a certain amount of shade and shelter, would in my opinion be to invite a succession of slow and stunted growths. In its native countries it is always found in sheltered and protected lands and always become stunted in the open vega. Trees planted in Trinidad under standing shade have been found to thrive well, and soon become the picture of healthy growth. At the experimental station it was necessary to shade with Banana, Cassava, &c., and under these conditions the plants have also grown well. In the nurseries at St. Clair are several thousands of Castilloa plants in bamboo pots; a large proportion of which are already ordered for the next planting season. Castilloa under favourable conditions in Trinidad makes rapid growth, and is probably better suited to the climate than any other class of rubber, as it comes to maturity earlier and can be handled with a minimum of previous planting experience. Specimens of the rubber sent to England for valuation prove that our Castilloa trees are the best *kind* in cultivation. The large crops of seed now obtainable from Castilloa will make it possible at an early date to grow stems for the purpose of extracting rubber from them in their young state. Stems of a year old have been found to contain some 8 per cent. of their dry weight in rubber and this amount has been extracted in the laboratory. Whether the same percentage can be extracted in actual practice, remains to be seen.

Hevea Brasiliensis, "Para Rubber."—This tree produces rubber of the finest quality, for which the demand is very regular. As a tree it is of slower growth than Castilloa, but grown for a permanent crop it will probably exceed that tree in value. The tree proves itself to be hardy, it can be handled with ease, and grows freely; although it takes a number of years before the trunk becomes large enough to bleed regularly. Growing at the old Gardens, the tree is seen to make itself at home on the hard and barren soil which there obtains; showing that although it is a tree fond of water, and delighting in frequently-flooded valleys, it will also grow in other situations. Specimens of rubber made from these trees have been examined in London and valued at high rates.

I have noted that seeds of this kind of rubber are being offered in France at a rate of over £40 per thousand or 10d. each; and in Ceylon rates of £3 per thousand on the spot—packing cases, and freight extra—are being charged. The vitality of Hevea seed like that of Castilloa, is very fugitive, and great risk is run by planters in obtaining seeds from a distance. Our seed harvested in Nov. was of excellent quality and fully 99 per cent germinated.

A tree of Hevea confusa, Hemsly, formerly known as Hevea Sprucei, also bore fruit. The distinguishing characters of the seed are its large size, its angular form, and the softness of its outer covering, when compared with those of Hevea brasiliensis.

What is apparently another Hevea has been presented to the Experiment Station by his Excellency the Governor, who obtained it from Dr. Carl Bovallius, who was recently exploring the territory of the Amazon, S.A.

These, when handed over, were in bad condition, as I proved by cutting a sample lot before sowing. Out of 170 seeds only some five seeds germinated, and only two plants promise to survive. This Hevea has seed not more than half the size of those of Hevea brasiliensis, and of much darker colour.

Kicksia africana, or Ire Rubber is obtained from a newly introduced African tree. A small section was planted out in November, and, so far as we can judge in so short a time, promises to do well. This rubber has been seen in the African forest by Mr. Millen, my acting assistant, who states that our plants are quite true to name. Mr. Millen has shown me samples of material collected by himself from trees in the African interior which shows this rubber is little, if it all, inferior to the best "Para." A parcel of seed sent to us by Kew did not germinate so well as did the first lot received, and but few plants were obtained from it. Every endeavour will be made to extend the culture of this species, as it appears to be of great promise and well suited for growth in Trinidad.

A report reached us from German sources to the effect that Kicksia africana does not produce rubber at all. Mr. Millen's evidence, however, satisfies us upon this point. In addition, however, it may be recorded that we have trees sufficiently large to bleed on a small scale, and from these trees we have recently procured latex, from which a small piece of excellent rubber was produced, which proves the report to have been a mere trade rumour.

Manihot Glaziovii or Ceara Rubber.—Some demand has set in for seeds of this rubber. These demands we have had to refer elsewhere, as we have no supply. There is one tree in the Garden which is said to be some 25 years old which bears a few seeds annually, but, although of this age, its stem is but barely six inches in diameter. Some of our correspondents, however, are quite sanguine as to its value for culture in Trinidad. Some few trees were planted a few years ago at the Chaguans Convict Depot, but their condition is far from convincing proof of its suitability for our climate. My own experience, the Ceylon records, and various other sources of information tend to convince that Castilloa, Hevea, and Kicksia are all preferable to Ceara for cultivation in this island. Ceara, when young, grows rapidly, and induce the cultivator in many cases to believe in a continuous run of growth, which often proves disappointing. It has been reported by some who have visited the Ceara districts that the trees never grow to a large size. It may possibly be grown with economy in some of our mountain lands, unsuited for other products, but as a rubber producer I cannot undertake to give it a higher recommendation. The rubber produce is, however, of good quality.

Landolphia and Ceropegia.—African and Ceylon rubbers These are both under cultivation, but at present there does not appear to be sufficient inducement to plant them extensively.

Tabornamontana Crasse.—This tree is a reputed rubber producer, and was grown on trial in these gardens for the past few years. Having a tree which had attained a large size, it was bled freely, and the latex was treated in different ways with a view of producing coagulation, but without success. Eventually a substance was produced which resembled in appearance a lump of chalk, or compacted starch, quite brittle in character, and certainly not rubber.—*India-Rubber and Gutta-Percha Journal*

RUBBER CULTIVATION IN FRENCH DEPENDENCIES.

Indiarubber Cultivation is attracting a great deal of attention in several of the French Dependencies. We have enquiries about our forthcoming Manual from Paris, Marseilles, West Africa and Madagascar; and an enterprising French Agriculturist reports that he has indented for, and is daily expecting to receive, *one million* of Castilloa seeds and asks if such are of use in Ceylon. We have advised him to send 500,000, if in good condition, out here at once and that we may get the seed auctioned by Mr. Symons (with his consent) with perhaps as good a result as in the case of Para seed, if not better! In a recent French Review devoted to Colonial Agriculture we find several important, up-to-date papers on Rubber. One is devoted to West Africa where France has now very large tropical interests, and one authority shows how, to supplement the indigenous creeper rubber vines, they are introducing four exotic varieties :—Para, Castilloa, Ceara and a new and as yet little-known kind "Maniçoba" rubber. It is evident that there is going to be a good deal done in "rubber" culture; but many parts of Ceylon have special advantages, especially where the rubber trees can be grown as a subsidiary to tea. As regards "preparation," we find the following in a letter addressed to the French Colonial Minister by M. Marcellin Pellet in the latest "Revue des Culture Coloniales":—

"M. Joaquin Asturias has found out a new system. He filters the milk, to get from it impurities of all sorts, and then lets it dry by natural evaporation, exposing it to the sun on mats, plantain leaves or skins. This process gives an absolutely pure product, equal or superior to the best Para rubber."

RUBBER IN FRENCH AFRICA.

(Translated for the "Ceylon Observer" and 'Tropical Agriculturist" from the "Revue des Cultures Coloniales for May 1899.)

There have been introduced into Africa, trees furnishing excellent Caoutchouc. Those who introduced them thought they would compensate for the irrational destruction of the (lianes) creepers as carried on by natives. The following are the kinds introduced :—

Manihot Glaziovii (the Ceara rubber tree).
Manicoba (little known, but allied to Ceara.)
Castilloa elastica (from Colombia).
Hevea brasiliensis (gives the kind known as Para).

These trees grow well on the Western coast, but it is quite a question whether colonists should be advised to start plantations of these only, just at present. M. Chalot, Director of the Experimental Garden of Librevil' has made a series of experiments with Manihot trees, aged six or seven years. The results, so far, are not conclusive, whether as to yield or method of collection; where they had expected one kilogramme of coagulated latex, they have only obtained 600 gr.; the value of the raw material being 3 fr. 60 c., in place of 6 francs as estimated, and the expense of harvesting had been much greater than was anticipated. Until now, they have been able to arrive at no conclusions as to the suitable soils, time for harvesting, &c. To get these, it will be necessary to collect information from private sources. Meanwhile it seems to us that a plantation of Caoutchouc would imply too tedious a sinking of capital, as there would probably be a waiting of 10 or 12 years involved. If an owner of plantations would put in belts of India-rubber amongst coffee or cacao, perhaps as boundaries or as shade trees, the experiment could be carried on at small cost. So, also, if foresters holding a concession, would put in young rubber plants, in the cleared portions—getting these plants from the Experimental Gardens—and employing only bands of children for the work, they could at small cost help in useful experiments.

CULTIVATION OF RUBBER CREEPERS *(lianes)*.

Would the cultivation of these be possible, it has been asked. In 1893 I asked that experiments in these might be made in the Garden at Libreville, but no information has been given. There are in the plantations of Aschuka a certain number planted as a hedge, said to be in good condition. Better still, I heard, there is a M. Lacour, who has in the Kasaï a plantation of 200,000 stumps of *Landolphia*. When was this plantation started? I have asked M. Merlin, General Secretary of the Congo, to answer several questions about this............I have since learnt that the estate is only three years old.

If it is a qusetion of creepers—these must be cultivated in a horizontal and not vertical direction, lest one should run against the other and cause great difficulty of harvesting—weather by incision or by cutting down trees. If by incision, one ought not to have to use ladders. Perhaps to solve the question of how to harvest, it would be well to follow the natives into the jungle for some days, noting carefully their methods and the quantity of vegetables used, the quantity of latex collected by one man, the distance covered and the means of transport used. The black man does not calculate his time or his food.........Should we not have to replace the plantain leaf in which the latex is collected by the native, by the earthenware vases provided with clamps that are used in the Gironde, for the collection of resin; and in place of the saucepan they use, should we not take a larger vessel and perhaps use acids, even if these are natural ones, made on the spot?

Finally we scarcely think our colonists could make a profitable industry out of rubber as things now stand. Perhaps it might be best to follow as near as may be the methods of collection of the natives if the trade is to be even profitable. But then the question of the destruction of the creepers and trees comes in and I would suggest that just as in some French departments a certain sum is annually set apart for re-foresting the hills and mountains, so here an agent for agriculture be employed to distribute plants and secure cultivation. He would not be content with simply collecting and despatching seed, but would see it well packed and planted; and once planted up, the lands would be regarded as communal forest and be hired or leased out at so much per tree, whether to Europeans or to natives. Another system has lately been put into practice in the Congo State. Inspectors of forests have been started, who are always moving about. Their work is not to forbid the cutting down of rubber creepers, but to oblige the chiefs, or village headmen to preserve a certain number of the fruits, which the natives used to eat, and to sow the seeds in the forest. Already many chiefs have come and announced their intention of so doing and the places have been marked where this was being done. The Belgians foresaw that their export would soon diminish, as has already been the case with Netherlands India. The native in Africa has further to be instructed in the preparation of the latex. They boil it, add some natural juices and earth, stones and woody fibres, and this product is of a lower value by 4 or 5 francs. The natives of the province of Para also coagulate by heat, but their process is in itself excellent. Into the vessels which contain the latex they plunge a wooden spatula which they afterwards expose over a hot fire of odorous planters. The spatula then goes and comes, from a hot fire to the vessel, and the latex coagulates in thin layers closed up and from which all humidity is driven away. This suppresses ulterior fermentations and prevents the disagreeable odour which comes from African stocks. In native Africa they use sometimes natural acids (native sorrel lemon juice). The process is excellent, but there is always the mixture of various juices and of foreign bodies. The native, then, must be taught that it is to his advantage to produce the best possible latex and that he must cause to coagulate rapidly the latex obtained from one single variety of creeper, the *Landolphia* is the best.

RUBBER-YIELDING TREES IN THE FRENCH SOUDAN.

In the *Revue des Cultures Coloniales* of June 5, 1899, we find an article on "The Exploitation of Caoutchouc in the French Soudan" which gives very recent news and shows how the French are now setting to work to make a wise use of their colonies. We give a special translation of the summary referred to:—

"We have received from Kayes the following interesting particulars:— The Governor of Soudan some time ago empowered a technical Commission to investigate in S. Soudan the Caoutchouc bearing zone, particularly as to the density of the growth of the rubber-bearing plants, the quality of the latex and the native methods of extraction. The sittings have now ended, and M. Hamet, the head of the Commission, has just given in information, from which it is evident that any undertakings for exploiting rubber in the Soudan are bound to be very profitable and that there is room in the Soudan for many such undertakings.

The rubbers were originally collected there under the auspices and under the control of the French military who gathered it partly as a tax and tried by this means on the one hand to prove to the natives the value of the exploitation and on the other hand to cause this Soudan product to be known in the European market. The rubber has gained a standing in the European market and often ranks after the rubber imported from Central America or even compares favourably with it. It was bought on the European markets at fr. 6·50 or fr. 7 or fr. 7·50 and the purchasers would still have freights, &c., to meet; and the price has risen of late. No trouble has been spared to secure the increase in value of the article. Schools of Agriculture have been started at Kouroussa to which natives from different rubber-growing districts come to learn the right methods for coagulation, &c.

M. Hamet also says "the Soudan rubbers com- pare favorably with those of the Belgian Congo, having all their purity, resistance and nerve and they also have greater resistance to heat."

M. Hamet and his co-workers have been studying the different kinds of milk-bearing plants native to Soudan: artocarpiæ, genus ficus, euphorbiacæ, apocynacæ, &c.

It is one of these latter, a Landolphia (hendolitic senegalensis) called, commonly *liane goi* or *gohive*, that gave the results referred to above. This creeper is one of the shrubs most abundant in the south of the Soudan. In places visited by the mission, its density attained to 100 to 150 plants to the *hectare* (about 2½ acres) 40 of the plants being very stout—rather thicker than a man's arm. These (8 or 10 years old) may give 8 to 10 gallons of latex a year. When the latex from this plant (the gohive creeper) is examined, says M. Hamet, one can see from the coagulation that it consists of two parts:—(1st) the liquid containing the rubber proper with albuminoid matter and a vegetable wax; (2nd) the serum which contains the constituent water, mineral matters and azotized matters which the rapid fermentation of the latex carries off before any coagulation takes place. On the other hand, these matters imprisoned in the bitter waters tend to deteriorate the rubber. It is these fermentable agents that it is absolutely necessary to destroy either before or during the coagulation.

These two operations are effected by the one stroke by using fluoride of sodium,—antiseptic and very strong in the proportion of 2% of the weight of the latex.

Other antiseptics, such as *formol*, *gaïcol*, *salol acid thymic* and ammoniacal acid do not coagulate.

M. Hamet has tried coagulation of this plant by the different processes in use in the country:—First mechhanical; second by heat; third by smoking; fourth by chemical agents; fifth by decoctions of native plants. The yield of rubber has been independent of the process employed; practically, it has varied from 28 to 32 per cent. All the methods tried have given excellent results, specially the two last. Amongst the chemical agents employed must be signalized chloryhydric, sulphuric, oxalic and citric acid, marine salt, chloride of aluminium and finally ammoniacal and chlorohydric acid together. Finally, the native plants that have given equally good results are: the *guama*, the *do*, the wild sorrel, *somo*, lemons or limes and the tamarind. They have been used in decoctions which have been left to lie for a night and been filtered through a cloth the next day, then warmed up to boiling point before being used. The experiments have been made on *aseptized* latex and have brought about the coagulation of a rubber of very first quality.

But we must remark that, even treated by natives and without first being *aseptized* and with decoctions of plants of the country, the latex of the gohiva has given a rubber that fetches four to five fr. at Kouroussa.

M. Hamet sums up and concludes by affirming that the rabber furnished by the Soudan, especially the South, is of excellent quality, that the methods of collecting prevalent should be continued; that they are simple and easy even for children who go into the brushwood to collect it and that experiments are being made in the agronomic stations for the multiplication of plants.

RUBBER ESTATES OF PARA (LIMITED)

DIFFICULTIES WITH THE VENDORS OVERCOME—RUBBER ALREADY BEGINNING TO COME IN.

An extraordinary general meeting of the Rubber Estates of Para, Limited, was held on June 7th, 1899, at Winchester House, Old Broad-street, E.C., the Hon. John Augustus de Grey in the chair. After the formal business.

Mr. Woodrow said: Will you tell us something about the business of the company now?

The Chairman: Our position, as I understand it, is now a very favourable one. But before going into that question, I feel that the board have to account to those gentlemen who originally subscribed for the shares of the company, for the fact that we have not yet been able to pay a dividend. I should remind those who held preference shares that their dividend has not been passed over; it is simply postponed until the company is in funds sufficient to enable it to pay them. The reason why we have been obliged to defer payment of the dividend is a very simple one. When we were in treaty for taking over the company's property in Para, we ought to have concluded our contracts in April; but the company's issue was not responded to by the public sufficient to enable us to do so, and consequently we had to ask for an extension of time, and so it came about that we were not able to do so until September 10 of last year, when we did complete our contract by the purchase of the property. The result of that was this, that the vendor had us more or less in his power. We received an assurance through the vendor's agent on which we thought we could rely, that we should receive compensation for their crop which the vendor announced that he was going to deprive us of, and at that time we were obliged to pay £2,000 as compensation to the vendor for not having fulfilled the contract at the time it should have been fulfilled. Then we were informed that the vendor intended to appropriate the whole of last year's crop, but that we should be compensated. I should explain that the season for rubber collecting begins in July, but that the arrangements are made as early as about the February before. The vendor had made his arrangement for sending men to the estates and was in process of getting that crop when we completed our contract. We should not, if we had taken over the estate then, been in a position to interfere, but we expected that the crop would have been handed over to us. But we were disappointed in that respect, and in the result none of the promises which were made to us by the vendor were fulfilled. And, moreover, we were promised the rents of the rubber roads from the tenants, and we received £1,400. The whole of the money we received from the estates was in the past season. Those facts are what caused us to be unable at the present time to pay a dividend for our shares, because it was not until March 1 of this year that we obtained full possession of the estates, and were able to commence working on them. Some months ago, however, we sent out Mr. Milne, our manager, who has had his work supplemented by an accountant and several storekeepers from this country. You will have received the circular, dated April 14, which was the first information that we were able to give you of our prospects in the coming season. That circular is of an encouraging description, and as far as the expectations held out in it about the beginning of the season, they have been fully realised, because we have received altogether from the estates during the wet season, and up to the end of May, some 7½ tons; and we have now at Parà about 1½ tons more awaiting shipment, which brings up the amount from the estate to a little more than we anticipated in that circular. We are, perhaps, the first people who have had any result at all from a rubber estate in the wet season; but we sent our men up early, and they consequently got this return, and we hope that the June returns will fully come up to what is foreshadowed in our circular. We have sent up about 650 men on our own account, and we are working the estates, as I told you that we should, on the direct system; that is to say, without the intervention of a middle-man. We sent our men to work the roads under our own supervision. The system hitherto has been to let the rubber roads to tenants at a rent which the tenant pays; but if you send your men to the estates, you have, first of all, to keep them supplied with food and necessaries, and then they are debited with the amount of the stores which you provide, and they have to pay that back in rubber. All the rubber which they collect has to be sold to this company, and it is invoiced to you at a price between which and the price at Para there is a considerable difference; the exact amount of difference I will not now venture to state, but I will say that it is in your favour. Some of our roads are still let to tenants; but we reckon that we still have about 750 men working on that property, besides our manager and the accountant, and the five inspectors. We are in process of negotiation for a steam launch for our estate. I do not like to say too much about the profits which we are likely to make on the season, but I hope that something like the gross product foreshadowed in our circular may be realised. You must remember that this is a new business; it is a thing that has never been tried by anybody before, and with the actual number of trees in Para, what the number of trees per road may be, &c., is more or less an unknown quantity. Therefore, I will not commit myself to more than this—I will say that from the returns which we have had we may expect a profit at the end of the year. One important point which I am reminded of is that we believe we have now plenty of working capital to carry us to a successful issue in the operations of the company. (Applause.)

Mr. Woodrow moved a vote of thanks to the chairman, which was seconded by Mr. Gillingham, and agreed to unanimously.

The Chairman having briefly acknowledged the vote, the proceedings terminated. —*Financial Times,* June 8, 1899.