REPORT

ON THE

CAOUTCHOUC OF COMMERCE,

BEING

INFORMATION ON THE PLANTS YIELDING IT, THEIR GEOGRAPHICAL DISTRIBUTION, CLIMATIC CONDITIONS, AND THE POSSIBILITY OF THEIR CULTIVATION AND ACCLIMATIZATION IN INDIA:

BY

JAMES COLLINS, F.B.S. EDIN.,

HONORARY CORRESPONDING MEMBER OF THE SOCIETY OF PHARMACY OF PARIS; OF THE PHYTOLOGICAL AND MICROGRAPHICAL SOCIETY OF BELGIUM; AND OF THE SOCIETY OF NATURAL AND PHYSICAL SCIENCES OF CARACCAS. LATE CURATOR OF THE MUSEUMS OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN.

WITH TWO MAPS, FOUR PLATES, AND WOODCUTS.

WITH A MEMORANDUM ON THE SAME SUBJECT

BY DR. BRANDIS,

INSPECTOR GENERAL OF FORESTS, TO THE GOVERNMENT OF INDIA.

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PREFACE.

THE numberless uses to which Caoutchouc is now applied has placed it in the front rank of vegetable products, rendering a large and constant supply imperative, and this necessity early led me to the consideration of the sources of supply, and how such supplies could be increased and insured.

In consequence of some inquiries made by Major-General Strachey, C.S.I., and Clements R. Markham, Esq., C.B., I was charged by Her Majesty's Secretary of State for India in Council to prepare this Report. When I had handed in the manuscript and it had been approved of, the Indian Government liberally granted my request that the Report should be illustrated with plates, &c.

To Trelawney Saunders, Esq., of the Geographical Department of the India Office, I have to tender my thanks for the oversight he has taken in the production of the maps, and to my friend Gustav. Mann, Esq., for kindly undertaking the production of the Assam map, and in a high degree to Dr. Forbes Watson, M.A., for material assistance in carrying out my previous inquiries in this subject.

The excellence of the four plates of plants by Mr. Blair speak for themselves, and to W. Carruthers, Esq., F.R.S., of the British Museum, I am indebted for the critical examination of my new species here described, and for his careful oversight in the production of the plates.

My new species, *Castilloa Markhamiana*, I have dedicated to C. R. Markham, Esq., C.B., as a small mark of my humble appreciation of his scientific attainments, of his untiring zeal and success in the acclimatization of the Cinchonas in India, and of the great interest he has taken in the production of this Report.

To Dr. Hooker, C.B., F.R.S., I owe many thanks for aid and facilities rendered me in this and other researches for a long period, and to Professor Oliver, F.R.S., J. G. Baker, F.L.S., and J. R. Jackson, A.L.S., Esqrs., my best thanks are due for assistance and facilities in consulting the Herbarium and Museum.

To my late dear friend Dr. Friedrich Welwitsch I am indebted for matter relating to Africa, and but for his death this Report would have been graced with a promised monograph on the Landolphias.

To Dr. Richard Spruce's kindness I am indebted for the most valuable information relating to the Heveas, and to my numerous correspondents at home and abroad I tender my warmest thanks for their invariable kindness in replying to my queries and requests.

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11, Arthur Street, Deptford, London, S.E.
30th August 1872.

To C. R. Markham, Esq., C.B., F.R.G.S., &c.,
India Office, London.

Sir,

I have the honour to submit, as directed by you, for the information of Her Majesty's Secretary of State for India, a Report on the caoutchouc of commerce, the methods of collecting it, the plants yielding it, their geographic distribution, climatic conditions, and the possibility of their being cultivated and acclimatized in India.

I have arranged my Report in the following manner:—Part I. Sources of supply (Botanical and Geographical), and Part II. The cultivation and acclimatization of the plants yielding caoutchouc.

I also send herewith a set of specimens of the different commercial varieties, which I beg to present to you for the purpose of being placed in England or India, wherever you may deem that they may be likely to prove most useful for purposes of reference.

I have the honour to remain,
Your obedient Servant,

James Collins, F.B.S.E.

INTRODUCTION.

The history of India Rubber or Caoutchouc is an exceedingly interesting one. Amongst the earliest accounts we have is that given by Herrera*, in his account of Columbus' second voyage, in which he mentions a game played by the natives of Hayti, with balls made of this substance. Juan de Torquemada† mentions also a similar use made of it, and notes the name of the tree which yielded it, as the *Ulequahuitl* or Ule-tree, the Aztec name for *Castilloa elastica* Cerv. M. Charles de la Condamine gave the first accurate information respecting the Caoutchouc yielded by the "Cahout-chou" or *Siphoniæ* (*Heveæ*) of botanists. M. Fresnau, an engineer, residing at Carzenove in Guiana, next turned his attention to the subject, and his researches were published by the French Academy in 1751. M. Fusé Aublet first described one of the species yielding "Para" Caoutchouc, in his Flora of Guiana, under the name of *Hevea Guyanensis*. In the Old World the credit of the first discovery of a plant yielding Caoutchouc is due to Mr. James Howison, a surgeon in Prince of Wales Island, and who gave an account of it under the title of "An Elastic Gum Vine." Howison's plant was named by Dr. Roxburgh *Urceola elastica*. The next discovery was by Dr. Roxburgh himself, who, receiving a turong lined with Caoutchouc, which, on inquiry he found to be the produce of a fig tree, afterwards named by him *Ficus elastica*.

India Rubber, or Caoutchouc, as we prefer to call it, is the inspissated milk or juice of various shrubs and trees, natives of both hemispheres. This milk is found in certain anastomosing

* Herrera, Historia, decada i., libro iii., cap. iv.

† Torquemada, De la Monarquia Indiana, tom ii., cap. xliii., p. 663, Madrid 1615. For the references and passages of these and other accounts, see my paper on "India Rubber, its History, Commerce, and Supply." Jour. Soc. Arts, London, Dec. 17th, 1869. The Council of the Society of Arts awarded their Lecturer's Medal for this Paper.

vessels termed *Cinenchyma* or laticiferous vessels, and are found in the greatest abundance in the *Mesophlæum* or middle layer of the bark (Fig. 1). This milk is only yielded in quantity sufficient for commercial purposes by certain plants within the isotherms of 70° Fahrenheit, and with a mean annual temperature not lower than 61° and averaging about 76°, and with an annual rainfall not lower than about 90 inches. I have appended to this Report two maps, in order to give some idea of the geographical distribution. The first shows the general distribution over the globe (Map I.), and the second that in Assam (Map II.). The former must, however, be taken as an approximation to the truth, as it is the first attempt to thus illustrate the subject. These shrubs or trees are restricted to three natural orders, viz.; *Euphorbiaceæ*, *Artocarpaceæ*, and *Apocynaceæ*, and in this Report these various plants are treated in this order.

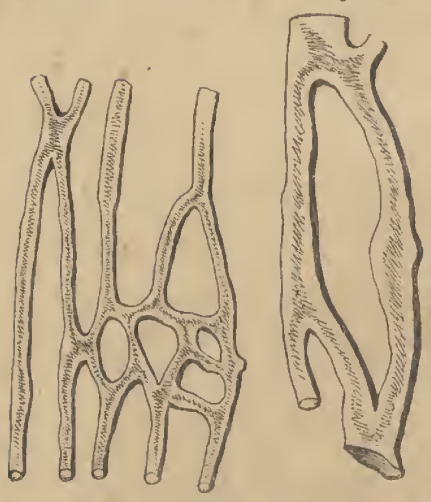

Fig. 1.—Laticiferous Tissue.

The following list gives the geographic and botanic sources of the different varieties of Caoutchouc :—

I. *American Varieties :—*

Brazil :—	
Pará.	*Hevea Braziliensis* Müll. arg., &c.
Maranham.	*Heveæ sps.*
Pernambuco.	*Hancornia speciosa* Müll. arg., &c.
Ceará.	*Heveæ sps.*
French Guiana.	*Hevea Guyanensis* Aubl.
British Guiana.	*H. paucifolia* Müll. arg.
Venezuela.	*H. Brasiliensis* Müll. arg.
New Grenada or "Carthagena."	? *Castilloa elastica* Cerv.
Ecuador or "Guayaquil."	*Castilloa elastica* Cerv.
Peru.	*Castilloa elastica* Cerv. ? *Hevea peruviana* ?

Panama.	*Castilloa elastica* Cerv. et C. *Markhamiana*, Collins, n. sp.
Costa-Rica.	*C. elastica* Cerv.
Nicaragua.	*C. elastica* Cerv. et *C. species nova ?*
Salvador.	*C. elastica* Cerv.
West India (so called).	? *C. elastica* Cerv.
Honduras.	? *C. elastica* Cerv.
Guatemala.	*C. elastica* Cerv.
Mexico.	*C. elastica* Cerv.

II. *Asiatic Varieties* :—

Malayan Archipelago :—	
Singapore (so called).	*Ficus species.*
Borneo.	*Urceola elastica* Roxb.
Java.	*Ficus elastica* Roxb.
Penang.	? ? *Cynanchum ovalifolium.* ? *Ficus sps.*
Siam.	? *Ficus sps.*
India :—	
Assam.	*Ficus elastica* Roxb. ? *Urostigma lacciferum* Miq. (= *Ficus laccifera* Roxb.)

III. *African Varieties* :—

Madagascar.	*Vaheæ sps.* ? *Willughbeia edulis* Roxb. ? ? *Ficus elastica* Roxb.
Comoro Islands :—	
Johanna.	*Vaheæ sps.*
Mohilla.	*Vaheæ sps.*
Eastern Africa :—	
Zanzibar.	? *Landolphiæ sps.*
Mozambique.	*L. sps.*
Zambesi.	*L. sps.*

Western Africa :—

Gaboon.	*Landolphiæ sps.*
Congo.	*L. sps.*
Angola.	*Landophia owariensis* Beauv., &c.
	? *Ficus sps.*
	? *Toxicophlæa sps.*
Benguela.	? *Landolphiæ sps.*
	? ? *Ficus sps.*

IV. *Australian Variety* :—

Ficus rubiginosa et *F. macrophylla.*

Of these mentioned, the only kinds commonly known in commerce, we have :

American :—

Pará ; Ceará ; Pernambuco and Maranham (less frequent) ; Carthagena ; Guayaquil ; Nicaragua ; "West India ;" Honduras (not frequent) ; Guatemala.

Asiatic :—

"Singapore ;" Borneo ; Java ; Penang ; Siam ; Assam.

African :—

Madagascar and "West Coast."

PART I.

NATURAL ORDER.—EUPHORBIACEÆ.

1. American Sources of Supply.

Heveæ Species, "Pará Caoutchouc."

Of all the various kinds of Caoutchouc, that of Pará is the most highly esteemed, and consequently obtains the highest price. It is furnished by different species of the genus *Hevea*, Aubl., or *Siphonia*, Rich. It, too, is one of the most important articles of export at Pará, the duty on it being stated to form a third of the whole revenue. The travels of Messrs. Edwards,* Bates,† and Wallace,‡ and Dr. Spruce,§ have added materially to our knowledge of these trees and their produce. They are found abundantly in the provinces of the Amazons and of Pará, less common in Maranham, and in large quantities in Ceará and Rio Grande du Nord; frequenting the river banks and marshy places. To the accuracy, industry, and perseverance of Dr. Richard Spruce, however, we are indebted for nearly the whole of our present information respecting the species yielding this important substance, and till his time unknown.

The Heveas are large trees, the trunks of which yield a very pure Caoutchouc, growing abundantly in the humid forests of tropical America, especially along the Amazon and its tributaries. The wood is soft and soon decaying, partly owing to the "tapping" operation to which they are subjected. The seeds are used for baiting fish, and also yield by expression an oil of a clear violet colour, not so siccative as that of linseed oil, but said to be of great use in the preparation of varnishes.

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* Edwards, "A Voyage up the River Amazon," New York, 1847.

† Bates, "Naturalist on the River Amazon," 2 vols., London, 1863.

‡ Wallace, "Travels on the Amazon and Rio Negro," London, 1853.

§ Spruce in "Hooker's Journal of Botany," 1854, *et seq.*, and in Letters to Collins.

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VERNACULAR NAMES:

Caoutchouc (Maimas Indians, French Guiana); *Caú-cho, Caoutchout; Cahuchu; Seringa, Jeringa,* or *Ciringa* (Garipon Indians and Portuguese); *Xeringue* (an Indian corruption of *Seringa: Xeringue* in Lingoa Geral means "a liar," Dr. Spruce queries "a stretcher"!); *Pao de Xirringa* (Portuguese); *Borracha* (Brazilian); *Hevé* (Esmaraldas); *Yápi dápi* or *dápiche* (Venezuela). The collectors in Brazil are called "Seringueiros."

Dr. Spruce remarks that all the species of *Hevea* do not yield Caoutchouc of good quality, those of the gapó* and caatinga† producing a brittle gum in small quantity.

The following is a list of the species of *Hevea* which have been described, their geographic distribution, together with remarks on them:—

1. *Hevea Spruceana,* Müll. arg., in Linnæa, vol. 34, p. 204; De Candolle's Prodromus, vol. xv., p. 716 *et seq.*

   Synonym.—*Siphonia Spruceana,* Benth. in Hooker's Jour. Bot., 1854, p. 370.

   Geographic Distribution.—Province of Pará.‡

   Remarks.—A smaller tree than *Hevea Brasiliensis*: "Caoutchouc is collected from it on the Amazon, about "the mouth of the Tapajoz" (Spruce in letter to Collins).

2. *H. discolor,* Müll. arg. in D. C. Prod. xv., p. 717.

   Synonyms.—*Siphonia discolor,* Spruce MSS., Benth. in Hook. Jour. Bot., l. c.; *Micrandra ternata,* R. Br. Pl. Jav. Rar., p. 238 (*not* a Javanese species!).

   Vernacular Names.—"Seringa de Gapó."

   Geographic Distribution.—Ega on the Alto Amazonas. Common in the gapo of the Rio Negro (Barra), and of its tributary, the Rio Uaupés (Panurè).

   Remarks.—"The tree scarcely exceeds 25 feet, but the "branches spread out horizontally, sometimes to a con-

* The "Gapó" (lingoa géral) is land inundated by the rivers and lakes in winter, constituting a breadth of from 20 yards to several miles, according as the land is abruptly ascending or perfectly flat.

† The "Caa-tingas" or "white forests" are parts in which the soil is a thin covering of white sand over granite.

‡ In very special cases only are the collectors, &c. given. The geographic distribution is based on systematic works on botany and plants in different Herbaria.

"siderable distance. The milk is sparing, scarcely elastic "when dry" (Spruce).

3. *H. paucifolia*, Müll. arg. in Linnæa, l. c., D. C. Prod., l. c.
   Synonym.—*Siphonia paucifolia*, Spruce, MS., Benth. l. c.
   Geographic Distribution.—In rocky situations (or "Caatingas") about Panurè along the Rio Uaupés (Spruce). Also found in British Guiana (Rob. and Richard Schomburgh. Hancock).
   Remarks.—A large tree 40 to 50 feet, yielding a very copious milky juice (Spruce).

4. *H. rigidifolia*, Müll. arg. in Linnæa, l. c., D. C. Prod., l. c.
   Synonym.—*Siphonia rigidifolia*, Spruce, Benth. l. c.
   Geographic Distribution.—Caatingas of the Rio Uaupés (about Panurè).
   Remarks.—A milky tree of 30 feet in height.

5. *H. Benthamiana*, Mull. arg. in Linnæa, l. c., D. C. Prod., l. c.
   Geographic Distribution.—Rio Uaupés (coll. R. Spruce, 2560).

6. *H. Brasiliensis*, Müll. arg. in Linnæa, l. c., D. C. Prod., l. c.
   Synonyms. — *Siphonia Brasiliensis*, Willd. Kunth in Humb. et Bonpl. Nov. gen. et sp. pl., vol. 7, p. 171; Benth. in Hook. Jour. Bot., l. c. (Plate I.)
   S. Kunthiana, Baill. Étud Gén. Euphorb., p. 326.
   Geographic Distribution.—Province of Pará. Also in Venezuela (Humb. et B.)
   Remarks.—"A large handsome tree 60 feet high, branching "from the base, and yielding the Caoutchouc most "abundantly exported" (Spruce).

7. *H. lutea*, Müll. arg. in Linnæa, l. c., D. C. Prod., l. c.
   Synonyms.—*Siphonia lutea*, Spruce, MS.; Benth., l. c.; Baill., l. c.
   S. apiculata, Spruce, MS.
   S. brevifolia, Spruce, MS.
   S. apiculata, Baill., l. c.
   Vernacular Names.—"Long-leaved Seringa" (*S. apiculata*) and "Short-leaved Seringa" (*S. brevifolia*).
   Note.—There is some little misunderstanding here. *S. apiculata* of Spruce is given by Müller as a synonym. *S. brevifolia* of Spruce I have treated as a synonym also, as it seems to have been distributed under the same number (3139), and from the same locality. They may

be varieties, or a second name substituted for the previous one.

Geographic Distribution.—Panurè on the Rio Uaupès. Also on the Casiquiairi.

Remarks.—(*S. lutea*, Spruce.) A tree 70 feet high, copious milk, though not so much as *S. Brasiliensis*, speedily turning black on the hands and clothes, and staining linen permanently. When dry, very elastic and tenacious. I saw a rubber manufactory on the same island (at the mouth of the Uaupès, six or seven miles north of the Equator), and rubber prepared from the same tree from which I had gathered my specimens. *S. apiculata*, "long-leaved Seringa," straight, tall, not very thick tree, smoothish thin bark, and yellow, odoriferous flowers. *S. brevifolia*, "short-leaved Seringa," yields less milk than *S. lutea*. A tree cut down near San Carlos measured 100 feet (Spruce).

8. *H. Guyanensis*. Aubl. Guyan, p. 871, t. 335 (1775).

Synonyms.—*Jatropha elastica*, L. Supp., p. 422 (1781).
Siphonia elastica, Pers. Enchir, vol. 2, p. 588.
S. Guyanensis, Juss.
S. Cahuchu, Willd. sp. pl., vol. 4, p. 567.

Vernacular Names.—*Siringa* (Garipon Indians); *Hevè* (Natives of the Esmeraldas); *Caoutchouc* (Maimas Indians).

Geographic Distribution.—French Guiana. About Barra on the Rio Negro. Naturalized in Saint Vincent.

Remarks.—A tree 50 to 60 feet high, trunk 2 feet to 2 feet 6 inches in diameter; bark greyish and not thick, wood white and light.

Heveæ species incertæ:

Geographic Distribution.—Seringa trees have been found to abound on the low islands in mid-river, and along the banks of the River Amazons,* from the Island of

* The River Amazon changes its name three times along its course. From its source to its confluence with the Yucayali it is called the Marañon or Maranoa. From the Yucayali to the Rio Negro it is called the Solimöes, Solimoens, Alto Amazonas or Upper Amazon, and from the Rio Negro to its mouth the Amazon or Orellana. The chief tributaries on the left from its mouth are the Tocantins, Zingu, Tapajoz, Ramos, Madeira, and Purus. On the right the Rio Negro, with its tributaries, the Uaupés and Casiquiari, the latter connecting the Amazon with the River Orinoco.

Marajó to its source. Also its tributaries, the Tocantins, the chief Pará district being between it, and the Zingu, along and between the Tapajoz and Madeira from 3° to 7° S. lat. On the Rio Negro, Casiquaiari and Uaupés. They also occur, according to Dr. Weddell, plentifully on the plains of the Orinoco.*

Of the species above enumerated, Dr. Spruce remarks (in letter to Collins) Caoutchouc is obtained:

At Pará, from *Siphonia Braziliensis*, Willd., and probably from several other species of the same genus:

On the Amazon. About the mouth of the Tapajoz, from *S. Spruceana*, Benth.; towards the mouth of the Madeira are other species not seen by him in good state:

On the Rio Negro, Uaupés, and Casiquiari, from—

S. discolor, Spruce;
S. rigidifolia, Spruce;
S. lutea, Spruce;
S. paucifolia, Spruce;
S. apiculata, Spruce,

and from two other species (Nos. 3326 and 3457).

Micrandra minor, Benth., l. c., D. C. Prod., vol. xv., p. 709, et *M. siphonioides*, Benth., l. c., D. C. Prod., l. c.

Geographic Distribution.—Rio Negro.

Remarks.—On the Rio Negro, Caoutchouc, elastic as that of the Seringas, is obtained from this genus (Spruce).

Dr. Spruce mentions another genus near *Hevea*, called by the Barré Indians *Cunuri*, whose sap contains Caoutchouc, and from whose seeds a vegetable butter is prepared.

Climatic Conditions of the Heveæ.

Pará District.—In Pará the seasons are modified, as to be almost exceptional. Guiana and Brazil to the N. and S. of the Pará district forms a somewhat elevated tableland, whilst between them is the Pará district, the river-valley of which forms a wide extent of low-lying country. During six months very little rain falls (August to February), the heaviest rains being in April, May, and June. Mr. Wallace gives the rainfall for 1847 as 15 inches in April, being the greatest monthly rainfall for that year. In January, Feb-

* Mr. H. A. Wickham ("Rough Notes of a journey through the Wilderness from Trinidad to Para, &c.," London, 1872) noticed fine "Ciringa" trees on the banks of the Orinoco, and collected caoutchouc for commercial purposes on an island in the River Caricia or Chirari.

ruary, and March it gradually increased from 5 to 10, till in April it reached 15. In May it gradually lessened, till in June and throughout the rest of the year it was under 5 inches (Fig. 2).

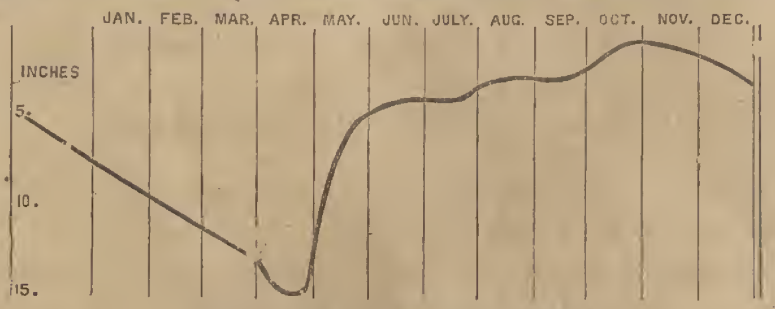

FIG. 2.—[Vide Wallace, l. c., p. 431.]

The heat not generally above 87° in the afternoon, or below 74° at night. The temperature during three years only once reached 95° (Wallace). The greatest heat is about 2 p.m., from 89° to 94°, and never cooler than 73°. The mean for the year, 81° (Bates). The Amazon begins to fall in the beginning of June; at the same time the forest trees begin to push out their new leaves, especially those of the river margins. The trees of the Gapó (land inundated during the winter) begin to flower as soon as the waters leave them. The Amazon is full of islands, and these during the wet season are covered with water, as also is a great extent of low country on either bank. The Amazon begins to rise in December, attains its greatest height in March, and least height in July and August.

The Amazon valley is remarkable for uniformity of temperature and for regular supply of moisture. From June to December is the dry season, and January to May the wet. In the dry season in November there are a few occasional showers, and during the wet season intervals of fine weather. On the Amazon itself the dews are scarcely perceptible, owing probably to the strong winds which almost daily sweep up it (as far as the mouth of the Rio Negro), whilst on the Rio Ramos Dr. Spruce found the dews to be very heavy.

Up the Rio Negro the heat early in the morning is about 75° (the temperature of the water 85°, and at noon 86°), increasing at noon to 95° to 100°. On the banks are *dense* moist forests, with Caoutchouc trees interspersed. Dr. Spruce, when at Barra, in December 1850, found that the rains had set in some weeks previous, and from December 10th to the beginning of the following February only a single day occurred without some rain. In February there

were six fair days; in March, the most rainy month, but one; and to April 18th three days of fine weather. During March the highest temperature was 84¼°, many days it not reaching as high as 80°.

On the Solimoens or Upper Amazons the sea breeze is not felt, and it is therefore more stagnant and sultry. The whole of the country along its banks is covered with one uniform, lofty, impervious, and humid forest. The soil nowhere sandy, but always either a stiff clay, alluvium, or vegetable mould. The vegetation is very prolific and the atmosphere densely vaporous. At Ega the year is divided according to the rise and fall of the river. The great annual rise begins about the end of February and continues to the middle of June, and the rain falls very heavily at times. About the first week in June the flood is at its highest, being over 40 feet above its lowest point. Towards the middle of July the banks begin to reappear. From the middle of October to the beginning of January the second or lesser wet season prevails, and the second dry season comes on in January and lasts throughout February (Bates).

Forests of the Amazons. Dr. Spruce gives five distinct series of vegetation:—

1. The Riparial Forests (or gapós), which with their scrub lie submerged for many months of the year;
2. The Recent Forests;
3. The Low or White Forests [caa-tingas?], the remains of an ancient and highly interesting vegetation, which are now being encroached upon by a sturdier growth;
4. The Virgin or Great Forests, which clothe the fertile lands beyond the reach of inundations; and lastly,
5. The Campos or Savannahs, regions of grassy and scrubby knolls, glades, and hollows.

Mr. Wallace (l. c.) gives the forest distribution of this part of South America. He says that if a line be drawn from the mouth of the Pariaiba (long. 41° 30′ W.) due west towards Guayaquil, it will cut the boundary of the great forest in long. 78° 30′, and for the whole 2,600 miles will have passed through the centre of it, dividing it into two nearly equal portions. For the first 1,000 miles, or as far as 56° W. long., the width of the forest from north to south is about 400 miles; it then stretches out both to north and south, so that in long. 67° W. it extends from 7° N. on the banks of the Orinoco to 18° S., on the northern slope of the Andes of Bolivia,

a distance of more than 1,700 miles. This central line which Mr. Wallace draws passes through the centre of the chief district for the *Heveæ*. If a line be drawn from about Parahiba to about the point of junction of the River Araias with the Madeira, then continued in a north-west direction to the source of the Meta (tributary of the Japura), then diverging it in a north-east direction to the junction of the Urichunge with the Orinoco, continuing this in an easterly direction, following the coast when intersected by the line till the Oyopok is reached, and continuing the line down it, and finally finishing the line at Santarem, it will enclose the whole of the Hevea region.

Collection and Preparation of Pará Caoutchouc.

The collection commences as soon as the waters have subsided, namely, in August, and continues till January or February. In the wet season the milk is too aqueous to allow of profitable collection. The milk is at first of the consistence and colour of cream. This soon changes its consistence by the coalescence of the particles of Caoutchouc, which are suspended in a thin whey-like liquid. Each morning the collectors visit the trees which have been incised the preceding evening and collect the milk. To obtain the milk from the tree, with a machete or knife a deep horizontal cut is made a few inches above the base of the tree; from this cut a vertical one is made extending high up the trunk. On either side of this vertical cut others are made at short distances in an oblique direction and meeting it (Fig. 6). The cuts form channels down which the milk runs, and which is received at the base in clay, shells, or other vessels. Sometimes the yield of the tree is increased by binding the trunk with cords or bands formed of the stems of twining plants (lianas or sipós), resulting often in the death of the tree.* When a sufficiency of milk has been collected, means are adopted to bring about the coalescence of the Caoutchouc. The method more generally adopted is by pouring the milk over clay or wooden moulds, and drying each successive pouring by means of a gentle heat. Into a brazier or pan, or pots with narrow necks, heated with wood from beneath, the fruits of various palms are placed; those of the Urucuri (*Attalea excelsa*, Mart.) are generally used, but when these are not procurable, those of *Maximiliana regia* or *Astrocaryum*

* From the frontispiece given in Mr. Wickham's book (v. ante) it appears that the barbarous method of denuding the tree for a considerable space of its bark is also resorted to.

murumurum are used. These nuts give off by this toasting to which they are subjected a thick white smoke. In this smoke the Caoutchouc is held and dried. The Caoutchouc prepared in this manner has a beautifully laminated appearance. A second and more modern method is by treating the milk with an aqueous solution of alum, and then subjecting the Caoutchouc to pressure. This method was purchased by the Provincial Government of Pará of M. Henrique Antonio Strauss, and is much liked, inasmuch as it allows of being performed away from the scene of collection, which is always unhealthy. Mr. Augustus Tappenbech, of Liverpool, who was formerly engaged in the Caoutchouc trade in Pará, tells me he believes an acid (?) is used in the preparation of the variety known as Virgin Rubber. Mr. Henry Lee Norris, likewise engaged in the same trade in Pará, found strong liquor ammoniæ, in the proportion of 3 %, had the desired effect on the milk. I believe too that the vapour of sulphur plays a part in the preparation of some of the Pará caoutchouc.

Pará Caoutchouc appears in commerce in several forms: 1st, Flat pouches or "biscuits," a very fine, carefully prepared Caoutchouc, made by successive dippings and "smoked," and with one side cut open, for the purpose of withdrawing the mould; 2nd, "Bottles," made also in the same manner; 3rd, "Negro-head" or "surnamby," consisting of the scraps of rubber left after the preparation of the finer descriptions, rolled into large balls or blocks, sometimes twelve inches in diameter, and often very much adulterated; and, 4th, Loose "scrap."

The export, about 4,558 tons, from Pará in 1869 is as follows:—

To London and Liverpool - -	161,987	arrobas.*
To European Continent - -	20,514	,,
To New York - - -	182,843	,,
Total - - -	365,344	,,

Maranham.—Occasionally parcels of this Caoutchouc are received here; it has the general character of that of Pará.

Ceará.—This Caoutchouc, which has the general character of that of Pará, consists of reddish-brown string-like pieces rolled up into balls or blocks, and known commercially as Ceará "scrap." Species of *Heveæ* abound here. The tree is incised at the beginning of the

* An arroba = 25½ lbs.

dry season, and the Caoutchouc which has oozed out, picked off at the end of the dry season. It is good but barky.

French Guiana.

Hevea Guyanensis, Aubl., abounds here, especially along the River Oyapok, the contested boundary line, where the Caoutchouc is collected by the Indians and transported to Pará.

Venezuela.

Caoutchouc is one of the principal articles of export, but it is not known under that name in this country. *Heveæ* are said to be found rather plentifully. *Castilloa elastica* may also exist.

Peru.

Under the name of *Siphonia Peruviana*, n. sp., is a specimen in the Kew Herbarium, collected by Lechler at San Gavan, in the Eastern Cordilleras of Peru. On the ticket there is a note that the tree attains 80 feet in height, and that the milk of it is used in making waterproof garments. Mr. Markham also (Travels in Peru and India) noticed Seringa trees in Peru.

NATURAL ORDER.—ARTOCARPACEÆ.

1. American Sources of Supply.

Castilloa elastica, Cerv., et *C. Markhamiana*, Collins, species nova.

Castilloa elastica, Cervantes.—Suplemento a la Gazeta de Literatura,* Mexico, 2 de Julio de 1794. Trécul sur les Artocarpées, Ann. des Sc. Nat. 3e série. Bot. T. 8, Pl. 5, 1847 (Plate 2).

Vernacular Name.—"Ulé."

Geographic Distribution.—*Vide post.*

Remarks.—Don Vincente de Cervantes describes the Ulé tree as one of the loftiest and most luxuriant of the forests which adorn the hot north-east coast of Mexico. Stem three to four yards in circumference, and very straight. Bark smooth, soft, three to four lines thick. Branches alternate, horizontal, round, flexible, and furnished at the upper end with stiff hairs. Leaves alternate, a foot and a half long, and seven inches broad, strongly sinuate at the base, generally terminating in a point, pubescent on both surfaces, entire, though appearing toothed at first sight, especially the younger ones, in consequence of the villous brushes formed by the pubescence at the margin of the leaves, and disposed at equal distances from each other; . . . . Fruit from 5 to 20 oval drupes.

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* In the British Museum copy there is no plate of this plant, that of another plant being inserted in mistake. There is an English translation of it, and a plate in "Tracts relating to Botany, by Charles König. Printed and sold by Phillips and Fardon, London, 1805." The account was given by Cervantes as an inaugural lecture on botany, and the plant named after Don Juan del Castillo, who was sent to examine the vegetable productions of Mexico, and died in that country in 1793. Cervantes' name of the plant is really *Castilla elastica*.

C. Markhamiana, Collins, sp. nov. (Plate 3).

Vernacular Name.—Ulé-Ulé.

Geographic Distribution.—Panama (Sutton Hayes !)

Description.—Leaves alternate, petiolate, oblong-acuminate, margin serrate, younger leaves entire, with a long slender nearly entire acuminate apex, and a rounded, not cordate base, upper surface glabrous, under surface, midrib and veins covered with stiff hairs; lamina as much as 13 inches long and nearly 7 inches broad, the midrib giving off from 18 to 20 lateral well-marked veins. Petiole semiteretc, clothed with stiff hairs, about three lines long. Stipule axillary, solitary elongate-triangular, glabrous within, covered with stiff hairs on the outside, caducous, half an inch in length.

Male flowers unknown.

Female flowers, many aggregated in a plane involucrate nearly sessile axillary receptacle. Perianth tubular formed of four oblong thick leaves, covered externally with short stiff hairs. Style short cylindrical, with two thick leaf-like stigmas having serrated edges. Ovary, one celled, and one seeded, the ovule suspended from the top of the cell.

A small tree 20 feet high. In low woods, Lion Hill, Panama Railway Station (Sutton Hayes, No. 7 ! in Herb., Brit. Mus., Kew, et Collins).

Remarks.—This plant, of which the materials at hand will not admit of a fuller description, differs from *C. elastica* in being pubescent on the nerves and petioles only, and not on the parenchyma of the leaves; in the margins of the leaves being dentate, the leaves of the *C. elastica* being entire, the villous brushes of stiff hairs on the margin being likely to be mistaken for serratures, and also in being somewhat smaller, ovate, the *C. elastica* being almost panduriform and somewhat auricular at the base. Mr. Sutton Hayes describes its general appearance as being very similar to *C. elastica*, having spreading branches, stem smooth, four or five inches in diameter, the fruit a little different, of a red colour, and covered with a silky pubescence, but the most

obvious difference being in the leaves. The Caoutchouc from this second species he did not consider so good as that of *C. elastica*.

In Nicaragua, Caoutchouc is obtained from *Castilloa elastica*, and another species which may be *Castilloa Markhamiana*, or a third species.* M. Paul Lévy, in a letter to me, thus describes it:—Very near to the *C. elastica*, but its leaf is oval. Fruit 6–10 centimetres in diameter; reddish yellow pulp enveloping the seeds. Trunk smooth, cylindrical, very straight, of about 50 centimetres, diameter rarely reaching 150 centimetres; primary branches not numerous and comparatively short, giving rise to a multitude of secondary branches, which are long and slender. Leaves in tufts of 5–6 or more, with a terminal bud. Behind these leaves in December appear small grey points, which eventually burst into an infinite number of small blossoms, many of which the February winds carry off. The remaining ones promptly ripen to fruit, and from two centimetres, the width of the flower, a fruit is produced from 6–12 centimetres in diameter. The fruit is covered beneath with greenish grey scales, and attached to the branch by a very short peduncle. In April the leaves fall off, and new ones are produced immediately. In the middle of January the tree begins to flower, and in March is the period of fructification.

However, as my specimens have not yet arrived, I cannot say whether it be identical or not.

Dr. Seemann† speaks of "a species of Caoutchouc "known by its Aztec name of *Ule*." Now he knew the *C. elastica* well, and often spoke to me respecting it. If it was *C. elastica*, I think he would have used more concise language.

General Geographic Distribution.—The Ulé trees are found in Mexico, all Central American Republics (viz., Guate-

* Since the above was in type, I have been favoured with a personal visit by M. Lévy. On shewing him the proofs of the two plates of *Castilloæ* here given, he remarked that his species differed from both, being in its characters intermediate between them.

† "Dottings on the Roadside in Panama, Nicaragua, and Mosquito," London, 1870.

mala, Salvador, Honduras, Nicaragua, and Costa Rica), Isthmus of Panama, West Coast of America down to Guayaquil, and the slopes of the Chimborazo. They have also been found in Cuba and Hayti.

Vernacular Names.—*Árbol del Ulé* (Mexico).
Ulé (of the Creoles).
*Ulé-Ulé.**
Ulequahuitl (Aztec Ule-tree, Huitl-tree).
Jebe† (Ecuador, written Jeve or Heve).
Hulé (Nicaragua, amongst Civil Indians and Creoles).
Uli (Carib Indians).
Tassa (Mosquito Indians).

Climatic Conditions.

The species of *Castilloa* seem to like best and thrive in thick, humid, warm forests. They abound in Nicaragua; and as I have, through the kindness of my friend Dr. Bureau, of Paris, received from M. Paul Lévy, a botanical collector in Nicaragua, a good account of their history there, it will serve to give a correct idea of their habits.

The basin of the Rio San Juan is where the Ulé tree grows to perfection. This river is the natural vent of the two vast basins of the lakes of Nicaragua and Managua, receiving numerous tributaries, which have all their sources in the innumerable tracts hitherto virgin and unfrequented, and where the trees abound. The ground is very fertile. The district is very unhealthy—it rains for eight or nine months in the year—and the climate very warm and humid. Castillo is the entrepôt where the huleros (as the Caoutchouc collectors are called) start from, having first ascertained at this old fort the best districts. These huleros are nearly all natives of Grenada, or of the Department of the Rivas. The trees prefer humid and warm soils, but not marshy, clayey, or gravelly ground, and the presence of these trees is looked upon as

* The duplication of a vernacular name gives intensity to its meaning, and is nearly always done in the case of medicinal plants. The milk of the Ulé is an effectual remedy in diarrhœal complaints; indeed, if a sufficient quantity were taken it would "glue up" the viscera.

† The same name is also applied to the *Siphocampylos Jamesonianis*, D.C., a small lobeliaceous herb yielding Caoutchouc (Spruce).

an indication of a fertile soil. It is not distributed irregularly through the forests, but sometimes in little groups, more or less isolated, such a group being termed a *mancha* (spot). This grouping is the normal state, and is believed to be caused by monkeys dropping the seeds near an isolated tree, as they are very fond of the pulp by which the seeds are surrounded. The trees are distributed in *vetas* (veins) or bands, either in a north to south, or east to west direction, the first probably caused by monkeys, by the trees being on a declivity, or by water, and the second by the wind, which daily blows in that direction. This irregular distribution has led M. Lévy to the opinion that in cultivation they should be interspersed between other trees rather than form separate plantations, as he thinks that this sympathetic and antipathetic tendency should not be lost sight of. The hulé is often near watercourses, and nearly always on the banks. Trees of small groups give a better net produce than those composing large groups.

Collection and Preparation of Ulé Caoutchouc.

Time of Tapping.—In Nicaragua it is found that although the Hulé yields the juice at all seasons, the most favourable season is April, when the old leaves begin to fall and the new ones to appear. During the rainy season from May till September the richness of the juice diminishes. From that time till January the rain diminishes and the milk increases in richness, and the tree prepares to flower, and the fruit appearing in March, during which month and the succeeding one the milk is at its richest. The difference of yield Caoutchouc contained in an equal quantity of milk would in April be 60 °/₀ more than in October.

Yield by Tapping.—A tree of about 18 inches in diameter bled by skilful hands in April would yield about 20 gallons of milk capable of giving 50 lbs. of Caoutchouc. This is, however, the maximum yield; the average is a little below this. A tree of from 20 to 30 feet to its first branches is *expected* to yield 20 gallons of milk, and each gallon of milk to give 2 lbs. or 2 lbs. 2 oz. of good dried rubber.

Mode of Collection and Preparation.—The huleros makes a ladder of climbing plants, if unprovided with *guachos* or hooks, and fastens it to the tree as high up as possible. He incises the tree with a machete or axe well sharpened, in either of two ways. One method is by making one long vertical cut, with diagonal cuts running into

it, as in Brazil, and a second is by encirling the tree with spiral cuts at an inclination of about 45° (Fig. 4). If the tree be large, two such spirals are made, either crossing each other or lying parallel with each other (Fig. 5). At the bottom of the trunk an iron spout is driven, and the milk received into iron pails. In the evening the milk is passed through a sieve in order to free it as much as possible from foreign matters, before transferring it to the barrels in which it has to be treated. The coalescence of the Caoutchouc is brought about by the addition of the juice of various plants, one named *acheté*, and another, or the same, named *coasso*. Dr. Seeman found that the acheté was the very common *Ipomœa bona-nox*, a convolvulaceous plant. This or these plants are collected and moistened with water, bruised, and the juice, after straining, added to the milk, one pint of the juice being sufficient to effect the coalescence of one gallon of milk. The Caoutchouc, after this operation to which the milk is subjected, appears as a soft mass floating in a brown fluid, and smelling like new cheese. This mass is subjected to pressure from a plank or iron roller, and is called a *tortilla*, and when dried weigh about two pounds, and generally the produce of one gallon of milk. If these plants are not procurable, about two parts of water is added to one part of milk, and allowed to stand for 12 hours. The residue which separates from the water is poured into vats made in the ground and left to dry. This drying takes from 12 to 14 days. Sometimes the milk is simply poured on prepared ground, and the watery portion allowed to evaporate or otherwise disappear. This, when dry, is subjected to pressure in order to get rid of the *bolsas* or pockets of watery liquid. These slabs of Caoutchouc are called *torta*, *tortillas*, or *merós*. When the Caoutchouc is allowed to dry in the iron trough, it is rolled into balls and called *cabezza*. That which dries in the cuts made in the tree is called *bola* or *burucha*, and is highly prized in New York. *Merma* or loss by drying is calculated at about 15 °/₀.

Nicaragua.

Caoutchouc, as has been seen, is an important article of export from Nicaragua, most of it going to New York. The production, chiefly of the San Juan district, from September 1869 to September 1870, amounted to 10,000 quintals, giving employment to about 600 hulerós.

New Grenada.

The Caoutchouc produced here is known in commerce as "Carthagena," and is imported in the form of sheets of $\frac{3}{4}$ inch thickness. It has a somewhat "chewed" appearance, resulting from pressure. It is of very good quality. In colour it is black, and also tough, and occasionally "tarry." If analogy of character be anything, I should say it was the produce of *Castilloa*, which is plentiful. Dr. Spruce says (in letter to Collins), "I have often "been told of a pinnate-leaved tree which I have never seen, but "there is said to be such an one about Serpa on the Amazon, and "the same or a cognate species in New Grenada, the Caoutchouc "of which finds its way to Cartagena."

Ecuador.

Ecuador Caoutchouc is exported from Guayaquil, and is the produce of *Castilloa elastica*. It is in large flakes or lumps of a whitish colour in the best kinds, the lower kinds being porous, the pores being filled with a disagreeable black liquid, which stains the knife and hands.

Perú.

The *Castilloa elastica* is reported here, but its produce does not seem to be exported.

Panama.

Large quantities of Caoutchouc from *Castilloa elastica* and *Markhamiana* are prepared, and chiefly sold in New York. The trees are plentiful on the Rio Gatun and Rio Trinidad. It is chiefly collected in the forests of Darien and Panama. About 2,000 men are engaged in collecting it along the principal rivers. The trees are cut down to obtain the "caoucho," and in Panama there are two establishments for cutting and drying it.

Costa Rica.

The Ulé-Ulé is said to exist here in great abundance.

Salvador.

Caoutchouc is collected from *Castilloa elastica* for export, though unknown as such in this country.

West Indies.

Under the name of "West India" the best description of Central American Caoutchouc is known. The finest is in the form of blocks, consisting of thin separable "sheet" and of great purity, and the second as "scrap" good, but barky. In general character it is good, but barky. None of the West India Islands seem to produce Caoutchouc for commercial purposes, and it owes its name to the fact of the West India steamer calling at St. Thomas as the last station. Yucatan or Belize or the Central Republics may furnish it.

Honduras.

This description of Caoutchouc, probably also the produce of *Castilloa elastica*, appears rarely in English markets. It is of good quality, and very free from "tarry" matter.

Guatemala.

This Caoutchouc is the lowest American variety. It is prepared in blocks, consisting of sheets pressed together, but contains mixed with the Caoutchouc more of the black resinous substance than any other variety. This resin, which gives Caoutchouc a "tarry" appearance, is not liked, and its presence in quantity prevents Guatemala Caoutchouc from attaining a much higher price. Mr. Mann informs me that in Hanover they do not intend to buy any more of this variety, as the "tarry" matter is believed to make the workmen ill.

Mexico.

As has already been stated, the *Castilloa elastica* is very abundant in some parts of Mexico, on the warm coast regions, and especially at Cordova and Vera Cruz. Parcels of Mexican Caoutchouc have been recently sold in London and Liverpool.

2.—Asiatic Sources of Supply.

Ficus elastica, Roxb. &c.

Ficus elastica, Roxb., Fl. Ind., v. iii. p. 545.

Vernacular Names.—*Kusnir* or *Kasmeer* (Bengal). *Pohon Karet* or *Kohlehlet* (Javanese).

Geographic Distribution.—Assam, Java, and probably other Malayan countries. Cultivated in Malabar, &c.

Urostigma lacciferum, Miq., Flo. Ind. Bat., v. i. p. 575. Thwaites' Enum. Pl. Zeylan., p. 265.

Synonym.—*Ficus laccifera*, Roxb., Flo. Ind., iii. p. 545. Wight's Ic. t. 656.

Geographic Distribution.—Assam, Java, Ceylon, &c.

Remarks.—The late Dr. Anderson, when in England, assured me that he believed a part of Assam Caoutchouc was furnished by this tree. It would be interesting and useful to collect authentic specimens.

General Remarks.—*Ficus elastica* is the chief, if not the only source of Assam and Java Caoutchouc. Other Artocarps deserve to be examined, especially those of the genus *Ficus* and *Artocarpus*, *A. chaplasha* and *lakoocha*—for instance.* Mr. Leeds, writing from the Silligoree Camp, Sikkim, says he has collected and sold Caoutchouc obtained from *Ficus Indica*. Is this a slip of the pen? It does certainly yield Caoutchouc, but, it has always been stated, in insufficient quantities for commercial purposes.

Ficus elastica, Roxb.

Indian or Assam Caoutchouc.

Geographic Distribution and Climatic Conditions.—To Mr. Gustav Mann's very excellent and valuable Report on the Caoutchouc Trees in the Durrung District,† and a long, valuable MS. account furnished me by the same gentleman, through the kindness and courtesy of Dr. Brandis, the Inspector General of Indian Forests, I am chiefly indebted for the geographic distribution, &c.

The *Ficus elastica* is found along the foot and in the low tropical valleys of the Himalayas, from the Mechi River on the Nepaul boundary at 88° E. long., to the extreme eastern boundary of Assam, 79° E. long., as well as along the foot and in the low valleys of the southern mountains of the Brahmapootra valley, viz. the Patkye Mountains, the Naga, Khasi Jynteah and Garrow Hills. Although found so far west as the Nepaul boundary, it is not abundant until east of the Bor Nuddee (the western boundary of the Durrung district), where it is common in the forests at the foot

* From what I recollect of a specimen I have seen, *said* to be from this tree, it had a brittle and non-elastic character very like that of *Bassia elliptica* Dalz.

† "Progress Report of Forest Administration in Bengal for the Year 1868–69." Calcutta, 1869.

of the hills in the Khaling, Booree-Goma and Koorceaparah Dooars, between the Bor-Nuddee and Moora Dhunseeree Nuddee, and has been exported from the forests, which extend over about 40 square miles), as well as from the low valleys of the Bhootan Hills, immediately above them, and especially from the forests in the neighbourhood of the exit of the Noonae Nuddee in the Khaling Dooar and the adjoining hills, and those between the Deemjany and the Rootah Nuddees.

In the Chardooar forests, between the Moora Dhunseeree, or Rootah Nuddee and the Bhoralee River, they are abundant. The Chardooar forests cover about 220 square miles. In these forests, between the Beelseeree and the Gobhoroo Nuddees, they are found as far as 16 miles from the hills; but as here the atmosphere is drier than at the hills, the produce is not nearly so abundant.

In the Nowdooar forests, covering about 2,000 square miles, the atmosphere is dryer, but the Caoutchouc obtained from trees close to the hills is good.

In the Chydooar forests, Caoutchouc trees are only found in the forest along, and immediately at the foot of, the hills. They are also most abundant in the Luckimpore and Naga Hill districts, as well as in the low valleys of the mountains immediately adjoining them.

Mr. Leeds, the conservator of the Bengal forests, writes me that he has been collecting Caoutchouc in Sikkim (Camp Silligoree), it being the first collection in that district.

Collection and Preparation of Assam Caoutchouc.

Mode of Tapping.—The collectors with their "Daos" or knives cut every part of the tree they can get at. The cuts on the lower portions of the stem, and the roots which run along for a distance of 30 to 40 feet, vary from 6 to 18 inches in length, and are made diagonally through not only the bark, but also the wood, which is thus injured. The cut is elliptical in shape, being about 3 inches across the centre. The milk flowing from these cuts is received into holes prepared in the ground, or in leaves doubled up in funnel shape. The cuts on the upper branches are smaller, and the milky juice is allowed to dry on the tree. About 50 oz. of milk is the yield of a tree in August, giving about $15\frac{1}{2}$ oz. of pure Caoutchouc. During the cold season, from October—March, the milk is scantier, but richer than in the warm weather, March—October.

Mode of Preparation.—The first or "loaf" kind obtained from the lower parts of the stem and roots is the only kind prepared artificially. The milk is poured into boiling water, and stirred till it gets sufficiently firm to be carried about without being clammy or sticking together. Messrs. Martin, Richie, & Co., of Tezpore, to prepare their Caoutchouc, poured the milk into large wooden boxes or bins 6 feet square, and partly filled with water, the Caoutchouc after a time floating on the top. The Caoutchouc (being still fluid) was then taken out and boiled over a slow fire in iron pans 4 to 6 feet in diameter, and 2 to $2\frac{1}{2}$ feet deep, 2 parts of water being added to the Caoutchouc, and the whole stirred constantly. As soon as the Caoutchouc coagulated into a mass, it was taken out with iron forks and pressed, and again boiled and pressed, and then dried in the sun, and finally washed over with lime.

Assam Caoutchouc is shipped from Calcutta in baskets made of split rattans, and generally covered with a "gunny" bag. These "baskets" weigh about 3 cwt. each. The Caoutchouc has a peculiar mottled appearance, and consists of pieces from a cream or flesh colour to that of a bright pink, verging into red. It is very glossy, and sometimes covered with a film (oxidized?) of a greyish white colour. The Caoutchouc is either in the form of separate balls of a stringy character, or large masses or irregular blocks. Though it is somewhat improved during the last year or two, it has always been noted for the large admixture of bark and earthy matters. Some "block" Assam has been known to yield 35% of bark, clay, and sand. During the past year Assam Caoutchouc has obtained 2*s.* 3*d.* per lb. (Pará, same date, 3*s.* 1*d.*) This Caoutchouc, which I saw, was very pure, and in small balls. Mr. Leeds' specimens, which were only an *average* of that collected at the Silligoree Camp, I valued at the same time at 2*s.* 0*d.* to 2*s.* 1*d.*, it being slightly "barky," owing to the hill men being unused to collection. At the request of Mr. Leeds I had furnished him with a few hints on the subject, and was glad to find they had had such a good effect. Mr. Leeds insisted, and rightly too, on the Caoutchouc being pure and unadulterated.

Mr. Mann gives the forest revenue derived from Caoutchouc in the Durrung, Luckimpore, and Nowgong districts for the years 1861 to 1870 as 83,733 rupees,* the total for 1869–70 being 23,940 rupees.

* Printed as "maunds" in the Report.

In 1868, 2,500 maunds were sold in the Mungledye Bazar, about the same quantity in the Tezpore, and 1,500 in the Chydooar.

A quantity of Caoutchouc is also imported into Assam, collected by the tribes from the hills beyond British territory.

Malayan Caoutchouc.

Singapore.—The Caoutchouc which takes its name from this island is the produce of surrounding countries, and has all the characters of the Caoutchouc yielded by the *Ficus elastica*, Roxb.

Caoutchouc is imported into Singapore, which is the entrepôt for the Malayan Archipelago, from Java, Sumatra, China, Manilla, Borneo, Malay Peninsula, Penang, and Malacca. Of these countries, that of Borneo and Malacca is the produce of *Urceola elastica*, Roxb.

Java *Caoutchouc* is the produce of *Ficus elastica* as identified by my friend Dr. de Vrij. It is called "*Pohon Karet*" or *Kohlehlet** by the natives. They incise the tree and allow the milk to dry on the trees, forming the strings so obtained into a rope-like torch, which they use in searching for edible birds' nests.

Penang and Siam produce Caoutchouc of good quality, and having the characteristics of that furnished by *Ficus*. With regard to Penang, there is an asclepiadaceous plant, the *Cynanchum ovalifolium*, Wight, a smooth twining plant, which Dr. Wallich says yields an excellent Caoutchouc, but all my inquiries respecting the question have had no present result.

China is said to contain Caoutchouc trees. Dr. Seemann† mentions the *Ficus elastica*, Roxb., as a cultivated plant in Hongkong.

African Caoutchouc.

Madagascar.—Dr. Meller records the *Ficus elastica*, Roxb., as occurring here.

Angola.—Dr. Welwitsch mentions a species of *Ficus* yielding Caoutchouc.

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* "Kohlehlet S. = *Ficus elastica*, Rxb., var. *bengalensis* Bl." Hasskarl. Cat. Pl. in Horl. Bot. Bagoriensi Cult.

† Seemann, "Botany of the Voyage of H.M.S. 'Herald,'" p. 413. London, 1852–7.

NATURAL ORDER.—APOCYNACEÆ.

1. American Sources of Supply.

Hancornia speciosa, Müll. arg.

Pernambuco Caoutchouc.

Hancornia speciosa, Müll. Arg. in Martius' Flo. Bras., Apocynaceæ, p. 24.

Vernacular Names.—*Mangaiba* (Piso, Bras., p. 76); *Mangabiba* vel *mangaiba* (Marcgr. Bras., p. 122).

Geographic Distribution.—About Rio Janeiro. In the provinces of Bahia, Pernambuco, Goyaz, Sao Paulo, Sergipe, Minas geraes, Rayal, &c.

Varieties.—a. *minor* = *H. speciosa*, Gomes, obs. bot. med. bras. 2, p. 1, t. 1; D.C. Prod., viii., p. 325.

b. *Maximiliana* = *H. speciosa*, Nees et Mart., Act. Soc. Cur., xi., p. 85.

c. *Lundii*. D.C. Prod. l. c.

d. *Gardneri*, Müll. arg. = *H. pubescens* β. ? *Gardneri*. D.C. Prod. l. c.

e. *pubescens*, Müll. Arg. = *H. pubescens*, Nees et Mart. l. c.

Remarks.—The fruit is held in high estimation, is of a yellow colour, a little streaked with red on one side, and about the size of an Orleans plum. The tree reaches the ordinary size of the apple tree, with small leaves and drooping branches, giving it the appearance of a weeping birch. It affords a good Caoutchouc, but is not much collected, as the tree is more valued for its fruit. M. Claussen* gives its general geographic distribution as being on the high plateaux of South America, between 10° and 12° S.L., at a height of 3000 to 5000 feet above the sea level. The *Hancornia laxa*, A.D.C. (*Tabernæmontana laxa*, Benth.) is the *Ambelania laxa*, Müll. Arg., Mart. Fl. Bras. The *Hancornia gracilis*, Benth., is the *Zschokkea gracilis* of Müll. Arg., l. c. The *Couma dulcis*, Benth., (= *C. utilis*, Müll. l. c.) and the

* Brit. Assoc. Reports, 1855, p. 103.

C. triphylla, Aubl. (= *Cerbera triphylla*, Rudge), yield also a milky juice which is elastic when fresh, but not so when dry.

2. Asiatic Sources of Supply.

Urceola elastica, Roxb.

"Borneo" Caoutchouc [and Sumatran].

Urceola elastica, Roxb., As. Res., 1799, v. 5, p. 167, c. icon. D. C. Prod., viii., p. 358. Wight, ic. t. 473.

Synonyms.—*Vahea gummifera?* Poiret.

Tabernæmontana elastica, Spreng.

Vernacular Names.—*Gutta-susu* or *susuh* (Mal., milk-gum); *jintawan*, variety a., *jintawan susu*, or milky jintawan; variety b., *jintawan bulat*, or round fruited jintawan; and C. *ngret* or *ngerit jintawan*? also variety a., *serapit*, most common; variety b., *petabo*, the best variety; and variety c., *menungan*, the greatest quantity. *Getah-katjai*? Sumatra.

Geographic Distribution. — Borneo, Singapore (all destroyed ?), Sumatra, Penang, and Malay Peninsula generally.

Remarks.—When first this Caoutchouc appeared in commerce (1864) under the name of "gutta-susu," from Borneo (*viâ* Singapore), I succeeded in identifying it as the produce of *Urceola elastica* from comparisons drawn from the "Singapore Local Reporter,"* Mr. James Motley,† Mr. Low,‡ Roxburgh,§ and Campbells'‖ accounts and specimens.

It is a climbing plant, sometimes attaining to a length of 200 paces, with a trunk at times as thick as a man's body. The bark is soft and thick. The fruit is large and of a fine apricot colour, containing from 10 to 12 seeds surrounded by a pulp of a delicious flavour.

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* August 7th, 1853.

† Kew Jour. Botany, v. 5, p. 167, &c.

‡ Sarawak; its Inhabitants and Productions, by Hugh Low, London, 1848.

§ Roxburgh, l. c.

‖ In Herb. Brit. Mus.

Collection and Preparation.

The plant is cut into small pieces from a few inches to two or three feet in length, and the milk allowed to flow into jars or buckets, the flow being hastened at times by applying heat to one end of the billet. When a sufficiency of milk has been collected, salt is added to it, by which means the particles of Caoutchouc are made to coalesce together, and the outside being acted on first encloses little cells or pockets of fluid.

Borneo Caoutchouc is white, soft, porous or spongy, generally wet, the pores being filled with salt water and whey. When old it changes colour to a dull pink or red, and frequently contains a saline incrustation on the inside.

3. Asiatic and African Sources of Supply.

Willughbeia edulis, Roxb., cor. pl. iii.; t. 280, ib. Fl. Ind., Ed. 1832, v. 2, p. 57. D.C. Prod., viii., 321. Ver. *Luti-am.*

Geographic Distribution.—Chittagong, Silhet, Madagascar, Mauritius. Cult. in Java.

Remarks.—A climbing shrub.

W. Martabanica, Wall., pl. As. Rar., iii., p. 45, t. 272.

Geographic Distribution.—Martaban, Chittagong.

Remarks.—"Juice copious. India rubber collected." (MS. note in Herb. Ind., Hook, fil., and Thomson.)

W. Javanica, Blum., bijdr. tot. fl. ned. Ind., p. 1024.

Geographic Distribution.—Woods in Java.

W. celebica, Blum., l. c.

W. ? *coriacea*, Wall., list n. 1620, pl. As. Rar., 3, p. 45.

Geographic Distribution.—Singapore.

Remarks.—Twining plant.

General Remarks.—Of these species we have only record of two species, *W. edulis* and *W. Martabanica*, having Caoutchouc prepared from them, but I have mentioned the others in order to direct attention to this point. Dr. Roxburgh found *W. edulis* in Chittagong and Silhet, and describes it as a climbing plant which when wounded yielded a pure viscid juice, when soon on exposure changed to Caoutchouc. This plant is worthy of attention. Species of *Willughbeiæ* have also been recorded from Rangoon, Malacca, Khasia Hills, and Ceylon.

4. African Sources of Supply.

Vaheæ species. Madagascar Caoutchouc.

Vahea gummifera, Lam., Ill. t. 169, D.C. Prod. viii., p. 327.
Synonym.—*Tabernæmontana squamosa*, Spreng.
Geographic Distribution.—Madagascar.

V. Madagascariensis, Boj., Hort. Maur., p. 207, D.C. l. c.
Synonyms.—*Echites*, Sieb., fl. Maur. Exs., n. 124.
Faterna elastica, Sieb., ibid, n. 278.
Vernacular Names.—*Voua-Héré; Voà-Hiné; Liane de Gomme élastique* (Fr.), *Voacanga.*
Geographic Distribution.—Madagascar and Isle of France.
Remarks.—A climbing shrub; flowers in March and December.

V. Comorensis, Boj., Hort. Maur., p. 207, D.C. l. c.
Vernacular Name.—*Vaughinia.*
Geographic Distribution.—Johanna (Comoro Islands).
Remarks.—A beautiful climbing shrub ten feet high, growing near the sea and by water, and in woods to an altitude of 4,000 feet. Flowers white, sweet scented; fruit, colour and form of orange. Flowers in September.

V. Senegalensis, A. D. C., Prod. l. c.
Vernacular Name.—*Anjouan.*
Geographic Distribution. — A climbing shrub in Senegambia.

General Remarks.—M. Coignet* mentions that on the North-east coast of Madagascar, Caoutchouc is obtained from three varieties of climbing plants (*Vaheæ*), and a shrub 16 to 19 feet high. Of the climbers one variety gives the best product, though the natives mix all together. The Caoutchouc is prepared in either of two ways, by treatment with salt water or by artificial heat. Madagascar Caoutchouc, which is rather new to English commerce, was first known as "Mauritius" Caoutchouc. It has been however largely used in France. At the present time it is highly valued in this country, standing next to Pará in price.

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* Bulletin de la Société de Geographie, Sept. 1867, p. 289.

Landolphiæ Species.

"West Coast" (African) Caoutchouc.

Landolphia Owariensis, Pal. de Beauv. Fl. Owar et Benin, I., p. 54. t. 34., D.C. Prod. viii., p. 320.

Synonym.—*Pæderia Owariensis*, Spreng., Sys. i., p. 669.

Vernacular Name. — *Licongue* or *Licomgue* (sing.). *Macomgue* (plural form) (Plate 4).

Geographic Distribution.—Dr. Welwitsch remarks (in MS. to Collins) that this species "first discovered by Palisot de Beauvais in Owar and Benin, and afterwards by Don in Sierra Leone, I have encountered rather frequently in several of the highland districts of Angola, and consequently the habitat of this plant may be stated as extending from 10° lat. N. to 10° lat. S. on the tropical coasts of West Africa."

Remarks.—Dr. Welwitsch (l. c.) describes it as a "large climbing plant, four to six inches in diameter, at a height of two or three feet from the ground. From this point it is divided into several long thin branches which are again and again divided, climbing along the stems and larger branches of neighbouring trees, to which they fix themselves by means of most tenacious spirally-twisted tendrils formed out of the indurated flower-stalks after the ripe fruit has fallen off. The fruit is about the shape of a middle-sized orange, containing under a hard, nearly woody, reddish brown shell, a sweet, rather acidulous pulp, which is eaten by the natives."

L. Heudelotii, D.C. Prod. l. c.

Geographic Distribution.—Senegal.

L. florida, Benth. in Fl. Nigritiana, p. 444.

Vernacular Name.—"*aboh*" or "*abo*" (fruits).

Geographic Distribution.—Dr. Welwitsch remarks (l. c.) this species is found "rather frequent in most of the primeval forests of inner Angola, where, at an elevation of 1,500 to 2,500 feet, I often met with this beautiful climber, and gratified myself with its sweet acidulous fruit, though not less so with the beauty and marvellous abundance of its large snow-white and jasamin-scented flowers."

Landolphiæ species incerta. In the Kew Herbarium and Museum are the following :—

L. species.

Geographic Distribution.—Tropical Africa, lat. 1° N.

Remarks.—"The leaf of the African Rubber plant." Coll. G. Mann.

L. species. Prov. Zanzibar. Coll. Dr. Kirk.

L. florida ? Fruits and Caoutchouc from the district on the Congo River. Coll. Dr. Hilliard.

Carissa species. Wood and rubber collected by Dr. Kirk (Livingstone expedition).

L. ? "Shupanga, India Rubber shrub." Coll. Dr. J. Kirk.

L. near *Owariensis*, Shupanga, India Rubber liana, wood, fruit, &c. Dar Salam, 1868. Coll. Dr. Kirk.

General Remarks.—Of these unascertained species of *Landolphiæ* which yield Caoutchouc, the Caoutchouc sent by Dr. Hilliard is identical with our West coast "ball" Caoutchouc. The last two specimens sent by Dr. Kirk are identical, and a portion of the stem of the "India Rubber plant of Zanzibar and East tropical Africa," as he calls it, also sent by him, is, at least as far as comparison of woods will admit, identical with the first specimen sent under the name of *Carissa*, and both agree with a piece sent by Dr. Africanus Horton from Cape Coast Castle. Dr. Kirk, in a letter addressed to Dr. Hooker, C.B. (and which the latter has kindly allowed me to copy), says :—"This plant (referring to the last sent) is a woody climber, common along the maritime region, 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 fault has been that the rough bark has often been imbedded in the gummy mass through careless collection. It is not an article of trade at Zanzibar, but I have been endeavouring to induce the natives to collect it. John Kirk. December 25th, 1868."

To Dr. Welwitsch however (whose valuable additions to our knowledge of the Flora of tropical Africa are so well known) belongs the credit of first identifying the plants yielding African Caoutchouc. He says (l. c.) it was principally from the *L. Owariensis*, Beau., that he saw the Caoutchouc collected by the natives of Golungo-Alto and of Cazengo.

Du Chaillu speaks of the Caoutchouc vine, doubtless a *Landolphia*, known by the name of Dambo, as being common about the River Benito. Also more plentifully in the valleys, bottomlands, and high grounds about the Rivers Moondah and Ikoi, the produce of those growing on high grounds being considered the best.

Collection and Preparation.

The collection and preparation of African Caoutchouc is conducted in a very slovenly and wretched manner. The natives cut off a piece of bark and the milky juice is allowed to run into holes made in the ground, or on leaves. In Angola Dr. Welwitsch describes the method there resorted to as even if possible worse. A native having cut a tree places the palm of his hand against the stem and allows the milk to trickle down his arm. He goes from tree to tree, and when his arm is covered, beginning at his elbow he rolls the Caoutchouc back towards his hand, till it comes off in the form of a ring. It is also by some collected and allowed to coalesce in wooden vessels. The wood of the plant contains a gum, so that if the cut penetrates it, this becomes mixed with it and spoils the Caoutchouc. African Caoutchouc has however improved in some districts recently, and the price has been higher for the improved kinds. Mr. Lee Norris, late Manager of the North British Rubber Company, wrote me that he believed the better kinds were prepared with the aid of strong liquor ammoniæ added in the proportion of 3 per cent. The chief districts from which African Caoutchouc is exported are the Gaboon, Congo, Angola, Benguela, and Zambesi.

African Caoutchouc is received in the form of flakes, round balls, and tongues, has a disagreeable odour, possibly the result of decomposition, is viscous, and generally least elastic of all the varieties.

PART II.

THE CULTIVATION AND ACCLIMATION OF TREES YIELDING CAOUTCHOUC.

The use of Caoutchouc or India Rubber is no longer restricted to the rubbing out of pencil marks, as the latter name implies, but has now really become a necessity in the industries. Its applications are indeed legion, and still more numerous would they be, if larger quantities of good quality and at lower prices could be supplied.

The cultivation of economic plants and the acclimation in localities where the various conditions, which are so many elements of success, are more controllable than in their native habitat, has a very important bearing on the commerce of a country, and becomes the more necessary for the sustentation and improvement of trade and manufactures, as the march of civilization and colonization or the recklessness of native collectors reduce the area and number of spontaneous forest products. It may be taken as an axiom beyond all controversion, that we cannot long rely on the spontaneous products of the forests, and that recourse must be had, sooner or later, to conservation, cultivation, and acclimation, in order to keep up necessary supplies of all necessary vegetable products. In illustration of this I may be permitted to quote from a lecture * delivered by me on this subject, some remarks on the collection of India-rubber, which will serve very well to convey a general idea of how forest products are collected, and also to illustrate a few points to which I wish to draw attention:—

"To those who are unacquainted with the forests of intertropical "America, the obstacles there met with are incomprehensible. "The traveller finds an inextricable confusion of vegetation, "covered with creepers, through which a day's hard labour will "not secure the advance of a hundred feet. Now, a straggling "and slimy marsh, out of which he is only with difficulty able to "extricate himself; next, an insurmountable ravine, which it is "necessary to flank, thus tripling the amount of labour. Add "to these, the perpetual fear of wild beasts, and the frequent want "of water, and then judge of what passes in the mind of the poor

* "On the Study of Economic Botany; and its claims, educationally and commercially considered." Jour. Soc. Arts, February 16th, 1872.

" *hulero*, who, after many of such risks and much labour, arrives " at the foot of a tree he had seen from afar, and discovers it is not " what he seeks. Besides the qualities required in a *hulero* to " enable him to find his way in an obscure forest, it is necessary " for him to serve an apprenticeship to learn how to properly bleed " a tree; that is to say, to extract as much milk as possible from " the tree without killing it. With respect to killing it, however, " he is not at all particular. Near the towns, all the trees along " the roadsides are marked by scars made by amateur *huleros*, and " present strange, exaggerated forms. The forests are full of these " attempts, by which, in ten years, the most beautiful trees within " a circle of many leagues of the rancho of a would-be Indian " *hulero* are frequently destroyed. It is to this cause alone that " the blighted appearance of the forests of the inhabited part of " Nicaragua is due. The cut with the machete, to be successful, " must penetrate at one blow through the bark without touching " the wood, otherwise the tree is destroyed; and from the difficulty " of handling the machete, and the carelessness of the *huleros*, " Caoutchouc trees are destroyed with fearful rapidity. The " *hulero*, having collected his rubber, returns to the towns to " dispose of it, where he is subject to great wrongs from the small " traders, nearly universally a very low class. When the price " has at last been agreed upon, the *hulero* finds that the greater " part is already owing for his outfit and spirit score, and frequently " the trader does not part with him till the small balance is " expended in debauchery and drink. Full of revengeful feeling, " the cheated, hardly-dealt-with *hulero* departs, and destroys all " the trees he meets with on his road. The contract between a " party of *huleros* and an agent is made after quite a patriarchal " fashion. They regard each other seriously, strike hands, and " the bargain is completed. It is to the agent that application " is made to secure the active and armed resistance and aggression " of the *huleros* in case of a revolution. He generally succeeds in " engaging them in the civil war by means of a good bounty, a " high rate of pay, a considerable equipment, and a more handsome " dress than that of the other soldiers."

Now, it can be easily seen from this, that such collection of forest products is precarious and objectionable in several ways. First, with regard to the collectors themselves. It is, as a rule, only when other means of employment are wanting that they take

to that of collecting, and, even on moral grounds alone, such a life is anything but humanising. Frequently, too, such operations are interrupted by the caprice of some petty ruler, who requires their services in warfare. This is the case everywhere. Then, often, from causes other than natural, the trees yielding the wished-for product are so far apart as to necessitate a vast extent of ground to be gone over before any quantity can be collected, which greatly adds to the cost, and in many cases precludes the possibility of collection at all. The transport, too, is difficult, confined very often to human or animal porterage, which will not allow of bulky articles being collected. Many valuable woods labour under this disadvantage, and unless they are on the margin of navigable rivers, and can be thus floated down, they are lost to man's use. Now, the great object of cultivation and acclimatisation is to centralise and concentrate in a manageable space. The modes of collection adopted afford many reasons why, in the case of all necessary products, cultivation and conservancy should be resorted to. The native modes of collection are, to say the least, very destructive, and entail a great loss of material, for often, were cheap means of transit available, other parts now wasted could be utilised.

1. THE CULTIVATION OF FICUS ELASTICA AND THE IMPROVEMENT OF ITS CAOUTCHOUC.

The condition of Caoutchouc industry in Assam at the present time is very far from favourable. Mr. Gustav Mann remarks (Report) on the condition of these trees as follows:—

"The privilege was sold (in the Durrung district) for "1,012 rupees to kyahs, in the Mungledye Bazaar, who purchased "2,500 maunds, but had not the slightest control over the tapping "of the trees by those to whom they sub-let their right, and "encouraged the latter as much as was in their power to obtain "the largest possible quantity during the short time they held the "monopoly of buying it, as consistent with their interest, without "any regard, however, for future supplies, which was of most "disastrous consequence, in as far as it induced the men who "tapped and collected the rubber to indulge in the most outrageous "wholesale destruction of these valuable trees, by either felling "them with axes, or, if this was too troublesome, to collect fire-"wood and burn them down, so as to render the operation of

" tapping more convenient than it would have been had the trees
" been left standing; and several hundred magnificent trees were
" counted, in all directions, lying on the ground with cuts across
" their trunks and roots from six to 18 inches long, three inches
" broad, and a foot to 18 inches apart, and smaller cuts on the
" upper branches of them, by which all that they could yield was
" extracted immediately after they were felled, with an utter
" disregard for future wants. So that at present there is absolutely
" no rubber worth speaking of to be got from these forests, nor
" for centuries to come, unless the tree is replanted."

The climate of Assam in the districts in which the *Ficus elastica* luxuriates is as proved by their condition admirably suited. It is excessively moist in the rains, subjected during this period to partial inundation, and the mixed forests in which these trees grow best, remain moist all through the dry season. The following figures of rainfall are taken from Mr. Blanford's paper on the normal rainfall of Bengal (Jour. As. Soc., 1870): Goalpara, 94·4; Gowhatty, 70·7; Nowgong, 80; Tezpore, 76; Seebsaugor, 90; Cachar, 123; Silhet, 150; and Chittagong, 108. In the best districts the soil is all diluvial and alluvial, but in the hot steamy valleys of the mountains it occurs also on rocky ground. The heat is about 98° in the shade in Upper Assam. Under these conditions, which are of excessive moisture, even partial inundation during a portion of the year, Caoutchouc trees of all countries thrive best.

Cultivation of Ficus elastica.—This, Mr. Mann proposes, should be done by opening out lines 15 feet wide, and planting alternately on either side of the lines, at about 100 feet apart. This should be done in the districts where the trees grow best.

The *Ficus elastica* is exceedingly easy of cultivation, branches planted in the ground will speedily establish themselves. Stock plants could also be kept in readiness to obtain the branches from.

Mr. Mann mentions the Durrung forest and the forests between the Deemajang and the Rootah Nuddees on the west of the Bhorolee river, and on its east the immediate neighbourhood of the "Duphalaghur" as being well adapted for the purpose of planting. I understand that since the publication of Mr. Mann's Report, more suitable localities have been discovered in the Luckimpore district. If planting were resorted to a tree so planted would yield at half the age a naturally grown tree would, as in the latter case several years elapse before an aerial root can reach

the ground and establish itself, and would be consequently all this time would be saved.

Mr. Mann calculates that even commencing at 50 years, the clear profit of a tree, tapped every third year, and lasting to 100 years old, would be 320 rupees of Caoutchouc, beside 250 rupees of lac. Each third year a tree, of 50 years old, would yield 40 lbs. of very pure Caoutchouc, but a planted tree could be safely tapped at 25 years, though its yield would not be so great as an older tree.

Preventative measures should be adopted both in the case of present trees and any which may be planted, by limiting the time of tapping, guarding against over-tapping, and not allowing binding or total destruction of a tree. It would be well to divide the various forests into districts so as only to allow tapping during the months of January, February, and March, in every third year in each district. The question of leases is an important consideration, and I believe that it will be found necessary either to extend the leases to a much longer period, in order to render it advantageous to the interest of the holder to take the greatest possible care of the trees or for the Government to take it entirely into their own hands and not grant leases at all.

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 per-centage 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 ornus*, 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 (Fig. 3).*

Fig. 3.

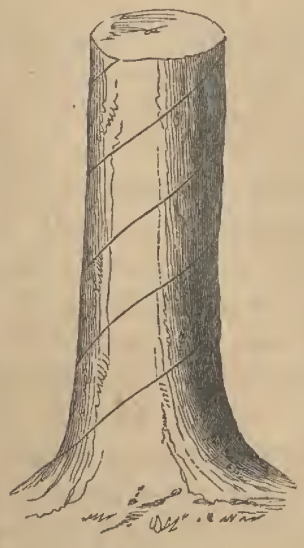


Fig. 4.

Fig. 5.

* Taken from a specimen collected in Calabria by D. Hanbury, Esq., F.R.S., and kindly lent me by him.

In Nicaragua the Ulé tree (*Castilloa elastica*, &c.) is tapped in the form of a spiral, surrounding the tree at an inclination of about 45° (Fig. 4). 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 (Fig. 5). This is however a very injurious manner.

In Pará, Guiana, &c. in tapping the Seringa (*Heveæ* 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 (Fig. 6). 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 above it.

Fig. 6.

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 physiological 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 laticiferous vessels, situated principally in the middle or *Mesophlæum* 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 (Figs. 7 and 8) are good for their purpose, and Mr. Mann has sent me a knife (Fig. 9), which had before suggested itself to me and which is

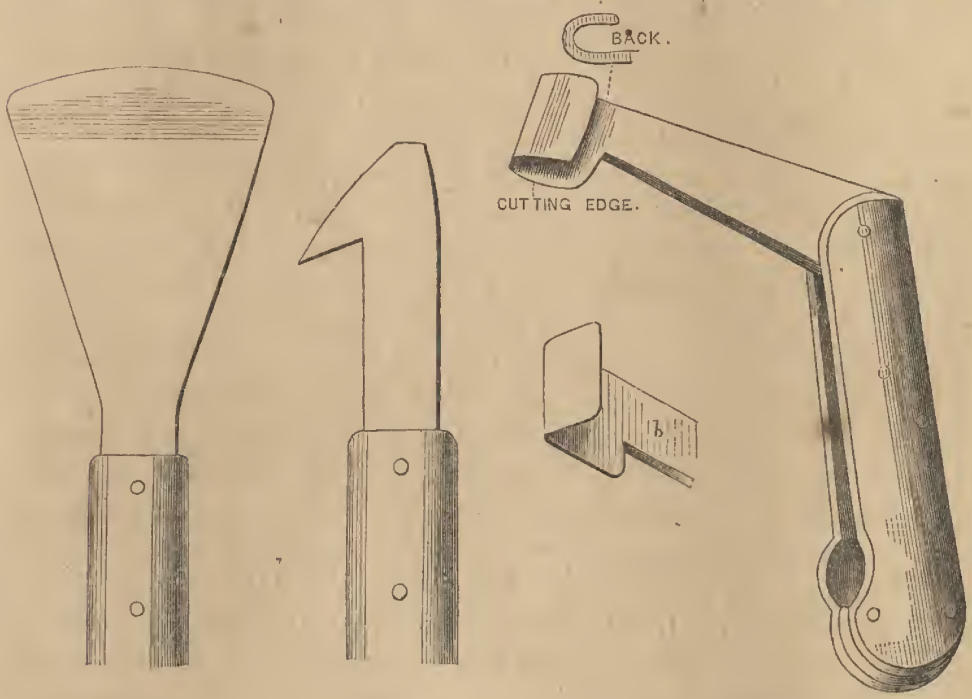


Fig. 7. Fig. 8. Fig. 9.

b. Proposed Tapping Edge for trial.

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.

NEW FORM OF TAPPING KNIFE (James Collins).

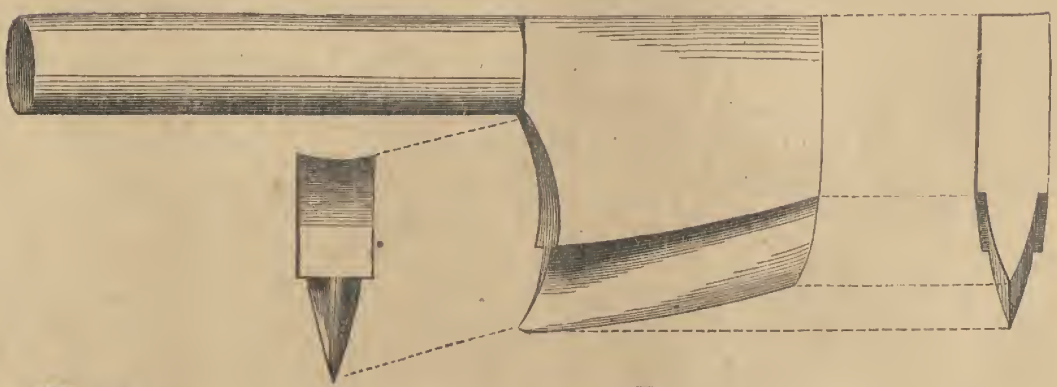
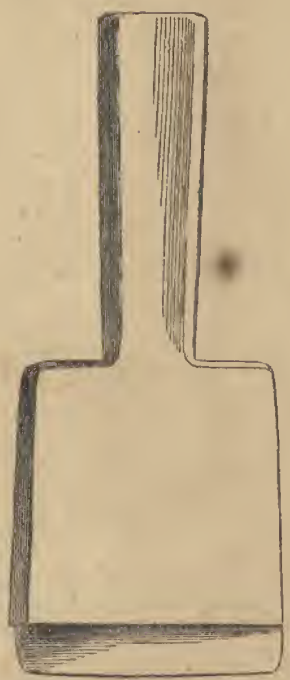


FIG. 10.



Simple form of handle with a blade with the same description of cutting edge.

FIG. 11.

A, shoulder; B, triangular base of knife blade; C, knife edge.

FIG. 12.

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 (Figs. 10–12). 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 termina-

tion 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 (*laticiferous 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 collecting 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 the cautious application of dry heat is generally accounted the best, and the Para 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 fulfils 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 Para 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 Para, would and does furnish the best *prepared* Caoutchouc. Of natural heat, or allowing the Caoutchouc to coalesce and the water to evaporate spontaneously, though 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 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 bona-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 Para. 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, 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 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.

This 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 is an 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.

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2. THE ACCLIMATION OF OTHER PLANTS YIELDING CAOUTCHOUC.

The acclimation, or acclimatization, as it is also called, leads us first to the consideration of the relative values of the different varies of Caoutchouc, and no better criterion can be taken than that of the actual market value. The following tables give the prices, together with the imports or actual sales of the same, in London and Liverpool, during the period from June 1871 to June 1872. The prices quoted are those actually paid for the *best* descriptions of each variety unless otherwise stated. The *average* price is taken from the total of the various prices paid during the 12 months, and not from the highest or lowest prices alone.

TABLE 1.—Imports and Prices of Caoutchouc in London from June 1871 to June 1872 (based on the Monthly Reports of Messrs. Jackson & Till, Colonial Brokers, Mincing Lane, London) :—

Description.	Imports for 12 Months ending June 1872.
East Indian - - -	1,347 tons.
Pará and W. Indian - - -	721 tons.

Prices paid, at per lb. during the same period, for the *best parcels only* :—

Description.	Highest Price paid.	Lowest Price.	Average for the year.
	s. d.	*s. d.*	*s. d.*
Pará - - - - - -	3 1	2 8	2 10
Singapore - - - -	2 3	1 10½	2 0
Penang - - - -	1 10	1 9	1 9½*
Borneo - - - - -	1 10¼	1 7½	1 9
Assam - - - - -	2 3½	1 4½	1 8†
West India - - - -	2 3½	1 11½	2 0
Guatemala - - - -	1 11	1 5½	1 7
Guayaquil (pressed) - - -	2 3	1 7½	2 0¾
Carthagena - - - -	2 3	1 11¼	2 1
African - - - - -	—	—	1 5
Madasgascar - - - -	2 4½	1 10‡	2 3

* Few parcels. † The highest price paid was for a parcel of *great* purity.
‡ This was early in the year, before it became so appreciated.

TABLE 2.—Sales and Prices of Caoutchouc in Liverpool from June 1871 to June 1872 (based on the Monthly Reports of Messrs. J. H. Rayner & Co., Colonial Brokers, Liverpool) :—

Description.	Sales.
Pará - -	3,610 tons (imported during the year).
Carthagena - -	1,770 bales sold „ „
Ceará - -	3,320 „ „ „ „
Guayaquil - -	480 tons „ „ „
African - -	905 „ „ „ „
Honduras - -	A few bales.
Mexican - -	„

Note.—The actual imports may be *slightly* lower, as at times a parcel may be re-sold for speculation purposes.

Prices paid at per lb. for best descriptions only, during the same period :—

Description.	Highest Price paid.	Lowest Price paid.	Average for the Year.
	s. d.	*s. d.*	*s. d.*
Pará - - - - -	3 1	2 8	2 11
Ceará - - - - -	2 1	1 10	2 0
Carthagena - - - -	2 3	1 10	2 1
Guayaquil (pressed) - - -	2 3	1 10	2 1
African* - - - -	2 1	1 8	1 11
Honduras - - - -	One parcel.		1 11¼
Mexican - - - -	„		1 10½

* This is for the best kind, which is new to commerce. It is the same description as the other kinds of African, but better prepared. The prices for African Caoutchouc for June 1872 are: tongues, 1*s.* 8½*d.*, balls, 1*s.* 11½*d.*, niggers, 2*s.* 2*d.*, knuckles, 1*s.* 8¼*d.*, and flake, 1*s.* 9¼*d.*

Allowing all the varieties to be *equally pure*, their relative value may be taken in the following order :—

Pará, Madagascar, Carthagena, Ceará, W. India (sheet), Guayaquil (pressed), Singapore, Assam, Penang, Guayaquil (common), African, Borneo, and Guatemala.

Species recommended to Introduction.—I should strongly recommend the introduction of as many as possible of the plants yielding Caoutchouc in quantities sufficient for commercial purposes, as possibly by cultivation there will be not only an *atavism* or returning to their original or primeval goodness, but even an *increase* of yield over that of spontaneous yield may be safely looked for, as has proved so remarkably the case in the *Cinchonæ*.

Pará Caoutchouc, as seen by the prices paid for it, is undoubtedly *the* best description. There are no purposes to which Pará Caoutchouc cannot be applied, the question of price alone precluding its application for purposes which, if price admitted, it would be used. For the production of the best articles possessing all the properties for which Caoutchouc is valued, Pará Caoutchouc would be undoubtedly chosen above all others. It is more tensile, retains its strength to a much greater degree, is less acted upon, than Assam or any other Caoutchouc whatever, and its superiority is not due to mere *purity* (as seen from the difference of price of 8½*d.* of "fine Pará" and *pure* Assam), but to its belonging to a different genus. Pará Caoutchouc is in certain cases absolutely indispensable, such as for articles requiring the greatest strength, elasticity, &c., and other cases again where its combination with the commoner varieties is necessary in order to impart the same qualities. Uses can be found for all kinds, and it would be impossible for the Pará Caoutchouc to be supplied in sufficient quantities to render the cultivation of other species unnecessary; no cultivation would be likely to render other kinds so good as to supercede Pará Caoutchouc. The milk of the *Heveæ* is very pure, and unmixed with resins or other substances, as is the case with some other kinds.*

Seeds of the *Heveæ* could easily be procured from the Amazon districts, and their germination ensured on the spot, as probably from the quantity of oil they contain, they would rapidly lose this power, oily seeds losing their germinating power quicker than non-oily seeds, owing to oxidation of the oil soon setting in. Young plants introduced, or plants raised from seed, in a new country more quickly accommodate themselves to differences of climatic conditions than larger plants do.

I should also strongly recommend the introduction of the *Castilloa elastica*, Cerv., and the other one or two species of the

* Is the resin present in many kinds of Caoutchouc a "stem" resin? if so, its presence would be owing to too deep incision.

same genus, as they furnish good Caoutchouc, capable of much improvement, and the tree is easily cultivated.

Of the remaining plants, I should also strongly recommend the introduction of the Apocynaceous climbing plants, viz., *Urceola elastica*, Roxb., *Vaheæ*, sps., *Willughbeia edulis*, and the species of *Landolphiæ*.

The *Urceola elastica*, Roxb., has long been known, and is said to be ready to tap after the third year's growth, and when cut down soon to spring up again.

The species of *Vaheæ* which yield Madagascar Caoutchouc are very valuable sources of supply. Although this variety of Caoutchouc is comparatively new to English commerce yet it speedily has had its good qualities recognized, and now stands next that of Pará in value.

The *Willughbeiæ* and the *Landolphiæ* are very near to each other, and may, when better materials for comparison exist, even prove generically the same. They are easily cultivated and are susceptible of much improvement.

Climatic conditions necessary.—As to the climatic conditions existing in India, isomeric with those under which the species recommended to be introduced exist in their habitats, Upper Assam seems to be remarkably well adapted, as the conditions under which the *Ficus elastica* best thrives are exactly those required more or less by all Caoutchouc yielding plants. Speaking of the cultivation of the *Ficus elastica*, Roxb., Mr. Mann describes the whole country of Upper Assam as resembling one extensive basin of diluvial and alluvial deposit, and that very rich and excessively moist plantations could be got up easily.

With special regard to the *Heveæ*, Dr. Spruce writes me that they thrive best at or near the sea level, in a mean temperature of 78° to 80°, and that does not pass the limits of 70° to 90°; in a humid climate where there are rarely 10 days together dry even in the (so called) dry season, and that they are trees of the primitive forest or river margin, never found in savannahs. Ceylon, Malacca, and some parts of Borneo, from what he has read, come nearest to the Amazon districts. However, I leave the comparison of climatic conditions to those who know India well, only recording my opinion that I believe the *Castilloa elastica* and the climbing plants would do well in Upper Assam, and the *Heveæ* almost, if not equally as well.

Results to be expected.—The tree kinds could be *safely* tapped at twenty-five years of age, and their produce if collected and prepared as I have intimated would realise a handsome profit. The climbing

plants, could be grown around existing trees and thus save much time, trouble, and expense, and would begin to yield at a much earlier date, the *Urceola elastica*, Roxb., being said to be fit for the tapping operation at three years old.

Conclusion.

On the whole question of the trees yielding Caoutchouc, its preparation, &c. there is still much to be learned. In this report I have incorporated all the essential points affecting the question, which I have been able to gather during several years study of the subject—searching at home and instituting inquiries abroad in order to obtain valuable and trustworthy information. I should in conclusion beg to recommend that the subject should be studied on the chief spots where the trees are found. Especially would I particularize the Amazon districts as likely to yield much valuable information to one going prepared on the subject, as to trees yielding Caoutchouc (for there is much to be learned on this branch of inquiry alone), its preparation, and other inquiries which would suggest themselves to a person well versed in the subject. I therefore beg to add a series of instructions, rather as indicating types or classes of questions requiring elucidation. In Assam Mr. Mann would be well qualified to seek answers to these queries if time and opportunity be granted him for the purpose.

SPECIMENS AND INFORMATION DESIRED ON CAOUTCHOUC AND THE TREES PRODUCING IT.

1. Samples of crude juice, without any preparation whatever, care being taken to place the same, immediately on collection in *air-tight* vessels in order to guard against any spontaneous change taking place. If two such specimens can be sent, to one should be added a small quantity of liquor ammoniæ. Care should be taken to exclude light. (Strong tinned cans would be convenient vessels to send the milk.)

2. Samples of Caoutchouc, prepared in as many different ways as possible, such as with the aid of (a) artificial heat; (b) hot water; (c) natural heat; (d) alum; (e) liquor ammoniæ?; (f) acetic acid?; (g) any plant, and also sending a quantity of the plant so used; (h) fresh water; (i) salt water; (j) burning sulphur, taking care to note the time occupied, and all the steps of each process, using in every experiment an *uniform* quantity of the same milk.

3. Samples of the whey-like substance which separates from the Caoutchouc during its coalescence.

4. Samples of prepared Caoutchouc in the form or forms proposed to export it in, care being taken that it is as *clean* and *dry* as possible.

5. Information on the average yield of each kind of tree, and at different seasons, the best season for collecting, and the relative yield by simple tapping; (2) tapping, assisted by binding, and total destruction. Of course, in practice, the two latter methods should not be resorted to. A specimen of the stem showing methods of tapping would be interesting.

6. Dried specimens of a branch of the tree, having the leaves, flowers, and fruit *attached*. These may easily be dried between sheets of any porous paper, care being taken to change the paper a few times at first, till the plants are perfectly dry. The specimens should be as characteristic as possible; leaves on different parts of a tree vary in some instances very considerably.

7. Specimens of leaves, flowers, and fruits *attached*, preserved in a jar or bottle, in some spirit as brandy, spirits of wine, or in acetic acid, or a solution of salt, care being taken that the mouth of the vessel be well secured to prevent leakage.

8. Specimens of the wood (a small section of the stem) and bark. All the botanical specimens and the Caoutchouc should be gathered from the *same identical tree*.

9. When there is more than one kind of variety of tree yielding the same substance, complete specimens of each kind should be collected and sent.

10. Small parcels of fresh seeds should be sent by post, as this saves much time; seeds also (in addition to the ordinary method) should be sent packed in sugar, as this method is said to prevent oxidation of oil.

11. Information respecting the geographic distribution and climatic conditions, how best propagated, native names, and any other information should be sent.

12. Great care should be taken that the labels should be correctly and securely affixed to the specimens, and that the letter or other account should coincide with the numbers or names on the specimens.

I shall be very glad to receive any such specimens and report on the same.

JAS. COLLINS,
11, Arthur Street,
Deptford.

MEMORANDUM

ON

MR. COLLINS' REPORT ON CAOUTCHOUC,

DATED 28TH OCTOBER 1872.

Mr. Collins' report seems to me to suggest two questions of great practical importance for India: — *First.* What can be done for the introduction into India of those trees which yield the Pará Caoutchouc, and of some of the climbing plants which yield the rubber of Madagascar, Africa, and Borneo. *Second.*—What can be done to increase the production and to improve the quality of the Assam Caoutchouc, the product of *Ficus elastica.* It may not be out of place to place on record a few observations with regard to these two questions, which have suggested themselves to me while discussing the results of Mr. Collins' valuable report, with Mr. Gustav Mann, who has the advantage of a personal acquaintance with the Caoutchouc forests of Assam and the Caoutchouc yielding tracts of Western Africa.

2. There is no doubt that Pará rubber is a very superior article, the price lists given by Mr. Collins prove this sufficiently, and the concurrent testimony of Caoutchouc manufacturers in this country seems to show that where great elasticity and powers of resistance are required, such as for buffer springs of railway carriages, and the like, Pará rubber must be used. Again there seems no doubt that Pará Caoutchouc retains its excellent qualities longer than most other kinds, that in fact it is more durable. I do not say that it may not be found expedient to introduce some of the other kinds into India also, but at first our efforts should be mainly directed to ascertain by actual experiment whether it is possible profitably to cultivate on a large scale some of the species of Hevea which yield Caoutchouc in Pará, on the Amazon river, and the Rio Negro.

3. The first question then appears to be, whether there is any part of India with a climate similar to that of those regions of Brazil where the best rubber is produced. The data brought together by Mr. Collins in his report seem to show the following facts. The mean annual temperature in the province of Pará, on

the Amazon and the Rio Negro, is stated between 78° and 81°, the extremes being 73° and 100°. The annual mean and the greatest heat is thus the same as what we have in British Burma and on the western coast (Malabar, Canara, and the Concan), but there is that difference, that in the northern part of these districts the thermometer falls lower during the cool season than appears to be the case in the equatorial forests of Brazil. By way of illustration I will give a table of means, and another of absolute extremes, of some stations on both coasts, to which, for the sake of comparison, I have added Calcutta and one station in Assam. The figures are taken from Schlagintweit's Meteorology of India, first part, 1866.

MEAN TEMPERATURE of the FOUR SEASONS and of the YEAR.

		Calcutta.	Bombay.	Cannanore.	Rangoon.	Gohatti.
Cool season.	Dec., Jan., Feb. -	68·1	76·0	80·0	76·0	65·6
Hot season.	Mar., Apr., May -	82·2	83·0	84·0	81·0	77·4
Rainy season.	June, July, Aug. -	83·3	82·0	79·0	80·0	82·6
Autumn.	Sept., Oct., Nov. -	79·7	81·0	80·0	81·0	77·5
Year - - - -		78·3	80·3	80·8	79·3	75·8

ABSOLUTE EXTREMES of TEMPERATURE.

		Calcutta.		Bombay.		Rangoon.		Gohatti.	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Cool season	Dec. -	51	80	66·2	90·8	62	90	49	73
	Jan. -	49	78	60·0	88·2	62	92	48	73
	Feb. -	52	81	68·8	87·2	59	97	48	80
Hot season	March -	61	90	67·2	93·3	64	100	52	90
	Apr. -	69	95	74·0	93·2	75	100	60	90
	May -	74	106	79·3	94·2	73	95	60	92
Rainy season	June -	75	105	76·0	95·3	75½	90	70	91
	July -	74	98	75·8	89·4	75	89	76	88
	Aug. -	76	92	74·4	89·2	76	88½	74	91
Autumn	Sept. -	72	92	75·0	88·3	76	96	70	90
	Oct. -	70	90	73·0	92·5	74	92	67	87
	Nov. -	59	87	71·6	91·5	69½	90½	58	81

4. At Bombay the temperature falls as low as 60° in January, and at Rangoon it sinks to 62° in December and January. Further south however on either coast this drawback would be avoided. I have no access at present to records of absolute extremes, but the mean monthly temperatures at sunrise are given in Schlagintweit's work for several places on both coasts, of which it will suffice to give Cochin as an example :—

COCHIN.

December - - - - - -	75 to 78·2
January - - - - -	74 „ 75
February - - - -	74·5 „ 76·8

Further south on the western and Burma coast the extremes of heat also are more moderate than at Rangoon and Bombay. At Cochin for instance the highest monthly mean taken at 4 p.m. does not exceed 90°. We may therefore conclude that Canara, Malabar, Travancore and the Burma coast from Moulmein southwards offer the desired conditions as regards temperature for the successful cultivation of the Caoutchouc yielding species of Hevea. I would specially draw the attention of forest officers in this respect to the moist evergreen forests at the foot of the Coorg Ghats, and in Canara, as well as to the Attaran valley, and similar localities in Tenasserim.

5. The annual rainfall in Pará seems to be about 60 to 90 inches, this would be somewhat less than the annual fall on the southern part of the western and Burma coast (Cananore 123, Cochin 105 inches, Moulmein 175, Mergui 165 inches); but the supply of moisture appears to be more uniformly distributed over the seasons of the year in the Caoutchouc yielding region of Brazil than is the case in most parts of the moist zones of India.

In Pará the rains are from March to July, but some rain falls also during the dry season. In the Amazon valley it rains from January to May, but there are occasional showers in November, and intervals of fine weather during the wet season. So far the data given by Mr. Collins would agree well with the seasons on the western and Burma coast, save that the principal rains occur at another time of the year. But Dr. Spruce states positively that the Heveas thrive best in a humid climate, where there are rarely 10 days together dry even in the so-called dry season.

The nearest approach to this would be found in some parts of Ceylon, which, as regards temperature also, would appear to offer to the Brazilian Heveas a most congenial climate. In Malabar, Travancore, and on the southern Burma coast the distribution of the rainfall over the year will be apparent from the following data, which I have mainly extracted from Mr. Glaisher's report upon the Meteorology of India.

	Cananore.	Cochin.	Quilon.	Mergui.
Cool season - - - inches	2·0	4·2	2·9	7
Hot season - - - - „	17·5	23·0	21·9	20
Rainy season - - - „	84·9	61·0	43·9	90
Autumn - - - - „	18·1	16·8	17·1	48
Total - - - „	122·5	105·0	85·8	165

6. So much is clear that the southern part of the western and Burma coast has a climate which is likely to suit the requirements of the Caoutchouc yielding species of Hevea, and it is not impossible that eventually these trees may be found to accommodate themselves to a wider range with regard to temperature and humidity. It will therefore be well at once to make special arrangements to obtain a supply of plants, and of seeds also, in case they should be found to retain their vitality sufficiently long. This is a subject which I would beg to recommend to the attention of the Government of India and of His Grace the Secretary of State for India in Council. Mr. Mann has communicated to me a detailed monthly price current of the London rubber market for the period from 1857 to 1866, from which it appears that the price of fine Pará was 1*s.* 7*d.* per lb. in 1857, that in 1866 it had risen to 2*s.* 6*d.* on the average, and Mr. Collins now informs us that the present rate is 3*s.* 1*d.* per lb. It appears certain that the demand for superior kinds of Caoutchouc for the rolling stock of railways and other purposes will increase considerably, and it will in every respect be advantageous to produce in India an article so useful and valuable as Pará rubber.

7. In the second place, attention should be paid to the introduction of the climbing Apocynaceous plants (Vahea sp.) of Madagascar, which yield the excellent article, which, according to Mr. Collins,

has been largely used in France and is now beginning to be appreciated in this country. The mean temperature of the year in the northern part of Madagascar is about 77° (hot season, January to April, between 80° and 85°).

The cultivation of this plant would probably yield an earlier return than the Brazilian Heveas, and that circumstance might be an inducement for the introduction of those climbers also which yield the African rubber (Landolphia sp.) and the Borneo Caoutchouc (Urceola elastica) both belonging to the same natural family of Apocynaceæ. In addition to the climbers it will be well by way of experiment to introduce plants of Castilloa elastica, a large tree which yields the Caoutchouc of Central America.

8. Before now proceeding to discuss the second subject, viz. the measures to be taken for increasing the production and improving the quality of the Assam Caoutchouc, it will be well to notice the relative value of the principal kinds of rubber imported into this country. 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 it.	Price paid for last Parcel.	
		Lowest.	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 (Indian Archipelago) - -	Ficus sp.	1 10½	2 3
Assam - - - - -	Ficus elastica	1 4½	2 3½†
Ceara (Ceara in Brazil) - - -	Hevea sp.	1 10	2 1

* 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.

The African rubber (Landolphia) varies exceedingly in price and quality, and the Borneo Caoutchouc, the produce of Urceola elastica, is only quoted at 1*s.* 7½*d.* to 1*s.* 10¼*d.* 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.

9. Mr. Mann thinks that apart from the accidental (and sometimes intentional) impurities, such as pieces of bark, wood, sand, stones, the Assam article is often adulterated with the milk of other species of Ficus, which is of a quality much inferior to the milk of F. elastica. Messrs. Martin and Richie* are said to have given up their lease before it had expired, because the supply had diminished so far that their business was no longer remunerative, and from late reports which I have seen on the subject I gather that the number of Caoutchouc trees remaining in British territory is believed to be limited. Under these circumstances it does not appear likely that any considerable improvement of the article can now be expected to be effected through the agency of private enterprise, except at the risk of exhausting the remaining sources of supply. The question then arises, whether it is possible in some way or other to place the collection and preparation for the market of this valuable article under the control of public officers who will devote their whole time and attention to this subject. No great skill is required for the collection and preparation of a pure and valuable article, the facts stated in Mr. Collins' report and in Mr. Mann's previous papers on the subject, will enable any intelligent and careful person to arrange and superintend the collection and preparation.

10. 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 penetrate 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.

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* Mr. Mann's Report on the Caoutchouc Tree in the Durrung District.

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 Pará.
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.

So much however is evident that unless the collection and preparation of the Caoutchouc produced in British territory is placed under the control of public officers who have an interest in the protection and improvement of the forests, no satisfactory result can be expected. If this is not practicable then we must for future improvements entirely rely on the Caoutchouc plantations to be established.

11. 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.

If suitable soil and localities are selected, and if these plantations are at once placed under efficient supervision, there ought to be no difficulty in this undertaking, and operations should in my opinion be commenced as soon as possible on a large scale, and in accordance with a well considered plan.

D. BRANDIS.