## CHAPTER I.

### THE RAW MATERIAL.

**Brief survey of Rubber-yielding plants, collection of the latex, and preparation from it of the crude Rubber of Commerce.**—Considering the great importance of repairing as far as possible the damage done by the ruthless destruction of rubber trees in the process of rubber-collection—a point which has for years been repeatedly insisted on by the technical press—one might have supposed that these plants would long ago have been most carefully studied in every aspect, and have become really well known. Actually, however, our knowledge of even the most important of the rubber-yielding plants is, as E. de Wildeman[1] has recently pointed out, still extremely meagre, despite the efforts put forth by zealous workers. The object aimed at in the following pages is to present to the man technically interested in rubber, a condensed general survey of the methods of collecting the various commercial sorts of crude rubber, so far as our knowledge extends at the moment.

The rubber of commerce comes partly from the northern parts of South America and from Central America, partly from Africa and Madagascar, partly also from India and the neighbouring islands, as well as from Polynesia.

At the present time the most important kind of commercial rubber, and, broadly speaking, the best, is Para,[2] which takes its name from the capital of the Brazilian province of Para. Para is obtained essentially from the latex of plants of the genus *Hevea*, of which numerous species are indigenous to South America. About thirteen of these species have so far been identified. *Hevea braziliensis* (Müller, Arg.) is at present the chief source of the rubber;

[1] "Caoutchoutiers de l'Amazonie" (*Le Caoutchouc et la Gutta-percha*, 1905, ii. 129).

[2] Pronounced Parà.





this species is found, according to E. Ule's investigations, principally in the southerly portions of the country watered by the Amazon and its tributaries. According to more recent observations, however, other species than those of *Hevea* contribute to the supply of latex from which Para is prepared, and the *Hevea* latex is occasionally worked up in admixture with that from species of *Sapium*; for example, the *Tapuru*, *Murupita*, and *Siringorana*. According to Franz Clouth[1] *Micranda siphonoides* also contributes to the production of Para, but information from other sources is to the effect that, in spite of the wide distribution of *M. siphonoides*, its latex is little used, for the sap is bitter and cannot be worked up with *Hevea* latices. Moreover, the natives do not trouble to work up *Micranda* latex by itself.[2] It must certainly be admitted that the mixing together of different latices is not altogether desirable in the interests of the quality of commercial "Para." Commercial Para is produced not only in the Brazilian portions of the country watered by the Amazon, but also in Bolivia and in certain parts of Peru. Bolivian Para in particular is recognised everywhere as being of excellent quality. This may be largely due to the fact that the districts from which Bolivian Para is derived are so extraordinarily rich in *Hevea* trees of more than a hundred years old, it being generally accepted that the latex from such trees is superior both in quantity and quality to that obtained from relatively young trees. On the other hand, the conditions of transport are such that Bolivian Para invariably comes on to the market in a well-matured condition.

The collection of Para rubber in the above-named districts of South America is carried out as follows. A contractor leases a stretch of forest of convenient size from the Government, and fits out gangs of labourers with tools and provisions. To each group of labourers a district is allotted, containing about 100 to 150 rubber trees. Footpaths having been made through the forest to the separate trees, the tapping operation begins. With the aid of a *machado*, a short-handled hatchet of American manufacture which has now been generally introduced, incisions are made in the bark of the tree to such a depth that, although the laticiferous vessels are laid open, the vitality of the tree is not affected by numerous incisions. This operation commences at daybreak. Beneath each incision is fixed a small collecting vessel to catch the latex which trickles out. About three hours after tapping, the cuts become

[1] *Gummi, Guttapercha, und Balata*, Leipzig, 1899, p. 74.

[2] E. de Wildeman, *Le Caoutchouc et la Gutta-percha*, 1905, ii. 171.

sealed up again, and the latex which has flowed out is transferred to larger vessels, *calabashes*. The cuts are reopened in the evening, and yield still further quantities of latex. After about a week fresh incisions are made, and the collecting process just described is gone through again. A district (*estrada*) of 150 trees yields on an average about forty-five litres of latex at each tapping. Assuming that the whole collecting season includes twenty tappings, one *estrada* will yield on an average about 900 litres of latex, from which about 400 kilos. of crude Para containing a normal percentage of moisture will be obtained. The latex is taken in the calabashes to the storage place, and is there worked up to rubber in the following way:—The latex is poured into flat dishes, from which it is scooped out and poured over a thick stick, supported at one end on a rough wooden framework, the stick with the adherent latex being then rotated by the hands while it is held in the smoke from a fire. The formation of a thin pellicle of rubber round the stick is brought about partly by the heat of the fire, and partly by the action of the chemical compounds contained in the smoke, and over this pellicle more latex is poured, the smoking process being repeated. By the repetition of this operation a ball of rubber is gradually built up, consisting of innumerable superimposed thin pellicles.

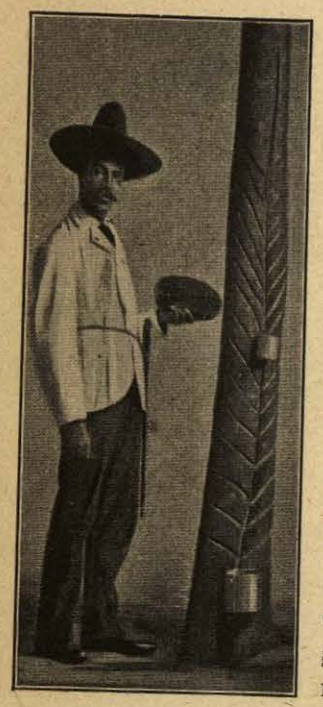

Fig. 3.

In some districts special virtues are ascribed to the smoke of a fire fed with nuts of the urucuri or tucuma palm. Containing as they do some 12 to 15 per cent. of moisture, the balls of rubber are of a more or less yellowish-white colour inside, frequently streaked with lines of a darker colour, representing bands of lower moisture-content, and surrounded by a dark, relatively dry, outside layer. Some of these balls of rubber come on to the market without any further sorting; some are first cut open and sorted by experts at the ports of Manaos and Para. On cutting the balls open a number are usually discovered in which the smoking process has not followed the normal course, and which contain patches of spongy lacunæ containing serum; such balls are designated "Entre-



fine" and not "Fine" Para. Both Fine and Entrefine Para have a pleasant, smoky, ham-like smell. A further distinction is made between *hard-cure* and *soft-cure* Fine Para; this, however, is not accompanied by any appreciable difference in price. As to when a Para may be designated *hard-cure* and when *soft-cure*, that is a point that still requires clearing up. Disputes between buyer and seller on the point are not infrequent; hitherto they have generally ended in favour of the seller, but there is little doubt that if some

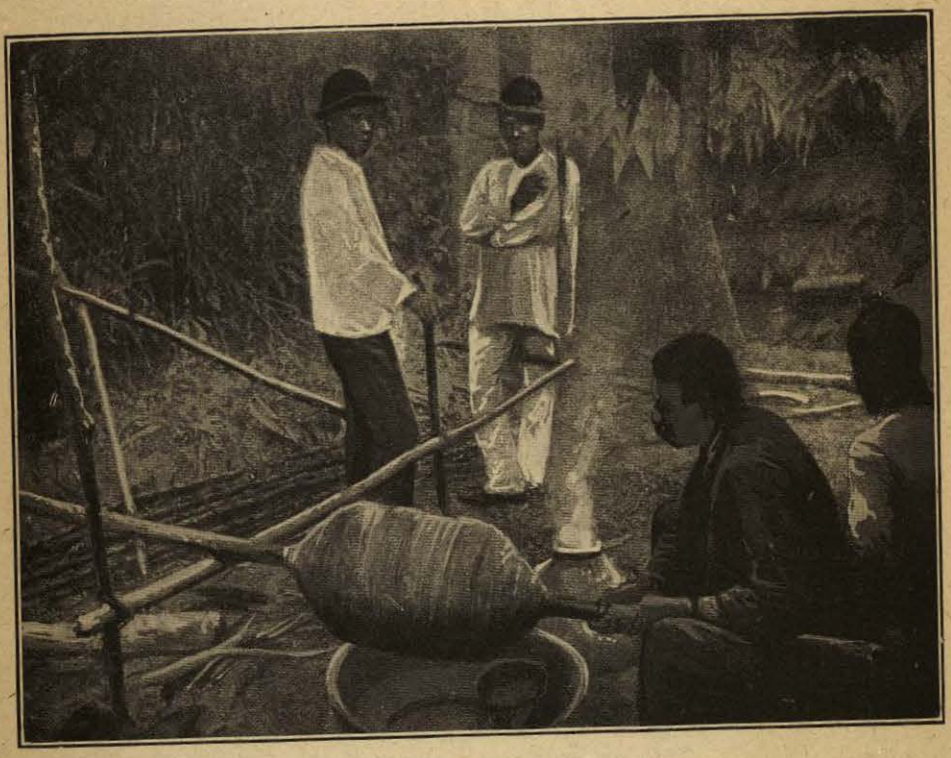

Fig. 4.

generally recognised system of classification could be agreed upon, the outcome of such disputes would be different. Finally, only about 70 per cent. of the latex collected from *Hevea*, etc., is converted into smoked Para. The remaining 30 per cent. cannot be smoked, either because rubber has already separated from it spontaneously in the various receptacles, or because the latex has coagulated while flowing from the tree-trunk. The rubber obtained in this way is merely pressed together into masses, which acquire a dark outward appearance owing to superficial drying, and come on to the market packed in casks as Negroheads, Sernamby, and, in the case of certain kinds, as Cametas. According to the latest accounts,

Cametas in particular are derived from rubber-trees which have become so badly scarred that it is no longer possible to extract the latex in such a way that it can be smoked. The product obtained in this way not only contains more water, but is a good deal more impure than smoked Para, owing to its having coagulated on the tree. In addition to particles of bark, sand is also an objectionable impurity in these unsmoked kinds of *Hevea* rubber. Still, when they

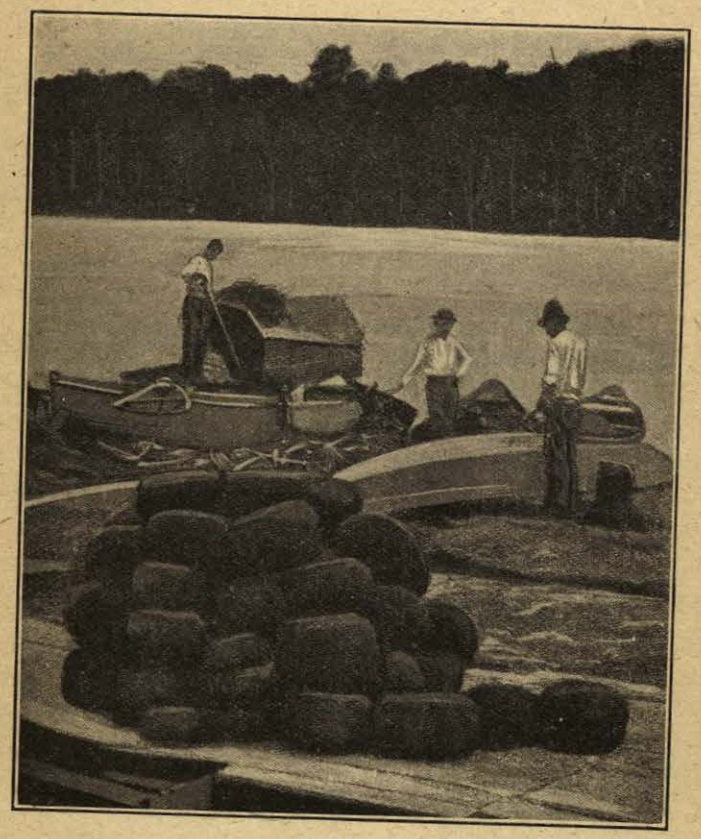

FIG. 5.

have been carefully cleansed, even these lower grades of rubber are very useful.

A peculiar kind of *Hevea* rubber is "Mattogrosso Para" or "Virgin Para" (not to be confused with the similar, but more impure, "Virgin Sheets"). It is probable that this rubber is derived from several species of *Hevea*; it is separated from the latex by the addition of alum or other substances, and comes on the market in large loaves with a pronounced cheese-like smell. "Virgin Para" gives a very light-coloured rubber when washed, and vulcanises quite as readily as ordinary Para. Unfortunately



"Virgin Para" has, as a rule, the drawback of containing the hard scales of beetles which have crawled into the rubber during the coagulating process, and these cause endless difficulty in the cleansing operations. Frequently they simply cannot be removed, and the use of Virgin Para for certain purposes must for this reason be, in general, excluded.

Fortunately, marked success has attended the efforts made to grow the valuable Brazilian *Hevea* in plantations, and to cultivate it instead of the unsuitable indigenous rubber-plants in Africa and Asia. The plantations in Ceylon and the Malay Peninsula already play some part in the actual production of rubber. On the plantations, however, the rubber is not as a rule prepared from the latex by smoking, but is separated by mechanical means. In order to prevent premature coagulation of the rubber the vessels are partly filled with water before use. The collected latex is filtered through sieves, before undergoing further treatment, and is then allowed to stand until the rubber-yielding substance has separated as a cream on the surface. The cream is freed from the greater part of its occluded water by a gradually increasing pressure, and is then rolled or pressed into thin sheets, which are converted by slow, carefully controlled drying into the wonderfully pure product which is now known and valued under the name of "Ceylon Para." It has now, however, become the general practice to wash and dry the product on the plantations, by methods similar to those in use in rubber-goods factories. However, the last word on the preparation of rubber on the plantations has not yet been said. In comparing the plantation Para produced so far, with South American Para, it must, of course, not be forgotten that there are no 150-year old Heveas to deal with as yet on the plantations, as there are in the Amazon district. The speed of vulcanisation of plantation Para is the same as that of ordinary Para.

The Brazilian province of Ceara also produces, from its dry stony soil, a rubber-tree—the *Manihot Glaziovii*—belonging, like the Heveas, to the *Euphorbia* family. Rubber is obtained from the Manihot by making an incision in the bark, and allowing the latex to flow out and to coagulate without attention, partly on the tree itself, and partly on the ground. When the rubber is scraped up together, it is unavoidable that it should be badly contaminated with fragments of bark and particles of sand. Despite the presence of these impurities, Ceara rubber, which is also called in the trade Maniçoba (pr. Manissōba), after the Portuguese name for the *Manihot*, is a good, strong rubber, very useful for many purposes.

Its resin-content is very little higher than that of Para, and its speed of vulcanisation is very nearly as great. The inorganic constituents are relatively high in Ceara, the high percentage of magnesia being, apparently, characteristic of this kind of rubber.

The rubber from *Hancornia speciosa*, also a Brazilian product, is of very much lower value than *Hevea* and *Manihot* rubbers. The *Hancornia* grows in the provinces of S. Paulo, Bahia, Pernambuco, and Maranhao. Coagulation is effected by adding alum or sea-salt to the latex, or even by merely allowing it to stand until the rubber-cream separates. The cream is lightly squeezed and dried, but still retains a considerable quantity of water. In the trade the rubber obtained from the *Hancornia* bears the general name of "Mangabeira," but latterly one has come across more precise names such as Santos Sheets, Rio Sheets, Pernambuco-Mangabeira, etc. This *Hancornia* rubber is generally of a pale pink colour, and has a strong smell of Moselle wine. One particular sort only, Mattogrosso-Mangabeira, which has been on the market for some time, is almost white in colour, with the same wine-like smell. Mangabeira rubber contains about 6 to 12 per cent. of resins, and differs from Para and Ceara in exhibiting a marked sluggishness in vulcanisation, which necessitates the employment of higher proportions of sulphur and higher vulcanising temperatures.

Formerly opinions differed very widely as to the tree from which the so-called "Caucho" or "Peruvian ball" of commerce is derived. On the one hand, it was assumed that Caucho was yielded by *Hevea*, *Cameraria latifolia* and *Hancornia speciosa*,[1] whilst Henriques[2] brought forward grounds on which he himself doubted whether either *Hancornia* or *Castilloa*, which had been mentioned by others as a source of Caucho, occurred on the eastern slopes of the Andes at all. The present position is that Dr. Ule's recent journey of investigation has shown that on the one hand *Hancornia speciosa* does actually occur on the eastern slopes of the Andes, and is much more widely distributed than had been hitherto supposed, but that, on the other hand, Caucho is derived from a species of *Castilloa*, viz., *Castilloa Ulei-Warburg*.[3] This fact explains the great similarity between "Peruvian" and "Ecuador balls" and "slabs," of which latter the source was long ago shown

[1] See Franz Clouth, *Rubber, Gutta-percha, and Balata*, Leipzig, 1899, p. 78. Translation, London, 1903, p. 90.

[2] *Der Kautschuk und seine Quellen.* Dresden, 1899, p. 13.

[3] *Gummi-Zeitung*, 1905, xix. p. 962.



to be a species of *Castilloa*. The similarity spoken of is not limited to external characteristics, but extends to the chemical composition and the speed of vulcanisation of the rubber. The only surprising thing is that, according to statements which formerly were frequently made, the Caucho-Castilloa cannot stand even careful tapping, but is completely destroyed by it, this being proffered as an excuse for felling the Caucho trees, a usual practice in Peru and Western Brazil, whereas *Castilloa elastica* stands tapping very well, and is tapped in plantation-fashion over a considerable area in South and Central America. The latex of the Caucho tree is mixed with the sap of the *Sachacamote*, or with soapy water; the clots which separate are partly freed from water and pressed together, the balls so obtained being bound round with strips of raw rubber, thus giving to the Caucho of commerce its characteristic outward appearance. It is asserted that cutting down the Caucho trees would not necessarily lead to their extermination, since the stump would very rapidly throw up shoots, develop new branches, and in a few years in the place of one felled tree a group of trees would be found.[1] In spite of its abominable smell and the dirt which it contains, and from which it is not easily freed, Caucho is a very valuable rubber. Its resin-content is low, its speed of vulcanisation only slightly less than that of Para sorts. In contradistinction to the latter and to Ceara, Caucho is very dark in colour, after normal vulcanisation to the stage of soft vulcanised rubber.

*Castilloa elastica*, mentioned above, with its numerous varieties, is found growing wild in all parts of Central America, and as far south as Peru in South America, and is already being extensively cultivated. When carefully prepared the rubber obtained from *Castilloa* is of quite a superior quality, containing little resin, light in colour, not unpleasant in smell, and having a high speed of vulcanisation. Unfortunately the methods of dealing with *Castilloa* latex are generally still so crude and uncleanly that the rubber produced for the most part lacks the good qualities which originally belonged to it. The amount of *Castilloa* rubber which comes on to the market, under the names West Indian, Ecuador, Guayaquil, Centrals, etc., is very considerable. It is to be hoped that the example of the planters in Southern Asia, who have obtained such excellent results, both as regards the quality of their rubber and financially, may serve as an incentive, and that we shall shortly have upon the market notable quantities of fine *Castilloa* plantation rubber.

[1] Clouth, *Gummi, Gutta-percha, und Balata*, 1899, p. 39. Trans., p. 56.

Within the last two or three years America has put on the market yet another kind of rubber known as Guayule. The North Mexican tableland produces a shrub—*Parthenium argentatum*, A. Gray, also known scientifically as *Synantherea mexicana*—in large quantities. The bark of the shrub contains no latex, but the cell-sap appears to contain the rubber-producing substance in suspension. The rubber is obtained from the plant in the following way:—The plants are dried, milled and pounded, then macerated with hot water, with or without the addition of caustic soda, the cream of rubber which floats to the surface being then sieved in order to remove as much as possible of the fragments of plant tissue. The sieved product is partly freed from water by pressure, made into the form of loaves, and packed in sacks. Guayule cannot, indeed, be completely purified, but forms at the moment, on account of its low price, a much-desired material, although its resin-content is very considerable and its pungent, aromatic smell cannot be destroyed.[1]

Whilst the greater part of American rubber is obtained from large trees, Guayule forming an exception, in Africa the vines of the genus *Landolphia* are at present the principal rubber-producers. Besides the numerous vine species, however, certain trees, in particular the species of *Kickxia* (*Funtumia*), play some part in rubber production; further, the rhizomes (undergound stems) of certain small shrubs, amongst them *Landolphia Henriquesiana*, Heim (formerly called *Clitandra Henriquesiana*, K. Schumann), yield the so-called herb- or root-rubber. Rubber-collection in Africa is still in a very primitive condition. In spite of all regulations and prohibitions, robbery of the trees, resulting in their destruction, is still largely practised. The methods of coagulation are still very varied. The latex is either allowed to stand, with or without previous dilution, until the rubber separates; or, to effect a rapid separation of the rubber, acid plant juices—for example, the juice of wild citrons, or Bossassanga-juice—are added; or the latex is sprinkled as it flows from the incision with an acid plant extract or with salt water, thus enabling the collector to draw away the rubber in the form of a thread or ribbon, which can then be wound up into a ball; or the negro smears the latex over his body, where it is allowed to dry, and is then rolled up into the form of balls or strips. Sometimes typical pieces of rubber are found in one and the same parcel, which clearly show that the individual native

[1] With reference to the future supply of Guayule rubber, see *Board of Trade Journal*, 11th June 1908.



collectors have employed quite distinct methods of collection. The quality of African rubbers varies very much even amongst parcels of the same origin. A cursory examination of the announcements of auctions published by the registered Antwerp brokers, which in every case give a correct idea of the condition of the lots coming under the hammer, is sufficient to show this. Unfortunately there is to be found against so many brands of rubber otherwise known as good, the warning: "*fort collant*" (very tacky); "*fort chargé de matière étrangère, de sable*"; "*en fermentation*," etc. (containing a large amount of foreign matter, or sand; fermented, etc.).

Generally speaking, African rubbers vulcanise a good deal more slowly than Para and Ceara, and require more sulphur—particularly the more resinous sorts—and higher vulcanising temperatures. The smell of the drier sorts of African rubber is, as a rule, quite tolerable, sometimes even pleasant; but the softer sorts generally possess a most unpleasant smell. The drier sorts usually give a much lighter-coloured sheet, after washing and drying in the factory, than do the softer kinds. There are only a few sorts of African rubber which are constantly of a very good quality, and amongst these should be named in particular the so-called "Massai niggers" of French Guinea and Sierra Leone, the "red" and "black" Kassai of the Congo, Equateur, Upper and Lower Congos, Lopori, etc.; and in the case of East African sorts, Mozambique "balls" and "spindles." In the case of Lopori, Equateur, and similar sorts of Congo rubber, considerable variations in quality no doubt occur, but the quality which is designated "Prime" from these sources is always pretty constant; at any rate the slight variations that do occur are of practically no importance in the case of goods vulcanised by heat. The medium and lower sorts of African have a very high resin-content. It may be mentioned that certain sorts of Madagascar rubber have the reputation of being particularly suitable for ebonite manufacture. In the Gold Coast colony, in West Africa, *Hevea brasiliensis* is also cultivated. In several of the African colonies Government regulations have been framed prescribing the planting of a certain number of rubber trees for every given quantity of rubber collected. If these regulations were strictly conformed to, the wholesale destruction in the African rubber districts, which was at one time feared, would be prevented. Such a long period must, however, elapse between the planting of the tree and the first tapping, that competent authorities fear that the total rubber output of Africa will drop during the next few years. Finally, rubber cultivation has been taken up in the Cameroons,