
Ecanda Rubber. (*Raphionacme utilis*, Brown & Stapf)

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No. 5.]

[1908.

XXVII.—ECANDA RUBBER.

(*Raphionacme utilis*, Brown & Stapf).

OTTO STAPF.

In 1906, Mr. C. E. de Mello Geraldès, Professor in the Instituto de Agronomia e Veterinaria at Lisbon, published in his "*Estudo sobre os latex borrachiferos*," pp. 143–172, an article dealing with a new rubber plant known in Benguela as 'Ecanda' or 'Marianga.' But it was only in the summer of the following year that the discovery became more generally known through a short abstract from Prof. Geraldès' paper published in *The India Rubber World* (vol. xxxvi., p. 300). About the same time, in July of last year, a portion of a tuber was submitted to Kew for identification by Mr. Spencer Brett on behalf of Messrs. Gow, Wilson & Stanton, Ltd. It was stated to yield good rubber, and to have been sent "from the neighbourhood of Lake Nyasa." The tuber was made out to belong most likely to the Asclepiadaceous genus *Raphionacme*. Later on in the year Kew received from the Companhia de Moçambique a number of healthy specimens of 'Bitinga Tubers' or "Tubers of the plant from which the 'Bitinga' Rubber is extracted." They were evidently identical with the tuber communicated by Mr. Brett and stated to have come from West Africa. The tubers have been grown in the Royal Gardens and one of them flowered early in March of the present year. Although it is proposed to figure and describe the plant in the Botanical Magazine, it seems desirable in this place to give a preliminary description and a general account of the plant and its properties.

The 'Bitinga' plant agrees very well with the description and figures given by Prof. Geraldès, of the 'Ecanda' plant, and there is practically no doubt that they are identical. It is a new species of *Raphionacme*, nearly allied to *R. Welwitschii*, Schlechter & Rendle, a native of Central Angola, and is described below as *Raphionacme utilis*, Brown & Stapf. It differs from all the rubber

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plants already known in so far as it is a dwarf herbaceous plant with a fairly large subterrestrial tuber abounding in caoutchouc. As practically all our knowledge concerning the distribution, properties of the plant, and the process of working it, is at present confined to what we may learn from Prof. Gerald's article, a translation of the more important paragraphs is given here.

"The interest attaching to the 'Ecanda' or 'Marianga' rests not only on the fact that we have to deal here with a new species and moreover one which is morphologically different from all the other known rubber plants, but also, and more especially, as I believe, on its capacity of producing first-class rubber and the facility of working it, in which respect it has no rival.

"The 'Ecanda' is a herbaceous, stemless plant with a tuber-shaped root fairly large and rich in latex.

"From experiments made in the interior of Benguela in order to find out the best process for the preparation of Ecanda rubber, I came to the conclusion that the only rational and practical method is by crushing the roots and treating the latex thus obtained by one of the processes of 'lato-borrachificação externa' (coagulation of the latex after extraction). It is evident that the method of first extracting the latex very much simplifies the preparation of rubber and clearly results in considerable economy. The 'Ecanda' or 'Marianga'* is found in the treeless, sandy and alluvial tracts (anháras) of Bailundo and Bihé and the Xánes (sandy and treeless tracts) of the region between the rivers Kwanza and Zambese (Ganguellas), the home of the Otarampa (*Carpodinus chylorrhiza*).† Those tracts occur locally, as a rule near the headwaters and along the banks of the rivers, occupying, sometimes, vast areas, and it is in their drier parts that the 'Ecanda' thrives. The altitude of the region where the 'Ecanda' grows is from 4,000 ft. (Ganguellas) to 5,500 ft. (Bihe).

"As stated, the laticiferous tubes of the 'Ecanda' are found spread all over the pulp of the root; at the same time the latex, being very concentrated, coagulates rapidly in contact with air. It is therefore not possible to extract it entirely from the roots by means of incisions.

"The extraction of the rubber direct from the roots necessitating, as it does, first prolonged boiling and then crushing, followed by repeated washing is not practical since, apart from the tediousness of the process, it implies necessarily the use of chemical agents in order to secure the complete separation of the caoutchouc from the pulp by the disorganisation of its tissues. And even so, unless dissolvents are used for the purification, the rubber remains somewhat impure as may be well imagined.

* 'Ecanda' is the name by which the species (which occurs in Bailundo and Bihe) is known to the Bailundos and Bihanos, and it is, I assume, identical with the species known to the Lutzases (Ganguellas) as 'Marianga.'

† I suppose that the 'Ecanda' also occurs in the Xana of Xifumage (an affluent of the Zambese which I have crossed) a vast, treeless, sand and humus plain to the north-east of the district of Benguela. But when I traversed it, the natives had set fire to it as they are used to do, and the whole vegetation was destroyed.

"But to my great satisfaction I made sure that it was possible to extract the latex of the 'Ecanda' (although mixed with the sap of the roots) with great ease by means of simply crushing the roots. To extract the latex proceed as follows:—After having washed the roots well, cut them into several pieces at a right angle to their greatest diameter and subject them to a slight pressure in a copying press. When the liquid ceases to flow raise the top of the press, turn the pulp and subject it anew to slight pressure. Repeat these operations as long as the liquid comes out yellowish and without streaks of white, that is to the point when the latex is completely extracted and only root sap continues to flow.

"To obtain this result it is necessary to extract from the roots, on the average, 77·7 per cent. (of the weight) of the liquor; hence the latex is much diluted (1·5 per cent. of the liquid extracted from the roots should on the average be pure latex). Having found a practical process for extracting the latex, I tried now to determine the best method for coagulation.

"I obtained good coagulation with alcohol or brandy whenever the latex was not very much diluted. This process is evidently not economical as the coagulating agents are dear. . . .

"Acetic acid, sulphate of aluminium and potassium, phenol and chlorate of sodium do not act on the latex diluted with root sap. . . . Other coagulating agents I was not able to try. . . . It is, however, probable that coagulation of the latex of 'Ecanda' may be obtained with other agents, even when it is diluted with root sap.

"The process of skimming leaves much to be desired, since, in my experiments, I have never succeeded in extracting by this method more than half of the caoutchouc contained in the latex . . .

"I also studied the effect of heat on the liquid obtained by pressing the roots of the 'Ecanda.'

"If the liquid is subjected direct to the action of fire, a skin forms on the surface, like that on boiled milk, consisting of caoutchouc. If this skin is removed in the measure as it forms, its production ceases after some time, and when at length the liquid is completely evaporated, a copious yellow and viscous residue is left.

"By substituting a hot bath for direct fire and proceeding in the manner just described, there also remains a yellow and viscous residue, but it is less copious. In this way I obtained a greater percentage of caoutchouc which was of greater elasticity than that produced by coagulating direct over fire.

"Thus by using heat as the coagulating agent I always obtained beside the caoutchouc a more or less copious residue of a yellow and viscous substance. Now, it is well known, that generally caoutchouc, if subjected to temperatures above 35° C., gradually loses its elasticity, and turns viscous, until at 170° to 180°C. it is converted into a thick liquid much resembling molasses. Therefore, it might be supposed that the residue mentioned above also consisted principally of resinified caoutchouc. .

"My suspicion was confirmed when treating the latex by a mixed process of skimming and spontaneous desiccation.*"

"By this method I obtained a much higher percentage of rubber and only a small residue, consisting likewise of a yellow and viscous matter. However, the rubber was less elastic than that obtained by coagulation in the hot bath. This is not surprising, seeing that the rubber prepared by the latter process contains all the components of the latex and the root sap (excepting the greater part of the water), and, besides, I had not been able to strain the liquid, having no metal net nor adequate strainer with me.

Processes employed.	Percentage of raw rubber per cent.		Loss by drying per cent.
	Green.	Dry.	
Coagulation over fire	2.90	1.870	35.50
" in the hot bath	3.54	2.415	33.09
Skimming and spontaneous desiccation	13.00	6.360	51.60

"In order to determine the percentage of pure caoutchouc obtained by these processes, I analysed the samples of 'Ecanda' rubber prepared in Benguela, in the chemical laboratory of the Instituto de Agronomia e Veterinaria, with the following results:—

RUBBER OBTAINED BY COAGULATION IN THE HOT BATH.

Caoutchouc	88.025 per cent.
Resins	4.725 "
Substances soluble in water	1.100 "
" " in alcohol at boiling point	1.300 "
Water	1.082 "
Impurities not determined	3.768 "

RUBBER OBTAINED BY SKIMMING AND SPONTANEOUS DESICCATION.

Caoutchouc	71.925 per cent.
Resins	3.300 "
Substances soluble in water	2.950 "
" " in alcohol at boiling point	1.385 "
Water	3.154 "
Impurities not determined	16.926 "

* To extract the rubber by this method I proceeded as follows:—I poured the liquid obtained by the crushing of the 'Ecanda' roots into enamelled iron dishes so as to form a layer 1 cm. thick. After a while in every one of the dishes and adhering to their sides a skin of rubber formed on the surface of the liquid. This skin I removed, and so I went on for two days—the duration of the experiment—new skins continuing to form, but every time less thick. Then the production of skins ceased. But to make sure whether the liquid still contained caoutchouc I left it in the dishes until the evaporation was complete, which was the case five days after the commencement of the experiment. As the dishes were exposed to the air, and the latex somewhat caught the sun, I believe that the little yellow and viscous residue which formed consisted to a small extent of resinified rubber.

"Thus I obtained by coagulation in the hot bath 2.125 per cent. of chemically pure caoutchouc, calculated from the weight of the fresh root, and by the mixed method of skimming and spontaneous desiccation 4.574 per cent. of pure caoutchouc; that is, I obtained by the latter process more than twice the quantity of pure caoutchouc than by the first.

"It follows, therefore, that, of the processes which I tried, it was the process of skimming and spontaneous desiccation by which I obtained the best result. The great drawbacks inherent in that method are, however, aggravated when it is applied to the treatment of a liquid resulting from the crushing of the Ecanda root, and that makes it hardly practicable.

"Indeed, as in this case a much diluted latex has to be dealt with, its coagulation (1) requires, *ipso facto*, much time; (2) implies the use of a great number of recipient vessels; and (3) necessitates a very spacious installation. Moreover, as the latex is not pure, but a mixture of latex and sap, (4) the rubber turns out very impure, the normal constituents of the latex being precipitated together with the substances which were dissolved in the sap of the 'Ecanda' root.

"No doubt points 1-3 could be improved upon by using for skimming and evaporating very porous earthen pans and keeping the liquid at a relatively high temperature; but the disadvantage mentioned under (4) is fundamental . . . Possibly better results will be obtained with chemical coagulents with or without the aid of heating . . . But in my opinion the really practical method of preparing the 'Ecanda' rubber should consist in the centrifugalisation of the liquid obtained by the crushing of the roots. As there was no centrifugal machinery in Benguela I was, to my great regret, unable to try that process."

It would appear that Mr. Gerald's experiments with 'Ecanda' rubber stimulated some Bihanos (inhabitants of Bihé) to prepare 'Ecanda' rubber themselves, and some of it was actually on the market. Prof. Gerald's describes two of their methods and gives analyses of a sample obtained by one of them:—

"The first method is as follows: They cut the roots into slices, and then expose them on the soil to the action of the sun. In this way the exuding latex is converted into rubber by desiccation and partly also by absorption of its serum through the soil. They thus obtain pieces of a mixture of rubber and soil out of which small cylinders (*mutáres*) about 12 cm. by 1.5 cm. are made, or small balls which they join in clusters of 4 or 5, and those clusters are also called *mutáres* (as it were fingers). The *mutáres* produced in this way have as a rule a good external appearance, but within they contain a great deal of earth which, apart from greatly depreciating the quality of the rubber, has the inconvenience of making them excessively heavy.

"I analysed several samples of *mutáres* prepared by this method which I brought from Benguela to the Institute.

						Average Composition per cent.
Caoutchouc	...	...	...	...	...	45.81
Resins	...	...	...	...	...	1.50
Substances soluble in boiling alcohol	...	...	...	...	...	1.27
Substances soluble in water and impurities	...	...	...	...	...	51.42

"Samples from the same origin, but previously dissolved in carbon bisulphide and filtered through a cotton filter, gave the following result :—

						Average Composition per cent.
Caoutchouc	...	...	...	...	...	92.640
Resin	...	...	...	...	...	3.570
Substances soluble in alcohol at boiling point						2.825
Substances soluble in water	...	...	...	...	...	0.965

"The other method is still worse. It is as follows : the roots are boiled and then pounded in a mortar. The mass thus obtained is washed out with cold water to eliminate the pulp, and then put in boiling water in order to become workable. Of this mass (which, of course, is still contaminated with a great percentage of pounded vegetable matter) they make mutáres analogous to those described above.

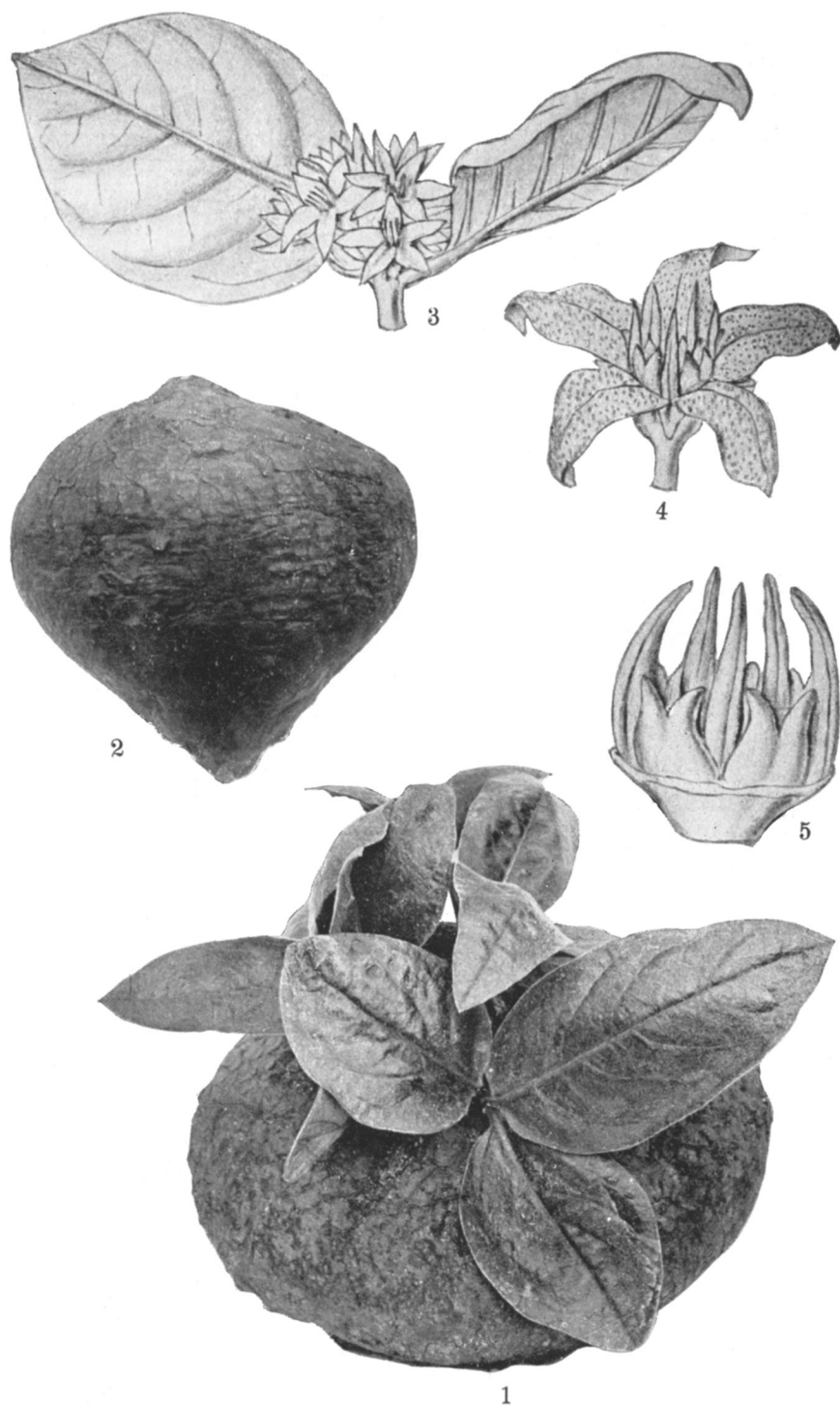
"This process is—as may well be imagined—much worse than the other, considering that the rubber remains contaminated with a great deal of organic matter which easily sets up fermentation and deteriorates the rubber."

Prof. Geraldès also touches the very important point of the rate of growth of the 'Ecanda' tubers. On p. 148 he describes the plants as "biennial (?)," and adds in a foot-note : "one-year old roots which I examined (in the fruiting state) had a diameter of 8-10 cm. (about 3-4 in.), and weighed 200-300 grammes (7-10½ oz.); the larger tubers which I saw and which were at least two years old measured 12-14 cm. (4½-5½ in.) across and weighed 400-600 grammes" (14-21 oz.). There is no evidence that Prof. Geraldès raised plants from seed, for he would no doubt have mentioned the fact had he done so, and his estimate of the age of the tubers measured and weighed rests, apparently, entirely on assumption. *A priori* it appears very improbable that the 'Ecanda' plant should flower in the first year of its growth, or that its tubers should attain the dimensions given above in so short a time. In any case this point demands close examination, as the productiveness of an 'Ecanda' plantation would to a great extent depend on the rate of growth. Prof. Geraldès' calculations of the yield of 'Ecanda' plantations have therefore to be taken *cum grano salis*, and appear in any case far too optimistic. This is what he says on p. 168 :—

"1. If roots one year old are worked, one hectare (nearly 2½ acres) might yield 111,111 'Ecanda' plants, weighing 27,778 kilos (about 27 tons), and producing 125 kilos (nearly 2½ cwt.) of caoutchouc (chemically pure and dry), or a gross return of 312 dols. 500 reis per annum.

"2. If only two year roots are worked, a hectare might yield 83,333 'Ecandas,' weighing 41,666 kilos (about 41 tons), and producing about 200 kilos of caoutchouc (chemically pure and dry), or a gross return of 520 dols. 830 reis per annum."

At present there are about 20 species of *Raphionacme* known, nearly all of them natives of Tropical Africa south of the equator.



Raphionacme utilis, *Brown and Stapf*.

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They are all small herbs, from a few centimetres to one metre high, and in many cases are known to possess a tuberous rootstock like that of the 'Ecanda' plant. Five species are recorded from Portuguese West Africa, whilst four occur in Nyasaland, and one each in Bechuanaland (and Rhodesia), the Bahr-el-Ghazal, and in Sierra Leone.

Description.

Raphionacme utilis, *Brown et Stapf*; affinis *R. Welwitschii*, Schlecht. et Rendle, sed planta nana foliis latioribus approximatis rosulatis, corona subbiseriata, i.e., lobis lateralibus contiguis per paria in squamam bifidam connatis et lobum intermedium extus leviter imbricantibus.

A perennial herb with a turnip-shaped tuber, up to 4 in. high and 2-5½ in. in diameter, with a dark brown, scaly bark. Stems solitary, erect, herbaceous, 1-4 in. long, fulvo-puberulous. Leaves in 2-5 pairs, forming in the wild state, according to Geraldès, a rosette close to the ground, spreading, broad-ovate or elliptic to suborbicular, obtuse, apiculate, 1½-2 in. long, 1¼-1¾ in. broad, rounded to subcordate at the base, sparingly puberulous on both sides, green above, bright purple below; petiole ½-¾ in. long. Flowers in terminal and axillary, sessile, crowded, fulvo-pubescent cymes; pedicels up to ¼ in. long; bracts linear, up to ⅙ in. long. Sepals lanceolate, acute, 1½ lin. long, puberulous, purplish with green tips. Corolla bright purple, about ½ in. in diameter, very deeply 5-fid, lobes very minutely puberulous on the back, glabrous on the face; lobes oblong, subacute with recurved margins. Corona subbiseriate; outer (epipetalous) corona of 5 bifid scales, 1 line long, white with bright purple-tipped teeth, inner (episepalous) corona of 5 subulate, acute lobes, ⅙ in. long, the sides covered at the base by the outer scales, dark purple, much exceeding the stamens. Follicles (Geraldès) broad spindle-shaped, acuminate, up to 4 in. long. Seeds about 50 in each follicle, about 4 mm. long with a coma, 15 mm. long.

EXPLANATION OF THE PLATE.

1. A large tuber, 5½ inches in diameter, with leafy shoots, growing in the Royal Gardens, about half natural size.
2. The 'Ecanda' tuber as imported. Half natural size.
3. An inflorescence produced in the Royal Gardens. Natural size.
4. A single flower. × 3.
5. The details of the corona of the flower. × 6.

Figures 1 and 2 from photographs, 3-5 from photographs of drawings by Miss M. Smith. All the photographs by Mr. C. P. Raffill.
