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João Barbosa Rodrigues: lore and practices

João Barbosa Rodrigues and "Queen Rubber": An innovative scientific culture

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Abstract

This work presents the history of rubber in the Amazon based on an article by João Barbosa Rodrigues. In his text, he emphasized the age of the traditional knowledge used by the native populations in the Americas to produce the various objects made from rubber. He showed how European scientists based their studies on that knowledge to understand rubber and expand its use. In his analysis of the exploitative production process that was introduced in the Amazon region, Barbosa Rodrigues presented the indigenous production methods, which have never been surpassed. He contrasted them with the social degradation to which those native populations were submitted, as well as the damage done to the environment, which the native populations had previously preserved. He concluded that far from being a mere condemnation of the violent process of colonization, his work was designed to promote continued rubber development. He defended cultivation in line with ecological principles that would preserve the environment, while also allowing those who held knowledge of sustainable production processes, as they are now called, to return to their self-supporting lifestyles. Barbosa Rodrigues proposed a new, and previously unknown scientific culture for development in regard to societal organization and production of wealth.

Key words: Amazon, Barbosa Rodrigues, environmental preservation, rubber, traditional knowledge.

Resumo

Este trabalho, apresenta uma história da borracha na Amazônia, partindo de um artigo de João Barbosa Rodrigues sobre o tema. No texto, ele chamou a atenção para a antiguidade da tradição dos conhecimentos sobre a produção de diversos objetos de borracha, feitos pelos índios da América. Mostrou o quanto a ciência europeia pautou-se naqueles conhecimentos para entender a borracha e expandir o seu uso. Ao analisar o processo exploratório introduzido na Amazônia, Barbosa Rodrigues discutiu os modos de produção do índios – nunca superados – contraposto à degradação social a que foram submetidas aquelas populações e a natureza, que até então haviam sabido preservar. Conclui-se que o seu trabalho, longe de ser uma mera acusação ao modo violento do processo colonizador, foi um projeto para continuar explorando a borracha, prevendo o seu cultivo agrícola, sob princípios ecológicos que preservassem o meio e, ao mesmo tempo, devolvessem a vida autônoma aos detentores dos conhecimentos de um processo produtivo sustentável, como se diz hoje. Barbosa Rodrigues propôs uma nova e, então, inédita cultura científica para exploração do meio relativa à organização da sociedade e à produção da riqueza.

Palavras-chave: Amazônia, Barbosa Rodrigues, preservação do meio, borracha, conhecimentos tradicionais.

Introduction

"The knowledge and use of elastic gum date back to ancient times." This statement opens the article by Barbosa Rodrigues about rubber that inspired this work. It means that societies have always learned to study nature, particularly plants, and to develop their qualities and social uses (Crosby 2011). The practical application of this knowledge and the objects derived from it have been passed down through the centuries and are still with us today.

In 1899, João Barbosa Rodrigues (1842-1909), then the Director of the Rio de Janeiro Botanic Garden, was tasked with providing information about "elastic gum," to the Minister of Foreigners of the Republic of San Salvador by

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the Minister of Roads and Public Works, Severino Vieira. He agreed readily, saying that he would take advantage of the opportunity to answer many requests he received to speak about the matter.

He noted that he would divide the work into chapters, in order to facilitate the study. He also noted that it would be impossible to exhaustively cover this matter, and in response to the request from Minister from San Salvador, he would only cover *Heveas*, leaving aside *Maniçoba, Mangabeira* and other species, which were already being developed at that time. This document was published the following year under the title: 'As Heveas ou seringueiras – Informações*'* (The Heveas or rubber trees – Information) (Rodrigues 1900).

In 1992, Barbosa Rodrigues was honored at the Botanic Garden on the occasion of its 150th anniversary with the republishing of two of his texts in a single copy: 'A botânica, nomenclatura indígena e seringueiras' (Botany, indigenous nomenclature, and rubber trees) (Rodrigues 1992). One of these texts had been written for the Minister of San Salvador, published in 1900, by *Imprensa Nacional.* The other one was published in 1905 by the same publisher and was entitled '*MBAÉ KAÁ – Tapyiyetá Enoyndaua ou A Botânica – Nomenclatura Indígena'* (MBAÉ KAÁ – Tapyiyetá Enoyndaua or Botany – Indigenous Nomenclature)[1]. The latter was presented in 1905, the same year it was published, at the 3rd Latin American Scientific Congress held in Rio de Janeiro. On that occasion, Barbosa Rodrigues was the Director of the Rio de Janeiro Botanic Garden and honorary Vice-President of the second congress with the same name that had been held the previous year in Montevideo, when he had been the President of the Physical and Natural Sciences Section.[2] As a result, he had extensive international scientific ties.

When Wanderbilt Duarte de Barros, then Director of the Rio de Janeiro Botanic Garden, presented the book in 1992, he justified the republishing of these two texts by stating it was designed to surround the event with honors for the memorable scientific production of Barbosa Rodrigues, which had paid tribute to Brazilian culture. The objective was to provide readers an opportunity to appreciate the position of this naturalist, which varied from a practical vision, whose roots were related to ecology, up to the limits of ecological pragmatism, based on the production of what can be obtained in work with plants. He also affirmed that the choice of the two studies resulted from the nature of the approach used by Barbosa Rodrigues to examine these two major topics (Barros 1992).

The common thread of the approach to these two topics that Wanderbilt de Barros spoke of was the high regard for indigenous knowledge of plants and the local environment. In both works, but with more emphasis in Indigenous Nomenclature, Barbosa Rodrigues demonstrated the in-depth botanical knowledge held the Indians, whose classifications referred to their nature and their uses.

The text first published in 1905, presenting the view of indigenous Botany, was published again in 2018 (Rodrigues 2018).[3] In that edition, as well noted by Sergio Besserman, then President of the 200-year-old Rio de Janeiro Botanic Garden, "[the topic in question] echoes in us the call of the wild which, instead of sending us to our primitive past, indicates a future. This is a future that has already been among us since the beginning, which we have systematically refused to see until now."[4] This idea was very well translated in the title, and consequently in the important text by Fabio Rubio Scarano, which opens that book: '*No caminho de Barbosa Rodrigues – Diálogo entre conhecimentos'* (On the path of Barbosa Rodrigues – Dialogue between knowledge).

The text on rubber, which was only republished in 1992, had been written for political purposes and fulfilled its goal. Barbosa Rodrigues presented a historical summary of botanic knowledge of rubber and its use by the oldest societies from the Orient to the Americas, specifically Brazil. He spoke about contact between the Indians and the colonizers in the Americas, when the latter learned of the many uses for the elastic gum objects produced. He spoke of the international economic trajectory of *Hevea*, until it became one of the most exported products from Brazil at the end of the 19th century, and one of the most sought-after in the industrial

[1] In the 1992 publication, the original page numbers for each text were maintained.

[2] Information on the participation of Barbosa Rodrigues at these congresses can be found on the title page of the 1992 publication, mentioned above. For information on scientific congresses (Almeida, 2011).

[3] This book contains excellent illustrations by young Guarani Indians from the Pyau village.

[4] Besserman, lucidly calls our attention to the holistic viewpoint of indigenous thinking about the forest, expressed in the text by Barbosa Rodrigues, showing that it is crucial to preserve the forests, since "the threat is not the jungle, but the omnipotent, narcissistic and impossible pretension to be civilized without recognizing that the forest is us, that it is in us."

revolution. At the same time, he vehemently criticized the terrible working conditions to which rubber workers were subjected, as well as the harm done to the environment. He underlined the importance of traditional knowledge, which developed products without threatening the survival of species, since they had learned that production and preservation of nature went hand-in-hand. Thanks to this knowledge, rubber had been developed and evaded extinction for centuries, as had the local populations.

That resistance of the species had been put to the test by the clash of cultures configured by the European colonization of the New World. Colonists began appropriating land, with everything on it - people, plants, animals, minerals – for social and economic domination, and for the scientific knowledge that was already institutionalized. Troublesome social relationships appeared. On the one hand, development of nature awakened the curiosity of scientists-naturalists, but on the other hand, it strengthened the greed of colonizers, who then politically and economically structured still incipient capitalist relationships in the New World. Scientists and colonizers engaged in sophisticated scientific and technological studies on rubber that resulted in numerous social uses, raising it to the highest levels of economic importance, making it an essential element of the so-called industrial revolution; its success continues to this day (Dean 1989: 45). This led to a contradiction, since at the other extreme, the holders of knowledge, as well as the workers aggregated to the production process, were relegated to the lowest and most degrading social levels. This contradiction was the key to the study by Barbosa Rodrigues.

Colonization of rubber in America

According to Barbosa Rodrigues, waves of Asian immigration to America brought with them objects made from rubber to the Americas, and they were used in games. In Mexico, archeological studies have found traces practically everywhere in the country. They were introduced by the Nahuás (the Aztecs) who disseminated ball games as part of their sacred ceremonies and sold them to different groups in the country (Domingues & Carrión 2021).

At one point, some of the Nauhás emigrated to South America, going down the Amazon River, where they were given different names: Nauhud, Moguá, Omauá and Omagua. When they fought with the Tupis, who lived along the banks of the Amazon, the Tupis called them *Cambebas*, or "flat heads", as said Barbosa Rodrigues (1900). The Omaguas passed their knowledge of elastic gum and its uses to the colonizers of the Amazon.

Using the method inherited from their ancestors of coagulating the milk from those trees, the Omaguas created different objects for domestic use, such as containers, balls, buckets, and flasks for storing drinks. Important among these objects was rubber, used in their celebrations and for their illnesses. According Rodrigues (1900), due to the frequency with which they were used, the Portuguese later gave the tree that produced the milk the name of *Pau seringa* or *Seringueira,* and they called its product *seringa*. The Omaguas that were taken to Peru by Spanish Jesuit missionaries encountered the *Castilloa elastica*, which they also called Ulé or Caaochô, from the Tupi language. This word spread throughout the world in several forms: Spanish - caotchu; French - caoutchouc, Peruvian - caocho. The English called it Pará rubber. In turn, the Portuguese used small flasks made of leather to hold liquids, which they called borrachas; upon seeing the same type of object used by the Indians made of elastic gum, began to also call them borrachas (rubbers); this name was later given to the substance they were made of.

For a long time, said Barbosa Rodrigues (1900), only the Indians used elastic gum; although it had been known since the 16th century, no one else knew where it was extracted or how it was prepared. News of rubber first arrived in Europe in the accounts of voyagers. In the sixteenth century, Cortez noted that the Aztecs in Mexico played with a hard elastic ball; Pedro Martyr and Juan de Torquemada mentioned the elastic material, used by the inhabitants of the 'New Indies', in their accounts (Minguet 1981: 15; Domingues & Carrion 2021).

In the 18th century, in the midst of the colonization process, the Portuguese missions in the Amazon region sent the region's products to Europe. Around 1820, elastic gum was sold in Europe in objects prepared by the Indians, such as 'seringas,' flasks, and an innovation, which were waterproof objects, such as backpacks for soldiers or shoes for missionaries. The latter began to be made directly with elastic gum, using clay molds, which were then broken. This was the beginning of rubber exporting. In England, elastic gum was initially only used to erase pencil marks on paper, which led to the name *Indian Rubber*; taken from *Ficus elastica Roxb.* (Rodrigues 1900: 10).

The appropriation of rubber objects by colonizers was not homogenous in the Americas. In fact, if we compare Brazil and Mexico, we see that the first impact of colonization in elastic gum producing regions was different. In Brazil, the colonizers loved rubber objects and immediately tried to trade for them with the Indians and introduce them on the international market. However, in Mexico, the use of a rubber ball called the *péla* in sacred games, a long-rooted part of Mexican culture, was considered witchcraft by the Spanish missionaries; this set the traditional populations apart from the colonizers (Domingues & Carrion 2021). However, elastic gum was also widely sold in Mexico (Rodrigues 1900:8).

Hevea played a special role in this process. It was the product, not the plant, that first reached Europe, awakening scientific curiosity and greed among merchants. This curiosity grew in the 18th century, when Charles Marie de La Condamine sent samples of that strange material to the Academy of Sciences of Paris, announcing the scientific and economic potential of rubber. During his expedition in the equatorial region, seeking to reject Newton's theory that the Earth's equatorial radius was larger than its polar radius, La Condamine observed the exuberance of nature with amazement and wondered what would happen if the 'virtues' attributed to those plants by the local inhabitants were examined. (La Condamine 1745; Safier: 2010) After a long scientific journey (1735-1745) through the Brazilian, Peruvian and Guyanese Amazon, Newton beat the French in the battle of Astronomy, and La Condamine returned with his suitcases full of revolutionary geographical, botanical, zoological and ethnographic knowledge (Domingues & Carrion 2021).

La Condamine sent samples stored in rolls to the Academy of Sciences in Paris, along with information on the uses of the plants from which the dark resinous material was extracted. Those samples were accompanied by *An Account of Rubber,* in which he noted that indigenous people used it to make very resistant bottles and containers, boots, and even hollow balls which collapsed when kneaded, then returned to their original shape. In the trip report, presented to the Academie des Sciences on his return to Paris in 1745, he stressed that the everyday use of certain plants was extraordinary. He explained that when *cahuchuc* was recently collected, with the resin still fresh, it could be molded however one wanted. The plasticity and impermeability of rubber were extraordinary (La Condamine 1981: 75).

This beginning was followed by a intensive botanic studies on the different species of the genus *Hevea*, of the Euphorbiaceae family. Heveas are majestic trees, with few branches at the top, which reach heights of 30 to 40 meters, and have diameters of around one meter (Rodrigues 1900: 27).

In France, in 1781, Jean-Baptiste Fusée Aublet published a description of a tree producing rubber, native to Guyana, and named it *Hevea guianensis* Aubl. without realizing its relationship to the sample sent earlier by La Condamine, said Rodrigues (1900). In the same year, Jean-Baptiste Lamarck analyzed a dry species suspected to be different from what was classified by Aublet (Dean 1989: 32). On the other hand, in 1785, Richard described it using the name *caoutchouc* and D. Jo. Christiano Dan. Schreber (1789) proposed a different genus from that of Aublet and called it *Siphonia*. Willdenow changed it to *cahuchu*. *Siphonia* was a common name, even though rubber belongs to the genus *Hevea*. *Siphonia* was a synonymy.

By 1810, the Austrian botanist Franz Sieber, passing through Belém, in the state of Pará, Brazil, obtained a specimen with flowers and sent it to the then director of the Berlin Botanic Garden, Carl Ludwig Willdenow. In Germany, the species already known as the rubber tree was given a scientific name by Willdenow in 1811: *Hevea brasiliensis* (Dean 1989: 33). In 1865, Johann Müller von Aargau confirmed the name *Hevea brasiliensis* and established this as the highest yielding species of rubber latex. For Barbosa Rodrigues (1900:21), the *H. discolor* (Spruce *ex* Benth.) Müll. Arg. and *H. guianensis* species were also rich in latex. In this botanical race, the rubber tree finally won a prominent place in the herbarium of the botanic gardens in Rio de Janeiro and Pará, Brazil, in Kew Gardens, England, and in the Berlin Botanical Garden (Domingues & Carrion 2021). Botany was a dominant scientific specialization until the middle of the 19th century (Domingues 1995).

Intensification of knowledge and exploration

From the end of the 18th century, the search for new products from nature led to increasing scientific studies throughout Brazil. An intrinsic part of colonization, scientific knowledge was

developed in the region, specifically in regard to the natural sciences, through exploratory expeditions that began right after the arrival of the Europeans in the Americas, and increased from the 18th century on, reaching its apex in the 19th century.[5] Networks were created to collect natural objects and send them from colonized locations to Europe, where they went to scientific institutions, such as natural history museums, botanic gardens, scientific organizations, national and international expositions, and encouraged innovation in agriculture and manufacturing. This process includes the institutionalization of science in the New World – the first natural history museum, today the National Museum, was founded in Brazil, in 1818. In the state of Pará, what is now called the Museu Parense Emilio Goeldi was founded in the 1870s, and reorganized in the last decade of that century, in reflection of the major scientific institutions of that age, by Emílio Goeldi, after whom it was named (Sanjad 2010). Scientists were the protagonists of that process, including Barbosa Rodrigues, who spent many years conducting studies in the Amazon.[6]

Expeditions to the Amazon had increased greatly since Humboldt's trip at the end of the 18th century, and they grew even more in the second half of the 19th century due to rubber, but also to the poisons, oils, perfumes, medicines, and countless other forest products that the indigenous populations used. Numerous scientific expeditions conducted extensive work in the Amazon. As Dean (1989) noted, since studies of the different types of rubber increased throughout the 19th century, competition surrounding the production process increased greatly. At the same time, due to their accelerated growth, Belém and Manaus were becoming major urban centers, standing out not only for the wealth they offered, but also for the number of economic transactions taking place there (Reis 1972).

At the same time as the expeditions and taxonomic studies, other studies appeared on the social uses of rubber. Barbosa Rodrigues (1900) noted some of these works, such as the one by the surgeon Macquer, in France, who experimented with rubber surgical instruments made from elastic gum and concluded that they were superior to those made from metal. In 1868, he presented a study to the Paris Academy of Sciences about tubes made from rubber (Barbosa Rodrigues uses the term *algalia*), justifying their benefits. These instruments were rapidly manufactured and brought enormous profits. In 1791, Grassart used elastic gum to make pipes, and Nadler used it in the preparation of wires.

Rubber development was so great that it became essential for the revolutionary steam-powered machinery as insulation in belts and bumpers between railway cars. Around 1874, it began to be used in telegraphic wire, and Brazilian exports exploded. That year England imported 58,710 kilos of rubber from the Amazon region, six times more than it had imported two decades before (Dean 1989: 30).

At the Goeldi Museum, botanist Jacques Huber, internationally recognized for his work with rubber, maintained contact with naturalists from other countries. Huber collaborated for a long time with English scientists, notably those from Kew Garden. At this time, England joined the fight for rubber production, and began studies to make *Hevea* farmable. Huber discussed the quality of the *Hevea* seeds, their germination, and acclimation with his colleagues from Kew, with a view towards planting them in other tropical countries, which they did.[7]

The taxonomic definition of the plants was no longer central. They were interested in the quality of the plants (whether they produced high- or low-quality rubber, in the case of the species *Benthamiana*) and the amount of gum that each species produced, mainly *Hevea brasiliensis* (Ducke 1934)[8]. Agriculture was of interest to the English, and in the early years of the 20th century, they had success on Asian plantations with seedds of "*Hevea brasiliensis*" that had been smuggled from Pará by a British botanist who had lived in the Amazon region for many years. (Dean 1989: 41). Huber visited those plantations, and his visits resulted in a consistent report; in other words, it was not only foreign institutions that were participating in this process. Barbosa Rodrigues (1900) promoted the growing of Heveas in the

[5] The bibliography on scientific trips in 19th century in Brazil is vast. For an overall view, see Losada *et al* 2013.

[6] For more information on the scientific achievements of Barbosa Rodrigues, see Sá (2001).

[7] Kew Gardens Archives, Box Brazil-Miscellaneous. According to these documents, between 1913 and 1916 there was an intense exchange of letters between several colonial entities from England and Asia, and with English representatives in Pará, Brazil, and Kew Garden.

[8] In addition to rubber, the English were also interested in cellulose, fibers, and coffee.

Amazon as a government policy, to maintain it as a source of wealth, minimizing problems associated with working conditions in the forest.

Promoting development while preserving

In almost unheard-of attitude at that time, Barbosa Rodrigues raised the flag in favor of local activities in the midst of the international scientific and economic euphoria seeking to learn more about natural products to obtain economic gain from them. In fact, rubber achieved such great value in the 19th century that it can be taken as a symbol of the colonialist exploitation process. Barbosa Rodrigues questioned the social and economic extent to which rubber production had reached; however, he did not criticize the scientific knowledge acquired, nor its economic value. He was seeking sustainability, "avant la lettre".

At that time, rubber production in the Amazon was unchecked, being conducted under extremely unregulated conditions. However, for Rodrigues, *Queen Rubber* had the strength to rule, although limited to a specific environment that only existed in very particular locations that he described, thereby configuring ecological principles.

In the case of *Hevea*, the best locations for its cultivation were hot, humid, swampy *igapós,* alluvial lands, with a certain clay content, enriched by the peat humus from flows and valleys (Rodrigues 1900: 24). Those plants lived together with other forest trees and were rarely found isolated on dry land. The study conducted by Barbosa Rodrigues about the environment and rubber trees was meticulous. He described the geographic location - the sub-equatorial region, where the substances necessary for their development and propagation existed; the large plains, the exact heat and the large forests in whose shade they grew. In regard to heat, he indicated the precise temperature that the air needed to be in relation to the soil; if there was an imbalance, the plant would die. In order for rubber trees to enrich those who planted them, they needed low terrain, rich in peat humus, which was very hot and humid.

He showed how the physical conditions of the soil acted on the plants. At the same location, there would be spaces where the light would be more conducive to growth than at another spot. In the Amazon Valley, the left bank of the river was a poorer choice since it was higher and more mountainous. The right bank was a better choice because of its wide plains and the valleys of its tributaries, which were low and swampy areas, propitious to growing *Hevea*.

In order to confirm the arguments about the type of geographical propitious areas to development of the best plant, he mentioned his experience with planting rubber trees at the Rio de Janeiro Botanic Garden, where, in land that was always moist and fertilized, the trees never reached their ideal height, nor did they bloom at the expected time, and were poor milk producers. That region did not provide the temperature balance between the soil and the atmosphere; altitude was a factor; the change in temperature and the altitude of the land changed the shape of the plant as well as its lifespan and main components. "By describing details of the effect of the environment on the plant, which could vary even within a region, he affirmed that the differences would be much greater when latitude was added to the mixture. The position of the Earth in relation to the Sun is very different – the Earth moves from the south to the north. These changes, due to the variations in temperature, extended to the milk-producing veins and to the latex." (Rodrigues 1900: 29)

Likewise, light had a powerful influence on the plant's organization and structure. Sunlight at the equator was more constant, its changes were slower, and the night was the same year-round, unlike in the tropics, and much less in subtropical regions, where the amount of sunlight varied even more, creating an imbalance in heat between the soil and the atmosphere, which modified the nature of the plant. He explained that sunlight was responsible for formation of chlorophyl, which decomposes carbonic acid and feeds the plant. This is why equatorial forests have darker green leaves, while in tropical forests, leaves are a lighter green. At regions with higher temperatures, water contains more carbonic acid than air; as a result, oxygen absorption is lower, which changes the anatomy of plant tissues, and the latex also changes, loosing quality as a result.

Therefore, geography was determinant for soil properties, temperature, water systems; planetary movements determined the climate and incidence of sunlight, etc. Both had a direct relationship with the development of the best tree that would produce the best latex. The environmental factor was responsible for maintaining the qualities of the "Queen."

In regard to the quality of the latex, he showed that it could vary from one location to another; it would be higher if the rubber plantations were only

composed of one species of local plant; however, if there was close planting, that is, different species together at the same location, the mixture of milk would not yield good quality rubber.

At the same time, he made a long comment about circulation of the milk in the tree trunk, which caused its chemical transformation until it formed the milk that could be collected, which was the plant's wealth. As a result, obtaining the best milk depended on the technique used; that is, the type of cuts and the trunk height at which they were made: "The closer to the ground, the more milk the trunk has, and the better its quality." (Rodrigues 1900: 21) This knowledge, "before the systematization of biology," was only known to and safely used by the Indians.

The seasons, also observed by the Indians, determined the best time of the year to collect the milk from the plant, when it was most abundant. This was the time nuts were ripe, when the leaves fell from May to June, and when sap flowed. The Indians knew that at this time of the year a kilo of latex would yield half a kilo of rubber. This contrasts with the period when the sap began to rise, the milk became watery, and the latex was of poor quality, yielding only half a kilo. At this time, the trunk should not be cut for production (Rodrigues 1900: 40).

The best months for latex extraction were from May to September, the summer months, since the headwaters of the rivers that were drier at that time, were home to the best rubber plantations. Nonetheless, there was a problem. The land was still humid and swampy and caused marsh fevers, which were lethal for workers on the rubber plantations. As rubber extraction increased, with growth in exports and foreigners in charge of production locations, the Indians abandoned the rubber plantations, since death was a tangible threat, aggravated by poor working conditions.

On the other hand, it was important to pay attention to the age of the plants. The first cut should only be made when the tree was perfectly formed in its adult stage, after the second bloom, when the plant was more or less 10 years old, although full maturity would only be reached at 20 or 25 years. (Rodrigues 1900: 22)

All this knowledge was applied by the Indians. Barbosa Rodrigues translated it scientifically, certain that if nature were respected, the preservation of *Hevea* would be ensured, at least in regard to the life of the trees. They needed to be preserved, so they could last as a source of wealth. However, what happened in the Amazon region was that in the name of easy profits, traditional knowledge was sacrificed, the Indians moved away from that type of production, and the rubber plantations were subject to extinction.

Rubber processing modes

The expression *Queen Rubber*, which was coined by Barbosa Rodrigues, described the rubber kingdom in the native environment. In the case of *Hevea brasiliensis*, the ideal environment was the hot and humid forests located at a certain distance from the Equator. Furthermore, the success of that kingdom depended on the knowledge [both botanical and chemical] that was silently developed by the Indians and made it possible to transform the tree's milk into objects for daily use and products sold internationally that were worth their weight in gold – hence the expression *Queen Rubber*.

Latex collection would begin with the beautiful days of early summer, on Saint John's Day in June, when the ebb phase in the Amazon Valley would leave the rivers covered in forests (Rodrigues 1900: 32). However, latex extraction was not easy work and required a ritual that began with the preparation of accommodations, opening of paths in the rubber plantation, and marking of the rubber trees from which latex would be collected during that harvest.

Once their precarious accommodations had been set up, the workers would use their rustic tools, such as hatchets, collection cups, buckets, smokers and gourds to begin work. First, they would prepare the location for the smoking by preparing a large ball of clay, where they would burn dried nuts, which they also gathered to burn when smoking the latex. They would then go out to distribute the collection cups on the trees selected to extract the sap. At the beginning of the season, they would perform work they called 'preparing the rubber tree," which consisted of some cuts in the tree trunk, but without allowing the milk to run. According to Barbosa Rodrigues (1900), that first cut allowed air to enter the plant's tissues and the sap would begin to flow down from the branches and the upper part of the trunk, flowing towards the roots. This is why more liquid was always obtained from the lower part of the tree.

The next day they would repeat the cut on the tree, attaching the cups, and the milk would gradually begin to flow. Hours later they would collect the latex. Going from tree to tree, they would collect it in a bucket and quickly take it to

the shelter to begin the smoking process, which was the actual preparation of the rubber. If processing was delayed, the milk would coagulate, affecting the quality of the rubber.

The smoking process was another meticulous stage of the work. They prepared the fire that they covered with the smoker, and introduced the dried palm nuts into the opening, which released thick smoke as they burned. The gases that came out defined the elastic quality of the rubber. This was traditional knowledge, which science proved much later, but which has not been completely synthesized to this day (Rippel & Bragança 2009: 818).

After the smoke was released, they would place the latex in the basin with the bowl and spilled it over a wooden shovel that was immediately placed on the smoke. Using a turning movement, they were able to have it collect all of the latex. After it had coagulated, they spilled a new layer of latex on the shovel and repeated the process until they had formed a ball, whose weight could be held. These balls were left to rest until the next day when the rubber was ready. They were in the shape of compact blocks, made from extremely thin layers that separated like pieces of paper.

During the collection period, the position of the collection cups was changed every day. They were placed in line, from higher to lower, and successively formed a new line, until they surrounded the tree. As the result of this process, different qualities of rubber reached the market, at different prices, as follows: fine rubber; medium fine, thick, and *sernambi* (the lowest quality). Work began each day around 6 a.m. and ended around 5 p.m. It was divided into two parts: in the morning, they collected the latex, and in the afternoon, it was coagulated/smoked.

This entire process, described in detail by Barbosa Rodrigues, was the indigenous, traditional process that had been repeated for centuries and was still the only one used in the Amazon. According to Barbosa Rodrigues, even though it was old, this process served its purpose, providing rubber that was of a superior quality, pure, very elastic, and not perishable. The latex coagulation method kept it pure, due to the creosote vapors and other antiseptics that came from the palm tree nuts. (Rodrigues 1900: 40)

In the transition from the "living laboratory" to the specialized "chemical laboratory," traditional knowledge was treated as new knowledge. The merit of this discovery was not attributed to the Indians, but instead, to the scientists, who intermediated, or chemically defined the properties of the plants[9]. Epistemologically, there was a cut between subject and object – the separation of man and nature, which characterized the natural sciences of the 19th century (Larrère & Larrère 1997). By promoting traditional knowledge, Barbosa Rodrigues was showing his opposition to this idea.

Tradition and preservation

From botanical classification through the most elaborate processing of the rubber, indigenous knowledge played a fundamental role. In the middle of the 19th century, the Indians used at least eight different species of rubber-producing plants (Dean 1989: 30). In his study published in 1900, Barbosa Rodrigues presented ten species classified and described by botanists. The species had been identified by their leaves because it was easier for common people to distinguish them this way. Science was using traditional knowledge as its basis. It was noted that there were many species of rubber trees in the Amazon Valley; "however, only a well-trained '*tapuyo*' could distinguish all of them", said Rodrigues (1900: 17)

In their botanical classification, the Indians made comparisons between plants and their properties, demonstrating the depth of their knowledge. Thus, the word *caocho*, which was a corruption of *caaochô* ou *caaochu*, a Tupi word, was derived from *caa*, meaning stick or wood, and from the verb *caô* or *chu*, meaning that which distills, which runs or cries – thus, "crying wood" (Rodrigues 1900: 20). Barbosa Rodrigues revealed himself to be an ethno-botanist.

In his interpretation, knowledge and work were different things; the former expressed a cultural tradition, while the latter expressed the conditions of the moment in which the work was being done. Barbosa Rodrigues valued traditional knowledge and practices. He explained the indigenous rubber development process, which had no ambition beyond using strictly what was necessary. No matter how much damage they might do, they would never kill a tree. For this reason, the same system they used was employed by the colonizers in the beginning. However, as production grew, it was abandoned. For Barbosa Rodrigues, this meant that veritable vandalism began to occur in the Amazon, with the

[9] In response to a chemical analysis request, in 1916 the laboratory Clayton Beadle & Stevens Analytical & Consulting Chemists declared the superiority of latex from the species *Hevea brasiliensis*, as said in a letter from Beadle to David Prain, Royal Botanical Garden, Kew, May 29, 1916 (Kew Garden Archive, Miscellaneous File, p. 36).

unbridled destruction of the rubber plantations, threatening the very survival of rubber production and of those who worked on it. As a result, he emphasized two immediate measures to preserve it.

First, he said it was necessary to establish control over the types of cuts made, in order to keep the trees from dying. He noted that there were several types of cuts that could be made, and that all of them, without exception, presented problems. However, there was legislation that limited some of the practices, although enforcement was precarious. The cup collection method should be reduced by half; the cutting should protect the rubber trees from blows, to avoid shortening their lives. After removing the cups, it was important to let the milk flow out, because this would protect the cut and help it heal faster. Certain types of cuts were very hard on the trees, and in a short time, they would die. Many rubber plantations disappeared from the banks of the Amazon, Tocantins, and Jari Rivers, and from the islands, as well as along the lower Madeira and Solimões Rivers (Rodrigues 1900: 48)

Second, it was necessary to grow *Hevea*. Hevea forests needed to be planted, in order to preserve the plant, which had been disappearing. In spite of spontaneous dissemination of the seeds, planted by the waters in faraway spots, the source of wealth for the Amazon Valley was under threat. Once Hevea was being cultivated, this would prevent the nomadic population from moving away. Villages would appear (so many had disappeared) and drifters would disappear; social customs would change; schools would be built, and this would bring prosperity (Rodrigues 1900: 55).

However, seeds had to be treated with care. Immediately after they fell from the trees, they were to be collected, since they would lose their ability to germinate in 15 days. Their transportation, sowing, and preparation of the land for planting needed to be done meticulously. He suggested using different cultivation methods, depending on the different soil conditions. He also noted that rubber production needed to respect nature; it was prudent to wait at least 10 years before beginning to extract the latex. A rubber tree that was well-treated could produce for another 20 years beyond the time it needed to reach maturity. If replanted every 15 years, it could provide a fortune, said Barbosa Rodrigues (1900: 60).

However, Barbosa said that *Hevea* must be grown in its ecologically correct environment; for it to be productive, the specific environmental conditions and time for the tree to reach maturity needed to be met. However, greedy planters disregarded this advice, Barbosa Rodrigues claimed. If the necessary environmental conditions were not provided, rubber trees would become extinct, and the land would be exhausted, as would the exaggerated gains that had occurred in recent times.

While the extraction methods for the best rubber were based on indigenous practices, cultivation of Hevea was outside that cultural tradition, since it had always represented extractivism. Although Barbosa Rodrigues greatly valued indigenous knowledge, he suggested cultivation of *Hevea* in order to prevent the failure of the so-called rubber industry. As he emphasized, the goal was to control nomadic extraction and to socialize the population, keeping them on the rubber plantations, reaping the fruits of their work.

Nevertheless, Barbosa Rodrigues did not make any suggestions for intervention regarding the indigenous techniques for transforming the latex into rubber. In 1900, no alternative method for smoking had been found in the latex processing, in spite of the many attempts throughout the 19th century. None of the methods developed managed to achieve the quality and purity of the rubber; no chemical process replaced smoking, which was very labor-intensive and time-consuming. Indigenous knowledge remained untouched in centuries of science. Even into the 21st century, natural rubber continued on the market, and the secret of its original knowledge was not surpassed; however, it began to gain visibility (Rippel&Bragança 2009; Domingues 2020).

That was, in fact, a project for preserving rubber since it established environmental conservation and promotion of traditional knowledge. It was almost impossible for this to be recognized, whether by peers, or politically. From the standpoint of application of science and principally, of politics, it wasn't exactly original, yet it was still a new idea. In the United States, field work with the goal of preservation was being conducted at the end of the 19th and in the early 20th centuries, as noted Vetter (2001: 108). In Brazil, work such as that by José Augusto Pádua showed initiatives that also began in the 19th century (Pádua 2002). Yesterday, as today, the resistance to facing climate and environmental problems was enormous.

A process of labor exploitation

At the time he wrote his article, Hevea cultivation did not seem to be on any political agenda, except in England. The supply of processed rubber was still significant, and for many years this dominated trade relations in the region, with rubber reaching the status of largest export. If there were any spotlights, they were focused on rubber, since it was expanding throughout Europe, as an important element of major technological innovations. According to Barbosa Rodrigues (1900), foreign industries established themselves in locations where latex was collected, placing it among the highest commercial interests. However, signs of exhaustion of the plants and their productivity were rapidly being seen in the Amazon region -"The Amazon is heading towards destruction".

At the same time, the increased rubber exports left behind a trail of poverty. This was noted by Barbosa Rodrigues as a contradiction of the system, since initially, finished goods were exported by the Indigenous peoples. Later, as it became more commonplace, rubber was exported as a commodity (Almeida 2010). In 1844, after Goodyear invented vulcanization, exports grew enormously. As a result, indigenous manufacturing was fated to disappear, together with its historical culture. As noted by Rodrigues (1900), "Rubber extraction went from the hands of the Indians to the civilized nations. They began to build the rubber plantations, and these attracted the descendants of the Indians, who, seduced by the gains from rubber, abandoned their villages and livelihoods and became nothing but captive forced labor."

Barbosa Rodrigues said that in previous days, individuals would look for a forest rich in rubber trees along one of the tributaries of the Amazon and would take charge of it, building a straw hut and establishing their little rubber plantations, generally without legally possessing the land. However, as the rubber plantations grew, they brought in families from the surrounding areas, who had previously been self-sufficient. They had been seduced by the wealth that rubber provided but would soon be reduced to living like slaves.

According to Barbosa Rodrigues's estimate, each day a road of 60 rubber trees would produce 30 kilos of rubber for a man. At the price of 12,000.00, this would yield 360,000.00, which was not an insignificant amount. Rubber production was not small, but as extraction grew, the gains did not make their way to the workers at the rubber plantations. Parallel to the increase in exports, the Indians who worked the rubber to make objects for their own use abandoned that work routine, moving back to the forests.

As rubber cultivation and its economic benefits grew, the rubber plantations were occupied by immigrant families from other locations; even though they had learned the indigenous methods of production, they were forced to submit to unimaginable working conditions and exploitation. Under the system used by the employers, the product of their work was received "on account" of what had been forwarded to them outside the harvest period, at the trading posts owned by the employers - the company stores. Prices charged at these trading posts were extremely high, and the price for a single category of goods was repeated several times on the same bill, which left workers indebted and unable to leave their jobs. The bill could never be paid. As Barbosa Rodrigues (1900: 43) pointed out: "Among other defects, rubber plantations have that black page."

Outraged with that situation, Barbosa Rodrigues made the following observation about labor: "I must note that this work has always been done by free workers, even though slavery existed at that time; however, those who undertook it were reduced to extreme poverty and lived as if they were slaves. Company stores and travelling salesmen appeared and led to abuse, immorality and moral enslavement."

He completed this idea by adding that under the control of foreign trade, rubber production began to eliminate large and small farms, leading to a strong decline in the local industries of cotton, indigo, tobacco and manioc. Settlements did not arise, because the fevers at the rubber plantations reduced the population or forced workers to move. The Indians fled to small, geographically dispersed agglomerations. Only the rubber plantations grew in size. In 1877, a major drought in the state of Ceará provoked hunger and there was massive emigration to Amazonas, which led to a temporary increase in rubber production. This unchecked rubber production led to enormous degradation in local life, leading to a transformation of local culture - linguistic expressions disappeared, new accents arose, and different names were given to plants or locations: "They put an end to the characteristic features of the Amazon region" (Rodrigues 1900: 14).

Concluding [that] Once upon a time there was a kingdom...

The many studies on products from nature and their local uses have led, over the course of time, to the establishment of relationships between scientists and the holders of local and traditional knowledge; however, they were not recognized. It is only today that more and more attention is being paid to them (Safier 2010; Chambers & Gillespie 2000). In the Amazon, scientific or economic development of the products of nature, together with traditional knowledge, went politically from colonization to imperialism and then to developmentalism, today they serve as the test balloon for sustainable development (Petitjean *et al*. 2012; Almeida 2010).

In his analysis of rubber, Barbosa Rodrigues emphasized the economic potential of *Hevea brasiliensis*, stressing its origin in the indigenous knowledge of the native environment, the exploration methods and chemical processing (although primitive, or perhaps because of this); this was why he recognized "Queen Rubber".

More than just a scientific report with political purposes (to provide information to a foreign government), the article by Barbosa Rodrigues affirmed principles of ecology and ethnobotanics, calling for environmental preservation and respect for the climate. At the same time, it was a vehement condemnation of the exploitation of labor imposed by the greed in the rubber industry, calling it as or more violent than slavery. He saw, and foresaw, that if things continued at the pace they were going at, things could get even worse. Although he wanted to believe that this type of relationship was already disappearing, the 1930s and 1940s showed that the problem was endemic. It recurred again when Amazonian rubber again caught the interest of the market on the eve of the Second World War.

With his ideas, Barbosa Rodrigues destroyed the values of land colonization, easy profits, unchecked exploitation of nature and of the societies that lived in the New World. He was an optimist and based on what he saw and experienced with the Indians, he visualized preservation of the forest and the means of production that would return the wealth produced by rubber to the Amazon Region, valuing both local knowledge and the society that organized the entire production process of something as valuable as rubber. He visualized a scientific culture of symbiosis between natural sciences and social sciences, which until to this day is difficult to establish.

References

Almeida AWB (org.) (2010) Conhecimento tradicional e biodiversidade: normas vigentes propostas. PPAGAS-UFAM, NSCA CESTU-UEA, UEA Edições, Manaus.

Almeida M (2011) Congressos Científicos na América Latina. Espaços de debate, exposições e intercâmbios. Available at <http://site.mast.br/hotsite_mast_30_anos/pdf_03/capitulo_06.pdf>. Access on 28 January 2022.

Barros W (1992) Apresentação. Rodrigues, JB. A botânica, nomenclatura indígena e seringueiras. JBRJ e IBAMA, Rio de Janeiro. p. s/n.

Beadle C to Prain D (1916) Letter May 29, 1916. Kew Garden Archive, Miscellaneous File, Kew. p. 36.

Chambers DW & Gillespie R (2000) Localty in the history of science: colonial science, technoscience, and indigenous knowledge. *In*: Macleod R (ed.) Nature and Empire - science and the colonial enterprise. Osiris 15: 221-240.

Crosby AW (2011) Imperialismo ecológico : a expansão biológica da Europa, 900-1900. Cia. das Letras, São Paulo. 376p.

Dean W (1989) A luta pela borracha no Brasil. Um estudo da história ecológica. Nobel, São Paulo. 286p.

Domingues HMB (2020) Rubber: the invisible movement of traditional knowledge. CIST 2020, Session P, Paris. 591p. Available at <https://cist.cnrs.fr/wp-content/uploads/2021/01/cist2020-proceedings.pdf>. Access on 31 January 2022.

Domingues HMB & Carreón E (2021) Rubber. *In*: Thurner M & Pimentel J (eds.) New World objects of knowledge. University of London Press, London. Pp. 51-56. Available at <https://humanities-digital-library.org/index.php/hdl/catalog/view/new-world-objects/201/397-1>. Access on 31 January 2022. doi 10.14296/2104.9781908857835.

Domingues HMB (1995) Ciência, um caso de política. As relações entre ciências naturais e agricultura no Brasil Império. Tese de Doutorado. USP, São Paulo. 320p.

Ducke, A (1934) Colheita de material botânico na região Amazônica (Relatório 1931-1933). Ministry of Agriculture Bulletin, April, June, Year 23, n. 4-6.

La Condamine ChM (1745) Extrait historique de la suite des opérations des académiciens pendant les dix années qu'a duré le voyage de l'Équateur (1745). Dossier Biographique, Institut de France-Academie des Sciences, p. 31, Doc. 15.

La Condamine C-M (1981) Voyage sur l'Amazone. Relation abrégée d'un voyage fait dans l'intérieur de l'Amérique méridionale depuis la côte de la mer du Sud jusqu'aux côtes du Brésil et de la Guyane, en descendant la rivière des Amazones. Lue à l'assemblé publique de l'Académie des sciences le

28 avril 1745, par M. de La Condamine de la même académie. François Maspero, Paris. Pp. 35-137.

Larrère C & Larrère R (1997) Du bon usage de la nature. Pour une philosophie de l'environnement Aubier, Paris. 355p.

Losada J, Puig-Samper MA & Domingues HMB (2013) Um álbum para o Imperador. MAST, Rio de Janeiro; EDUFU, Uberlandia. 160p.

Minguet H (1981) Introduction. *In*: La Condamine CM (ed.) (1785) Voyage sur l'Amazone. François Maspero, Paris. Pp. 5-27.

Pádua, JA (2002) Um sopro de destruição: pensamento político e crítica ambiental no Brasil escravista, 1786-1888. Jorge Zahar, Rio de Janeiro. 318p

Petitjean P, Kleiche-Dray M & Domingues HMB (2012) Composição e recomposição dos saberes sobre as substâncias naturais. *In*: Domingues HMB, Kleiche-Dray M & Petitjean P (eds.) História das substâncias naturais – Saberes tradicionais e química. MAST – IRD, Rio de Janeiro, Paris. Pp. 7-24.

Reis ACF (1972) A Amazônia e a cobiça internacional. 4ª ed. Cia. Ed. Americana, Rio de Janeiro. 98p.

Rippel MM & Bragança FC (2009) "Natural rubber and nanocomposites with clay". Química Nova 32: 818-826.

Rodrigues JB (1900) As *Heveas* ou seringueiras – Informações. Imprensa Nacional, Rio de Janeiro. 86p.

Rodrigues JB (1992) [facsimile] A botânica - nomenclatura indígena e seringueiras. IBAMA e JBRJ, Rio de Janeiro. 86p.

Rodrigues JB (2018) Mbaé Kaá - o que tem na mata: Tapyiyeta Enoyndaua: A Botânica Nomenclatura Indígena; 2ª ed. rev. e ampl. Dantes, Rio de Janeiro. 136p.

Sá MR (2001) O botânico e o mecenas: João Barbosa Rodrigues e a ciência no Brasil na segunda metade do século XIX. Revista Manguinhos - História, Ciência e Saúde 8 (supl.): 899-924.

Safier N (2010) Global knowledge on the move: itineraries, Ameridian narratives, and deep histories of science. Isis 101: 133-145.

Sanjad N (2010) A coruja de Minerva: o Museu Paraense entre o Império e a República (1866-1907). Fiocruz, Rio de Janeiro. 492p.

Vetter J (2001) Rocky Mountain high science: teaching, research and nature at field stations. *In*: Vetter J (ed.) Knowing global environments - New historical perspectives on the field sciences. Rutgers University Press, London. Pp. 108-134.

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