When Madagascar produced natural rubber: a brief, forgotten yet informative history.

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ABSTRACT

From 1891 to 1914, Madagascar, like other western African countries, was a production zone for forest rubber destined for export to Europe when Asian plantations where not yet sufficiently developed . Numerous species endemic to the forests of the three major Malagasy ecosystems were exploited, often with a view to maximising short term productivity without any consideration for the sustainable management of the resource. This episode represents one of the first cases of industrial exploitation of Madagascar's biological resources. Although Madagascar occupies a modest position on the world rubber market at that time, the exploitation of rubber bore major consequences for the island's forestry resources and, moreover, influenced the vision and discourse of scientists and politicians concerning their management. It was one of the factors triggering awareness of the value of Madagascar's biodiversity and the threat to which it might be exposed through poorly-controlled human activity. As a result, highly repressive and forcible legislation was introduced aimed at containing the activity practiced by local populations considered to be mostly to blame. But from the early days of French colonial rule, naturalists judged the outcomes of political decisions too weak to offer any guarantee of an effective defence. They responded by adopting an intentionally alarmist and catastrophist discourse with the object of provoking a reaction from the politicians, considered too lax. This discourse, in fact, took an about-turn from 1942-45 when the war effort led to a revitalisation of the Malagasy rubber sector as Asian production was mainly out of reach. A second consequence came in 1927 with the creation of a network of protected areas managed by naturalists, making Madagascar at that time, a pioneer in Africa. There was a simultaneous flurry of activity to promote the domestication of Malagasy rubber species, combined with the introduction of new species with high potential (*Hevea brasiliensis, Castilloa elastica*).

However, with the emergence of far more profitable Asian rubber, all attempts at cultivation in Madagascar were abandoned when exploitation ceased to be

profitable, and thus the Malagasy forests were redeemed. This episode demonstrates how it was in fact economic reality, by condemning an unprofitable sector, that was the real vehicle by which the survival of Malagasy rubber species was secured, and not the naturalists' discourse, nor the creation of protected zones, nor the promulgation of repressive legislations. This case study is of more than purely historical interest, in that it still has currency where, for example, the exploitation of *Prunus africana* is concerned.

INTRODUCTION

Up until 1900, the world's natural rubber was produced entirely through collections from wild plants. The commercial product was thus generically known as forest or natural rubber (as opposed to plantation rubber). Following the discovery by Charles Goodyear, at the turn of the 19th century, that the process of vulcanisation (mixing with sulphur prior to heating) allowed rubber to retain its elasticity and resistance, industrial development, and more particularly that of tyre manufacturing, created a strong and constantly expanding demand (Bouvier, 1947; Serier, 1993; IRSG, 1996; Mooibroek and Cornish, 2000). The tyre industry still absorbs today 70 % of natural rubber due to its particular heat and shock resistance compared to synthetic rubber.

At that time, the market in forest rubber, obtained from a diverse range of species, from lianas to trees, was supplied by three continents: America, Asia and Africa (Figure 1), with the production zones being limited to tropical regions without typhoon or cyclonic climax.. *Ficus elastica* was exploited in the British and Dutch possessions of South East Asia (India, Burma, Java, Borneo, Malaysia), essentially prior to 1870 (Jumelle, 1903; Lavauden, 1941; Serier, 1993). At the end of the 19th century, Amazonia, and in particular the regions of Para and Manaus, became the principal regions for the production and exportation of rubber from the hevea tree (*Hevea brasiliensis*) mainly through extractivism as a fungus, Microcyclus ulei did not enable large scale plantation of rubber trees. But, after having represented more than half of the world's production, making towns like Manaus fleetingly rich, Amazonian production plummeted discernibly after 1910 when rubber from Asian plantations took over (see table XXX). Other species, in other regions, were also solicited, such as *Manihot glaziovii,* or *Castilloa elastica*, originally from Mexico, and for some time, considered to be the best rubber species (Weinstein, 1983; Homma, 1992; Serier, 1993; Coïc, 2000).

The production of rubber collected from the African continent was transient, beginning around 1880 (Delmas and Duffart, 1908b; Chevallier, 1926) and lasting until around 1910, in particular along the western coast from Guinea-Bissau to Cameroon. At its peak in 1900, it represented around a third of the world's production. Numerous forest and savanna species supplied the African production, amongst which the main ones were *Futumia elastica*, *Clitandra cymosa* and *Landolphia heudelotii* (Chevalier, 1921, 1926; Serier, 1993). Consequently, Landolphia almost diseappeared along the coast. African production after WW I declined dramatically due to over-exploitation of local species and supply from Southeast Asia

However, from the middle of the 19th century, it became apparent that the production of forest rubber would be inadequate to provide for the growing requirements of European and American industrialists, in particular with the development of the car and tyres industries after WW I. . Hence, the idea was conceived to domesticate and cultivate the main rubber species. After numerous attempts, frequently recounted (Bouvier, 1947; Chevalier and Le Bras, 1949; Serier, 1993), the first hevea rubber trees were established in 1876 in Ceylon, then transfered to Kiew garden in Singapore, and then to Malaysia in estates. Henceforth, cultivation spread to the whole of the British and Dutch possessions in South East Asia at the turn of the century. The first recorded production (Chevalier and Le Bras, 1949) from Asian plantations, in 1900, was modest (four tonnes!), but from therein it increased rapidly. Figure 1 shows that from 1915, forest rubber was swept aside by productions from the Asian hevea plantations. By 1930, they were supplying more than 95% of the world's requirements.

Rubber, coming from Malaysia *(Hevea brasiliensis),* was introduced in Indonesia by the Dutch at the turn of the century in North Sumatra and originally cropped in private estates, following the trend observed by English estates in the western part of Malaysia. The market for natural rubber was

booming, due to a constant growing demand and is still sustained by a permanent demand (around 8 millions tons /year/ world consumption in 2007). Rubber spread rapidly as well mainly trough smallholding in Thailand, now the first rubber world producer before Indonesia and Malaysia (90 % of total natural rubber production in Southeast Asia). In Sumatra, rubber seeds had been introduced through estates in North Sumatra and by Chinese traders into the south in the 1910's. In Borneo, the first seedlings had been introduced in 1882 (Treemer, 1864, cited in Dove, 1995). Seeds were distributed to the 'natives' in 1908 by the Sarawak government. In Kalimantan. Chinese merchants, Catholic missionaries and a dutch private company ("Nanga Jettah") introduced rubber seeds in 1909 (Uljee 1925 in King, 1988). Local Asians farmers immediately saw an opportunity for rubber production and began to collect seeds in estates to plant their own rubber. Rubber was cultivated in a very intensive way in estates, with fertilizers and continuous weeding requiring much labour and capital. Local farmers, as well as spontaneous migrants partly coming from the estate sector, adapted their own system according to their limited resources of cash and labour. They planted rubber trees with rice after traditional slash and burn with a higher planting density than that of estates in order to compensate tree losses due to competition and depredation to finally end with a comparable number of productive trees (between 300 and 500/ha). Rubber is then let to grow with the secondary forest in an agroforestry system called jungle rubber (Penot, 2001) that rapidly proved to be very efficient, easy to develop and booming. However, improved clonal rubber covers more than 85 % of the area in

Malaysia and Thailand (more than 95 % in other producing countries such as India , Sri Lanka, Cambodia, China and Vietnam), jungle rubber covers still 80 % of the area for 70 % of the production in Indonesia (BPS, 2004). 100 % of rubber is obtained from hévéa brasiliensis when *Microcylus ulei* does not prevent in Asia and Africa[1]. In Africa most rubber plantations have been established in the 1950's except in Nigeria where introduction occured in 1910

A regular, low cost supply, with long term stability, of a product conforming to optimal technological qualities, rapidly got the better of a production varying in quality and quantity, the scarcity of which was being predicted by botanists (Bourdariat, 1911; Serier, 1993).

The short-lived history of African forest (non-hevea) rubber has been long forgotten. And yet, it still serves as a valuable example of an economic sector set up and then abandoned as a direct result of immediate overexploitation of a natural resource due to strong economic incentive, before plantations alternatives became dominant in the 1920's in Asia. Rubber plantations have been later developed in western Africa (Ivory Coast, Cameroun) in the 1950's after the end of the first french Indochina war[2]. This history also marks the emergence of an environmentalist and conservationist discourse, which is still current. These are the elements that this article aims to elucidate, focusing particularly on the case of Madagascar where rubber plantations have never been developed in potentially East coast humid tropical climate due to typhoons. The rubber trees are very sensitive to wind and cannot be properly grown in areas prone to cyclonic climax. However some trials or small scale plantation

[1] Total natural world production was 6,81 millions tons in 2002.

[2] In the event of a fall of the French armies after communist China could help the Vietminh since 1949, the main rubber companies has already prospected since 1951 the feasibility of large scale estate rubber development in Ivory coast, Ghana, Cameroun and even Madagascar.

have been established in Nosy Bé, in the valley of Sambirano in the North-West and in the Southeastern coast, and even hevea rubber beeing considered as a potentially reliable source of rubber (1951, in Entreprises & produits de Madagscar), hevea plantations have never been developed at large scale. It was assessed at that time that rubber could grow where coffee grows. Beside climatic conditions prevailing long life rubber trees, land availability was not favourable to large scale plantations and Malagasy men where considered too individualistic to have any interet in rubber. (according to 1951's colonial perspectives). A proposal of large scale planting with estates and smallholding has been set up but never implemented due to the fact that economic, climatic and social conditions where far more favourable early 1950's in Western and central Africa rather than in Madagscar. May be a lost opportunity ?

Back to non-hevea rubber between 1891 and 1914, the island of Madagascar was a region from which forest rubber was collected and exported.

It occupied a minor place on the world market, even though rubber was one of the island's principal export products. Its extraction had major consequences at a biological level but also in the awareness of naturalists of the degradations that the Malagasy forests, remarkable for their biodiversity and endemicity, were suffering (Baron, 1890; Perrier de la Bâthie, 1921). Therefore, this study will describe in detail the processes which, (i) allowed Madagascar to participate for the first time in the world economy, (ii) engendered what was presented as an ecological catastrophe and, (iii) uphold the conservationist discourse and policies still active to this day (Gade, 1996; Myers *et al.*, 2000).

Figure 1 shows the rubber prices from 1914 to 1941 with two main peaks : 1914-1921 and 1925-1928.

MAIN FEATURES OF THE MALAGASY RUBBER SECTOR

The objective in this first part will be to describe the place occupied by the rubber sector in a local and international context both from an economic and a biological perspective.

A modest sector on a global scale but of local importance

Rubber production is described as soon as the XVIII century, in 1768 by Rochon in his "journey to Madagscar" citing the "flinguère" , as well as Durmont d'Urvile in his "trip around the world" citing the "Voane". The product from Vahea gammifera, cited by Poiret in 1917 is dispayed at the "exposition coloniale " in Paris in 1851. At that time, the West coast production was entirely reserved by the royal government. The first exportation of Malagasy rubber to Europe (12 tonnes) appears to have occurred in 1870 (Decary, 1962) from East coast (Mananjary). But it was not until 1891 onwards, when the quality of rubber sourced from *Euphorbia intisy* (Plate 1, Figure 2) in the region of Fort-Dauphin was recognised, that the exploitation of rubber became significant (Prudhomme, 1899/1900; Decary, 1962; Tixier, 1982; Serier 1993). Production increased significantly with the exploitation of *Landolphia*, a liana, after 1883 from the Esatern coast with export to Germany and Great Britain. Over-exploitation led to complete destruction of the resource and soon, only rubber from Intisy from the outback of Fort Dauphin remain (Southern tip of the Eastern coast). The English "Madagascar rubber" exploited a forest of 50 000 ha in the West after 1913. Over-exploitation and rapid diseappearing of local resources explain such shift in production from East, South to West. Rubber trees such as *Mascahenshasia* (Guidroa, Barabanja) where cut to death and lianas (..) collected to the point of total destruction.

Figure 3 shows that this production peaked in 1906 and 1910, the only years for which records show a yield in excess of a thousand tonnes. Despite this,

Malagasy production represented no more than 5 to 6% of total African output and less than 2% of world output.

The production of rubber in Madagascar was directly dependant on the political events which marked the beginning of French rule. The exploitation of rubber was coetaneous with the wars and insurrections which preceded and followed the voting of the act dated 6th August 1896 declaring Madagascar a French colony (Galliéni, 1908). The production curve of Malagasy rubber is a stark reflection of the ups and downs of the island's military and political circumstances. Thus the insurrection which broke out in the south of the island at the beginning of 1897 explains the drop in harvest and exportation during this period (Prudhomme, 1899/1900) (Figure 3). This region was the field for military operations again in 1900-1902, to which fall in production recorded at this time can be partly attributed (Poisson, 1908; Brown, 2000). On the other hand, the sharp fall in exports from Madagascar (as well as Africa) in 1908 resulted from the financial crisis that rocked America in 1907-1908, which can be attributed in part to the poor sales of cars and over stocking of primary materials in previous years (Fayol, 1909; Fauchère, 1911).

Malagasy production diminished to almost zero from 1916. following a similar trend in West Africa from extractivism. *Hevea brasiliensis* became the major rubber source, from Asia (Malaysia, Indonesia, Thailand and Sri Lanka) with the highest profitability compared to other sources (Penot, 2001).

Figure 4 compares the value of rubber exports from Madagascar with the value of other principal exports during the period in which rubber production was significant in Madagascar. Gold was the main export product. Its value increased steadily until 1909 before gradually diminishing. Before the war, leather and raffia were major resources for Madagascar, whilst vanilla played a marginal role. After the war, these three products became the island's principal exports. The curve of exports linked to rubber was highly erratic. These variations

reflect the previously mentioned political events. However, on four years (1898, 1899, 1906 and 1910) rubber was Madagascar's number one export product.

Malagasy rubber was essentially destined for the European market. Germany and Britain were the two main importers prior to French colonisation, after which production was shipped to the French ports (Le Havre, Bordeaux, Marseille), as well as Liverpool, Hamburg and Antwerp (Besson, 1908; Durand, 1908; Claude, 1909; Canaby, 1932).

Numerous Malagasy ports served as exit points for rubber. Tonnages exported varied considerably from year to year, but as a general rule, the main points of export were Tamatave on the east coast, Majunga and Hell-Ville (Nosy Be) on the west coast, Fort-Dauphin and Tuléar in the south (Figure 2).

Exploitation implicating all the Malagasy ecosystems

At the outset of the 20th century, the forest zones of Madagascar covered between a fifth and a third of the island's surface (Perrier de la Bâthie, 1936; Coudreau, 1937; McConnell, 2002). The presence of lianescent, arborescent and shrubby rubber producing species was charted in all the forest ecosystems: the evergreen humid forest in the east and north (Prudhomme, 1899/1900; Thiry, 1903; Vergely, 1907; Jumelle and Perrier de la Bâthie, 1909, 1910, 1912), the dry deciduous forests in the west (Jumelle, 1901; Louvel, 1910; Jumelle and Perrier de la Bâthie, 1911; Perrier de la Bâthie, 1912) and the xerophilous scrubland in the south (Chapotte, 1898; Vacher, 1907; Poisson, 1908) (Figure 2).

Figure 5 takes into consideration the respective proportions of these three major vegetation zones in the production of Malagasy rubber. Between 1897 and 1910, production was divided relatively equally between the three ecological regions. The forest in the east had a share which, depending on the year, varied from 22 to 52%, that of the western forest from 25 to 31% and the southern bush had a share of between 17 and 34%.

The entire species of Malagasy rubber belong exclusively to three botanical families: Asclepiadaceae, Apocynaceae and Euphorbiaceae. Table 1 shows that the Apocynacaea belong, for the most part, to the *Landolphia* genus (*voahena*, or *fingotry*, as it is known in Malagasy), *Mascarenhasia* (*guidroa*, *barabanja* and *hazondrano*), and *Plectaneia,* and are present in the evergreen forest in the east and deciduous in the west. The Asclepiadaceae are represented by species belonging to five genus, *Cryptostegia* (*lombiro*), *Gonocrypta*, *Pentopetia*, *Marsdenia* and *Secamonopsis*, which are present in the west and south. The Euphorbiaceae are represented by two arborescent species: *Euphorbia pirahazo* in the west and *E. intisy* (*herotsy*) (Plate 1) in the southern bush (Baron, 1890; Girod-Genet, 1898; Lecomte, 1899; Jumelle, 1901; Drake del Castillo, 1902; Thiry, 1903; Canaby, 1932; Boiteau, 1943; Comité du Caoutchouc, 1943; Decary, 1962, 1966).

The majority of rubber species are endemic to Madagascar, with the exception of *Cryptostegia grandiflora,* which is also present in other islands in the Indian Ocean (Jumelle, 1912), and *Mascarenhasia arborescens*, also distributed in East Africa (Schatz, 2001). Often, even the genera are endemic, as is the case for *Gonocrypta*, *Pentopetia*, *Secamonopsis* and *Plectaneia* (Boiteau, 1943; Mabberley, 1987; MBG, 2006). On the other hand, the *Landolphia* species is very widely represented amongst the rubber species exploited in dry and tropical Africa, as far as Senegal (Delmas and Duffard, 1908b; Fayol, 1909; Etesse, 1913; Chevalier 1926; Chevalier and Le Bras, 1949).

The quality of rubber produced was highly species dependant. Hence the majority of *Mascarenhasia* produced good quality rubber with a high latex content (40-45%) and low resin content (5-6%). They were marketed under the name of "Madagascar Niggers". "Palay Rubber" was extracted from the *Cryptostegia* species. The brands known as "Majunga Rose" and "Madagascar Pinky" were associated, on the whole, with rubber from the best species of *Landolphia* from the west of the island, and for which the value on the European market was close to that of Para (derived from Brazilian hevea rubber), which

was (and remains) the gold standard at the time (Bourdariat, 1911; Boiteau, 1943; Fournier *et al*, 1990). *Gonocrypta grevei* (*kompitso* in Malagasy) also produced a good quality rubber. However, the best Malagasy rubber was obtained from *Euphorbia intisy* (Plate 1), which had a very high latex content (44%) and extremely low resin content (around 1%). The other species were of low value, producing rubber with a high resin content, and often sticky (Constantin and Galland, 1907; Boiteau, 1943).

PS on ne parle pas de résine pour le caoutchoux mais plutot de latex

"*A FINE EXAMPLE OF LACK OF FORESIGHT AND A DESTRUCTIVE ECONOMY*"

The preparation of rubber required a series of simple stages, which were nonetheless decisive in the quality of the finished product and for the conservation of the biological resource: extraction method, coagulation method, drying and storage of the rubber. These procedures were carried out by Malagasy collectors in the forest. The rubber was then sold in the villages or towns, to locally based dealers, who were Malagasy, Indian, Chinese or European.

In actual fact, the potential financial gain generated by the sale of rubber was an incentive for many local peasants to set themselves up as collectors. Whereas the lack of skill and the concern for making quick short-term financial gains led to short cuts in the harvesting methods, endangering the producing species, in the process. This exemplifies what Decary (1926) defined as *"A fine example of lack of foresight and a destructive economy* ". The same strategy has been observed in Western Africa. Rubber from extractivism (with Hevea brasiliensis) did not diseappeared (even today) in Amazonia due to the very large and extensive extend of isolated trees that are tapped and not cut for production

Disappearing of local non-hevea source of rubber is as well due to a "dutch disease effect"[3] (mentioned as well by various authors) to understand the perverse effects of a natural resource boom on the structure and performance of a small and open economy. After resource depletion, no other resource or activity could stand such development leaving the formely producing areas into recession or even complete economic disarray or abandon.

Outdated modes of preparation

The trees were generally tapped, the only procedure compatible with sustainable conservation of the resource (Louvel, 1910; Bourdariat, 1911), but it was not always the case (Table 1).

The same tapping techniques were recommended by some for the lianas (Girod-Genet, 1898). Yet, the most commonly used method consisted in dragging the lianas to the ground, chopping them off at ground level and cutting them into 50 to 60 cm logs. These were put on an improvised stand to bleed, the latex being collected in a trough according to the diagram in Plate 2 (Thiry, 1903; Rey, 1905; Griess, 1907; Louvel 1910; Fauchère, 1911; Bourdariat, 1911). Louvel (1910) explained the use of this method as follows: "*It's not out of vandalism or a love of destruction, that the natives have always […] cut the lianas into logs, as generally claimed, but because they had practically no other means of harvesting*". This method was potentially ecologically sustainable, because the species in question puts out abundant suckers (Griess, 1907, Louvel, 1910) however over-exploitation was far more rapid than regeneration. In spite of this, yields of rubber remained poor. This led Perrier de la Bâthie and Jumelle (1907), and Louvel (1910) to recommend chopping the liana fragments (by crushing or pounding), a method which doubled, even quadrupled the yield in relation to draining the logs.

[3] Originally developed as a theorical model by the two Australian economists : W.M. Corden andJ.P. Neary.

The object of coagulation was to concentrate the rubber particles in emulsion in the latex in order to create a solid transportable mass (Chevalier and Le Bras, 1949). This operation occurs naturally for some latex, such as *E. intisy*, but for many others it was necessary to resort to the use of chemical (acid) , mechanical or thermal processes. In Madagascar, collectors used heating, or else the addition of dilute sulphuric acid, or concoctions of various fruits (lemons, tamarinds, and baobabs), sea salt or urine (Armand, 1901; Piolet, 1901; Rey, 1905; Bourdariat, 1911; Loisy, 1914; Comité du Caoutchouc, 1943).

It should not be overlooked that the work of the collectors was extremely gruelling and performed by people who often lived in extreme poverty, on a very low income. Thus Lecomte (1899), a colonial from Farafangana, estimated that collectors of *hazondrano* (*Mascarenhasia* sp.) "*were subjected to long treks in the forest, often travelling for a month, to amass a man's load of perhaps 25 to 30 kgs*". Whilst Prudhomme (1899/1900) described the collector in the following terms: "*The Malagasy who goes off in search of rubber […] does not burden himself with a mass of tools, he simply equips himself with a specially formed machete which he calls* antsibé. *If he is careful, he also takes along a cast iron cauldron to prepare his meals and coagulate the latex, as well as a vial of sulphuric acid diluted with water or a stock of sea salt, but in most cases, he considers this material too burdensome […] assured that he is of finding all he needs in the forest to perform his work, such as lemons and tamarinds for the coagulation, a container to collect the latex*". Collection of dry products for long haul foot transportation was fortunately in favour of a better quality of the product, compared to Asian rubber slab socked in water to remain "heavy" but leading to poor rubber quality

Another example of a method used in the south of the island consisted in scooping out a cup in the ground at the foot of the tree, which was then bled. The latex ran down the trunk and was collected in the hollow, and then mixed with sand and debris (Chapotte, 1898; Vacher, 1907).

Usually the rubber produced this way was formed into balls the size of two fists and sold to the dealers (Girod-Genet, 1898; Besson, 1908; Decary, 1962).

Exploitation gone astray

But these methods fairly rapidly fell by the wayside. According to Lecomte (1899), the natives initially bled the trees, but faced with the increase in demand, "*exploitation turned into a devastating fever*", in which the tree was felled, the trunk surrounded with dead wood, which was ignited. The effect of this was to coagulate the latex on the bark, which was then hammered off, producing in the process latex full of impurities (plant debris, sand, gravel…) in order to increase raw product weight, a common practices when there is no quality based pricing policy (still the case in some areas in Indonesia today). In 1911, Fauchère pointed out that the rubber hunters as a rule didn't fell the trees but inflicted wounds which often resulted in their death. He also condemned the fact that "*When lianas were involved, […]. It was not uncommon to see the roots dug up*". Girod-Genet (1898) spoke of "*barbaric procedures*", a concept which was echoed by numerous authors like Prudhomme (1899/1900), who talked about "*irreparable damage caused by the Negroes' carelessness and the collectors' greed*", and Hamet and Josse (1913) who decried "*the state of devastation*" of the rubber groves.

The care (or moreover the lack of care) taken during harvest depended partly on the collectors. Their motivations varied, but as a general rule, it can be said that rubber was not a tradition for any Malagasy, which Vacher (1907) translated saying that "*most of our natives […] were unaware of the existence of rubber trees in their region*". However, certain ethnic groups were used to seeking out all or part of their means of subsistence from the forest. Such was the case, for instance, with the *Tanales* and the *Sakalaves* who turned their hand to rubber collecting quite naturally and without changing their way of life

(Tralboux, 1902; Vergely, 1907). But for others, collecting rubber became a subsidiary activity, the main motivation of which was to earn income.

The same situation and actors ' strategies occurs in West Africa with the same consequence : the rapid disappearing of the resources. in particular in Guinea Bissau which trend and evolution was very similar to that of Madagascar.

Thus, the *Antaimoro* became rapidly aware of the gains that could be made from this new activity, so as to "*improve their savings, their well-being, their rice paddies and their herds*" (Vergely, 1907). Likewise, for the *Antandroy*, most of whom were cattle breeders, the motivation to convert to rubber collecting was the creation of a tax on cattle in 1903, "*anxious to keep their enormous herds intact, they turned to rubber for the cash they needed*" (Vacher, 1907). Durand noted in 1908, moreover, that the "*natives*" very often only turned to collecting rubber when the tax became due.

This lack of tradition and the primarily financial motivation explains why the exploitation methods used by the collectors were often careless, because the object was to ensure a harvest and one with a high return (Thiry, 1903; Perrier de la Bâthie, 1912; Boiteau, 1943).

The collectors were quick to come up with strategies to increase the weight of rubber sold to dealers, whilst minimising the amount of time spent harvesting. This chapter in the history deals with the frauds which were widely documented by traders, administrators and scientists. The most common fraud consisted in adulterating the balls of rubber by bulking up their weight with foreign objects such as stones, bark and sand (Baron, 1890; Durand, 1908; Bourdariat, 1911). Another trick was to soak them in water. An even more subtle ruse cooked up by some collectors involved mixing the latex of rubber species with that from widely available, poor quality species (such as *Ficus melleri*, *Plectaneia elastica*, *Plectaneia thouarsii* and *Marsdenia verrucosa*), increasing the collected weight in the process, but reducing the quality of the end product (Griess, 1907; Jumelle et Perrier de la Bâthie, 1908; Poisson, 1908; Louvel, 1910; Boiteau, 1943). It

seems as though this adulteration rapidly became standard practice, and that a large proportion of the Malagasy rubber harvest was subject to these types of fraudulent practice.

However, it is worth noting that the intermediaries in the sector never placed a high value on quality in the rubber delivered to them. Vacher (1907) pointed out that the best prepared rubber was never better recompensed than the latex coagulated on the ground, "*there was no incentive for the native to abandon his primitive extraction method*"… and so, they persisted in their corrupt practices. Bührer (1909) estimated that it was impossible to improve the quality of the rubber produced whilst "*remaining in this vicious circle which says to the buyer: 'the product is always poor quality, so I'll pay the minimum for it' and to the producer: 'I'm paid the minimum, so never mind the quality*". In other words, the lack of pricing policy linked with high rubber prices due to scarcity (up to 1918) did not favour quality and directly boost over-exploitation from extractivism whatever sources. The lack of another rubber source, trough for example hevea plantations which rubber was already considered as of better quality in the 1910's , that could take over resource depletion and maintain incomes re-inforce pressure on the already scarce resource.

Endangered species?

From 1898, Girod-Genet was writing of *Eeuphorbia intisy*: "*this plant has become extremely rare*". What's more, he announced, without any compunction, the imminent destruction of the ecosystems and the disappearance of the rubber species. Professor Lecomte (1929) of the *Académie des Sciences* spoke of "*plants currently or previously used by man"*, and in particular of *Euphorbia intisy,* that "*have almost entirely disappeared due to thoughtless devastation"*. Bigorne, in 1931, reviewing the products derived from the Malagasy forest, quoted "*for the record*" the rubber species "*which have almost totally disappeared*", and Decary (1966) stated with regard to *Euphorbia pirahazo* that

this tree "*has not been reviewed by botanists for a fair few years*". In fact, this species today does not appear to be particularly endangered (Haevermans, 2003).

The culprit was clearly singled out as the native. For Girod-Genet (1899) "*the majority of plants containing rubber, resins or latex of use to the industry were subject to barbaric exploitation by the natives. Not only were they expected to produce far greater annual yields than they should have been, but they were even destroyed to obtain in one go the greatest amount of saleable product*". Lieutenant Bührer (1909) denounced "*the lamentable exploitation of rubber plants by the natives*". In 1911, Bourdariat spoke of the Malagasy forest as a "*precious capital abusively exploited by the natives*". Sometimes however a more subtle and less Manichean stance was taken. Thus Prudhomme (1899/1900) and Perrier de la Bâthie (1931) admitted that the colonials were as much to blame as the natives. Likewise Decary (1926) held "*natives and Europeans*", "*whites and blacks*" equally responsible for pillaging the resource.

CONSERVATION AND VALORIZATION OF THE SPECIES, FROM UTOPIA TO INAPPLICABILITY

Acknowledgment of the disappearance of rubber species, and more generally the decline of the Malagasy forests, provoked a reaction (Jarosz, 1993; Kull, 2000). Politicians put forward a legislative corpus aimed at protecting the species and organising sustainable management of the ecosystems. The agronomists devised a set of strategies to develop cultivation of the most interesting species, in order to perpetuate the sector in Madagascar.

Repressive but unenforceable policies

Where the rubber species were concerned, the first legislative decisions were taken as early as 1897. An order dated 3rd July required of each producer that

he "*be obliged to plant every year, at his own expense, three times as many precious species as the number of trees felled in the course of the year*". The ministerial order dated 10th February 1900, which set out the Malagasy forestry regulations, specified the methods of bleeding rubber trees and lianas "*in order to avoid destroying the producing plants*". It also decreed that felling or uprooting rubber plants could be punishable with imprisonment for one to ten days. These points were confirmed in the order dated 20th September 1907 regulating the exploitation of forestry products and by the ministerial order of 28th August 1913 relating to the forestry regulations in Madagascar. This reiterated the requirement for planting in each farmed plot a minimum of 150 rubber trees or lianas per hectare, instituting an annual tax of ten centimes per hectare farmed, payable in advance and provided for a penalty of up to five years imprisonment for "*anyone damaging, burning, ransacking or destroying […] forests managed or artificially repopulated with rubber species*".

But the majority of decisions, as repressive as they were, remained ineffective, due to the administration having too few personnel to enforce them: in the years between 1896 and the 1920s, the number of forestry officers appointed to the island varied from one to two and the number of officials, from two to five (Lavauden, 1934)! Moreover, Captain Jeannot (1901) was under no illusion as to the impact these laws would have on the rubber collectors: "*it would be unfeasible to compel natives as undisciplined as those involved in the harvesting of rubber to abide by rules, even the simplest. […] A rubber hunter, camped out in the depths of the forest, is only concerned with his own immediate needs and will never take on a process which will yield less and create extra work*".

Short lived agronomic research

From the agronomist's point of view, scarcity of the resource led to the development of a double approach in Madagascar: (i) attempt to refine methods for preserving and managing the natural ecosystems rich in local rubber

producing species, (ii) promote the introduction and acclimatation of exotic species with an already identified potential.

These two approaches are neither original, nor specific to Madagascar (Bergeret, 1993; Pouchepadass, 1993). They correspond to the two major lines of action that scientists and colonials were applying at the turn of the 20th century. It was their ambition, out of a sense of national duty, to further exploitation of the colonies' resources to the advantage of the homelands' emerging industries (Chevalier, 1930, 1946; Lavauden, 1941; Bonneuil and Kleiche, 1993). Madagascar then became, like the whole of the newly colonised and pacified regions, a land ripe for the discovery of natural wealth, scientific exploration, domestication of exotic natural environments and agronomic innovation (Bergeret, 1993; Pouchepadass, 1993).

The work undertaken was founded on a principle declared by Jean Dybowski, the director of the Colonial Garden in Nogent-sur-Marne, in France (1897): "*Certain species are bled for rubber. Fibres from the palm trees are harvested for raffia […]. And one becomes so used to harvesting products which come spontaneously that sometimes one deduces from it, that this is what rational exploitation of our colonies consists of […] It is not enough to satisfy oneself with harvesting products that are freely available, one must cultivate*". To quote yet another, Eugène Tisserand, agronomist and statesman, in 1902, wrote: "*the forests that produced gutta-percha are becoming depleted; the rubber lianas under the devastating machete of bush runners are receding in the face of the progressing invasion; it won't take much for our most precious species, if we don't hurry to repopulate, to disappear, exhausted by excessive exploitation*" (from Bonneuil and Kleiche, 1993)[4].

And so it was that Madagascar and the rubber species represented a vast subject of investigation during the early part of the 20th century. The research proposals were directed three ways: (i) conservation and management of forest

[4] The only gutta percha plantation still remaining in activity is located close to Bogor in Java (Indonesia), which product is used for high quality golf balls.

ecosystems rich in rubber species, (ii) domestication and cultivation of local species and (iii) introduction of exotic species with previously identified potential and for which cultivation was already controlled.

Delmas and Duffart (1908b) recommended the first solution: " *The forest, alone, in its integrity – such as nature made it with its undergrowth, its dead layer, even its parasites (plant and animal), thinly yet robustly populated with 100 to 150 rubber plants per hectare – is and should remain the supreme resource of rubber production*". In the Menabe (western Madagascar) this proposal began to take effect at the beginning of the 20th century. The administration tried to instigate transfer of forestry management to local populations and farmers: " *The forests in each region will be divided between the villages of that region, each village fixing the boundaries of its* 'faritany'*, the village chief will then allot shares of the forest to his people*". The administration compelled the *Sakalave* collectors to regenerate the stands exploited by propagating the major rubber species from layering or cutting. Thus, in March 1905, 7000 layers were planted, each one registered in the owner's name (Rey, 1905). These proposals were upheld by the authorities since the order dated 3rd July 1897 and the ministerial order of the 28th August 1913 obliged farmers to aid the regeneration of exploited species. These attempts at managing the ecosystems rich in rubber species were, nonetheless, to no avail.

Other foresters, like Thiry (1903), appeared to be optimistic about the feasibility of cultivating Malagasy species: "*Madagascar is particularly privileged. The best of our lianas, which up until the present day have remained unidentified, even botanically, are […] liable to hold their own against those rubber species, currently mostly highly considered.* Landolphia *is easy to cultivate […], and suffers less hazards than any other cultivation yet attempted on the island*". Thiry estimated at 400,000 hectares the surface area of forest in the east suitable for planting and considered cultivating Malagasy lianas to be more economically beneficial than planting major exotic species (*Hevea*, *Castilloa*, *Ficus* or *Kickxia* (other name *Futumnia*)). This point of view was also

defended by Bourdariat (1911) and Louvel (1910), who advocated more than an assisted regeneration system, but envisaged implementing real "*rubber reserves*" by domesticating local species and, more specifically, lianas of the *Landolphia* species. In fact, a large base of preliminary knowledge was obtained, at that time, from various studies on the aptitude to propagation (sowing, layering, cutting), types of behaviour and methods of exploitation of these species (age of exploitability, harvesting heights, management of suckers…) and even on the likely economic profitability of such reserves This idea was picked up on by Perrier de la Bâthie and Jumelle (1907) who considered it possible to create groves of Malagasy rubber species from scratch in savannah zones. Griess (1907) proposed, along the same lines, to launch the cultivation of *Euphorbia intisy,* for which cutting was reputedly very easy (a point which was never confirmed).

However, all these fine projects were never implemented. The risks in launching a new cultivation and the need for investment with only long-term returns must have discouraged the colonials.

In the rest of the world, research did focus mainly on hevea brasiliensis with clonal average production around 1500 kg/ha/year in humid tropical areas and "Guayule" (nom latin ???, j'ai oublié !!) in dry areas (Brazil and Mexico). Currently, 99 % of rubber produced in the world is with hevea.

This explains why some envisaged instead the creation of groves of rubber obtained from introduced species (Griess, 1907; Bourdariat, 1911; Fauchère, 1911; Perrier de la Bâthie, 1912; Hamet and Josse, 1913) according to the model implemented in South East Asia. The candidate species featured, naturally, *Hevea brasiliensis* (Plate 3), but also the ceara rubber tree (*Manihot glaziovii*), *Castilloa elastica*, *Funtumia elastica* from Africa, as well as, *Ficus elastica* from Asia. Introduction trials were carried out under various edaphic and climatic conditions in the years from 1888-1902 (Prudhomme, 1899/1900; Perrier de la Bâthie and Duchêne, 1908; Fauchère, 1911) often with contradicting results.

According to Perrier de la Bâthie and Duchêne, (1908), the ceara rubber tree developed satisfactorily in the Morovoay region. Whilst Perrier de la Bâthie (1912) considered hevea and ceara took well in the Sambirano. Fauchère (1911) even pointed out that "*it seems that these trees, if correctly cultivated, should be able to provide crops which compare to those obtained in the countries where they are cultivated*". However Hamet and Josse (1913) were much more sceptical, concluding that in Madagascar, "*it has not yet been proven that the American species are able to acclimate profitably*". Prudhomme (1899/1900) was altogether doubtful on the success of cultivating rubber species. He advised, moreover, for the east coast "*cultivation which was better known and with more guaranteed success, such as that of vanilla, cocoa, cloves and coffee*". It was, on proof of evidence, the latter option which turned out to be justified: no economic development ever came of these trials and vanilla became one of Madagascar's principal export products (Figure 4). Little more than 800 hectares of plantation were counted in 1908 (Fauchère, 1911) and no rubber producing programme ever saw the light of day in Madagascar. Some small scale trials have been established in the 1930' in eastern and North-West coasts that rapidly disappeared due to the high prevalence of typhoons in average 2 to 3 per year). Madagascar was evidently not a good candidate for hevea rubber compared to Southeast Asia (the big 3, Sri Lanka, Vietnam, Cambodia, burma and recently India and China) and West and Central Africa (Ivory Coast, Ghana, Liberia, Nigeria, Cameroon and Gabon). Two opportunities could lead to a large rubber programme development : i) scarcity during WW II but time was too short to set up plantations[5] and ii) the loss of Indochina in 1954 that lead french rubber companies to diversify their supply to Africa. Madagascar was too far and with less comparative advantage than Ivory coast or Cameroun.

[5] It takes globally 10 years to effectively began to produce significative amount of rubber when immature period of rubber trees is between 5 to 6 years in average and plantations could be effectively established after budwood gardens are producing.

THE NATURALISTS GET INVOLVED TO COMPENSATE FOR THE INCOMPETENCE OF THE AUTHORITIES.

Naturalists have always reprimanded slash and burn cultivation (*tavy*) traditionally practised by Malagasy peasants and considered a prime factor in deforestation (Perrier de la Bâthie, 1921; Humbert 1927; Gade, 1996; Kull, 2000). The practices related to rubber collection were the first cause of destruction of the ecosystems for economic ends. They added a new dimension to the concerns of nature conservationists, who strongly doubted the colonial administration's capacity to ensure the preservation of Madagascar's biological heritage, because as Perrier de la Bâthie (1931) highlighted without any illusions, "*in Madagascar more than anywhere, there is a gulf separating the written law from its effective application*".

Two direct consequences of this distrust can be highlighted, which are not inconsequential for the Malagasy environmental policies of that era.

The first is the emergence of a very pessimistic discourse on the protection of Malagasy biodiversity. It should not be overlooked, and it is rarely documented (rightly enough!), that the catastrophist tone of this discourse was intentionally over-stated, as it was intended, in the minds of the naturalists, to convince a body (administrators and civil servants) judged "*too often apathetic and cautious*", as reported by Perrier de la Bâthie (quoted by Lacroix, 1938). This position, moreover, converges with another quote, typical of Perrier de la Bâthie, who in 1928 dramatised the situation by proposing to abandon the forest to the exploiter because in any case, "*the climatic conditions, the customs of the natives, the self interest of the farmers and the indifference of the leaders, all condemn the forest to extinction, anyway*". In actual fact, the naturalists seemed not to trust the politicians to take and apply the conservative measurers they were recommending. In their eyes, the political powers appeared very amateurish in the way they went about implementing the regulations in order to ensure the conservation of the biological heritage. Thus, Lavauden, in 1931, claimed that "*it's about time the authorities took stock of the real social danger*

in neglecting these massive degradations and in abandoning […] the evolution of the vegetation cover to the vagaries of habit, preconceptions and trends." In the same spirit, Roger Heim (1935), the deputy director of the *Muséum d'Histoire Naturelle*, in Paris, wrote: "*It is likely that one day, in Madagascar as elsewhere, the entire responsibility for technical services will finally be entrusted to men who are specialised and competent. But when it comes to the forest the implications are particularly serious, in that the solution cannot wait. It's now or never; either there is an immediate improvement or there won't be any at all*".

Hence, and this is the second consequence, it is out of defiance of the legislation in place and those responsible for applying it, that the naturalists imposed the idea of creating "*nature sanctuaries*" intended to "*provide life-long protection against exploitation*", and therefore established in uninhabited areas, with difficult access in order to dissuade any "*temptation to cultivate or exploit, and hence any complaints from present or future occupants*" (Lacroix, 1938). The first network was established in 1927 and consisted in ten reserves covering a surface area of approximately 350,000 hectares. It had been conceived with a view to preserving evidence of primitive fauna and flora. These reserves were free from all rights of usage; hunting, fishing and mining were all forbidden, as was picking wild plants (article 4 of the ministerial order dated 31st December 1927). The order made provision for the reserves to be placed under the auspices of the *Muséum d'Histoire Naturelle*, in Paris, in order to ensure the longevity of the action (Petit, 1928; Lecomte, 1929). This was because, had they had been entrusted exclusively to the forestry service, they "*would be left to themselves and there would soon be nothing more left of them but a puff of smoke and a pile of ashes*" (Perrier de la Bâthie, 1931). In this, Madagascar was at the vanguard, as one of the first countries in the world to possess a network of wildlife sanctuaries, and in Africa, was preceded only by the Albert National Park in the Belgian Congo (Perrier de la Bâthie, 1931) and the Kruger National Park in South Africa (Humbert, 1933; Anonymous, 2006).

However, certain factors in the history of Malagasy rubber show that scientific discourses are not infallible. The following historical points demonstrate how the naturalists, from 1943 onwards, under obligation to have Madagascar participate in the war effort were compelled to contradict their own discourse. They were forced to admit that the catastrophism they had been disseminating since the 1920s concerning the destruction of the rubber species was unfounded. And worse still, they became actively involved in the promotion of rubber collection.

It is possible to detect, in Figure 3, a brief yet distinct recovery in Malagasy and African rubber production during the years from 1943-1945, simultaneous with the dramatic fall in the output from Asian hevea plantations. This fall can be explained by the Japanese occupation of South East Asia from 1942 during which they took control of around 90% of the Asian hevea plantations (Bouvier, 1947). Rubber production in the occupied countries (Malaysia, Dutch East Indies, Thailand and French Indochina) dropped henceforth from 1390 tonnes in 1941 (manqué trois zero au moins !!!) to 21 tonnes in 1945 (Bouvier, 1947) idem . As a result, the Western powers turned to the past production zones of forest rubber production in order to compensate for the deficit in primary material. In America, rubber was considered at that time a strategic material, the absence of which represented the most serious threat to national security, in particular for plane tyres. The Rubber Survey Committee was created in 1942 and the country signed an agreement with Brazil aimed at reviving production in the Amazonian forest (Sérier, 1993) as well as promotion of Guyaule in the Sertao area. . As for Madagascar, a six month military campaign (from May to November 1942) by British and South African troupes culminated in the surrender of the French Vichy government, after which the Island was placed under Gaullist occupation (Brown, 2000). At the beginning of 1943, General Legentilhomme, the new governor of Madagascar, undiplomatically declared

"*there is an obligation for the natives to contribute to the war through restored discipline, increase in the output of labour and maximisation of productivity*" (Thobie *et al*, 1990). This war effort was accomplished by recourse to forced labour, the requisitioning of harvests (in particular, rice) and the resumption of natural rubber collection (François, 1945; Guillermin, 1947; Moranche, 1947; Thobie *et al*, 1990; Brown, 2000).

In 1942, when the war effort became a national priority, there was a change in naturalist discourse. A Rubber Committee ("*Comité du caoutchouc*") was created which published in 1943 and 1944 instructions "*for maximising production of the best quality Malagasy rubber*". The botanist Pierre Boiteau distributed at the time, under the seal of the Governor General of Madagascar, a study on the Malagasy rubber species, which could be read as a guide destined for use by farmers (Boiteau, 1943). These documents make no reference to the alarmist scientific publications of the previous years! The legislative corpus was more concerned then with providing a framework for the promotion of rubber collection. An order providing for the regulation of the exploitation, trade and distribution of rubber in the colony and dependencies of Madagascar was instituted on 3rd November 1942. It authorised, in blatant contradiction of the previous discourse, native cooperatives to exploit rubber plants in the national forests, which were neither allocated, nor classified as natural reserves. It regulated the methods of harvesting and preparing the rubber: uprooting and felling prohibited trees, obligation to cut the lianas at ground level and tap the trees, obligation to prepare the rubber in folds, ban on mixing different latexes, authorisation of only two methods of coagulation; acid or heating. Hence, natural rubber production was revived from 1942, with output peaking at 812 tonnes in 1944 (Figure 3) (yet representing only 0.2% of world output). And so, after twenty years of alarmist discourse predicting the irreversible destruction of the ecosystems, the Malagasy forests were once more producing rubber! The same went for the forests of the French African colonies (Aubréville, 1949). It is of note also that at that same time (1943) the USA attempted in Haiti, to

cultivate a species of Malagasy rubber, *Cryptostegia grandiflora* (Compagnon, 1986).

HISTORY REPEATS ITSELF BUT LESSONS ARE SOON FORGOTTEN

The birth, rise and subsequent extinction of the rubber sector of Madagascar, at the turn of the 20th century, was the first case of exploitation and exportation of a natural Malagasy resource for industrial ends. The setting up of this sector, supported by a strong economic world demand coincided with the development of naturalist and conservationist thinking, which is still dominant to this day (Kull, 2000). As a contrast between the past situation and the present context the following observations can be made. The first observation relates to the naturalists' discourse. There were times during the first half of the 20th century, when this was a caricature of exaggerated catastrophism. It was orchestrated so as to spur the authorities into action. The revival of rubber production as a contribution to the war effort proved blatantly that the condition of resources was far better than the biologists let on. Today, the question, as posed by some authors, such as Kull (2000), is whether the discourse propagated by international conservationist NGOs on the loss of biodiversity in Madagascar might not be motivated by the same intentions.

The second observation, a consequence of the first, is the similarity in the determination by politicians to ensure the preservation of the Malagasy biological heritage. Madagascar was one of the first countries in the world to equip itself with a network of nature reserves, starting in 1927 (Kull, 1996). Today, evidence of the continuity of this is visible in recurrent proposals for the creation of new protected sites (ANGAP, 2001; Randrianandianina *et al*, 2003). Likewise, the Durban Declaration of September 2003, made by the head of state during the world congress on protected areas, announcing his determination to extend the coverage of Madagascar's protected areas from 1.7 million hectares to more than 6 million hectares before 2008, follows in the

same vein (*L'Express de Madagascar*, 17th April 2004). This objective mobilises numerous local and international capacitates (Borrini-Feyerabend and Dudley, 2005a, 2005b). These observations highlight a paradoxical situation in which, despite an early awareness of the need, and constant efforts over the past 80 years, to preserve Madagascar's biological heritage, the situation is judged at present to be critical. This ranks Madagascar amongst the "hottest hotspots" of global biodiversity (Myers *et al*, 2000).

Finally, in a last observation, it can be noted that once launched, the process elaborated during the rubber producing enterprise: revealing the value of a natural resource, its exploitation, and subsequent impoverishment of the biological heritage, proved irreversible. All the fine discourses and attempts at sustainable managing the ecosystems, domesticating high performing species and installing cultivation based on high-potential exotic species were ineffective at arresting the process. Thus, beyond proposing technical solutions for prolonging the Malagasy rubber sector, no apparent determined efforts in the economic sphere for investment in the field ever materialised. The transition from a context of instantly profitable, investment free rubber collected by a native workforce, in a *de facto* context of free access to the resource, towards one involving the establishment of cultivation with an unpredictable return on investment did not come about. Guaranteeing the protection of Malagasy rubber species has not been accomplished by scaremongering, repressive legislation, or networks of protected areas, but by pure economic realism, which has simply condemned an area of production that has become unprofitable. This is not a new or recent observation, but one which has already been put forward in relation, for example, to the extraction of rubber in Amazonia (Homma, 1992). This, alas, is history which has long been forgotten, but which today is repeating itself in an identical scenario where for rubber species, just read *Prunus africana* as reviewed by Stewart (2003).

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Index of figures

Plate 1: A remarkable specimen of *Euphorbia intisy* and collector near Fort-Dauphin (not dated) (Doc. XI. Ba n° 48, *Fonds Grandidier, Parc botanique et zoologique de Tsimbazaza*, Antananarivo, copyright PBZT)

Plate 2: Diagram of the device for collecting the extract of segments of liana, as used by the collectors (Thiry, 1903).

Plate 3: An example of hevea introduced in the trial garden at Tamatave, in the bleeding phase at the turn of 20th century (*Photothèque du Foiben-Taosarintanin'I Madagasikara,* Antananarivo, copyright FTM).

Family	Species	Plant type	Latex extraction method	Quality of rubber
		Eastern evergreen forests		
Apocynaceae	*Landolphia gummifera* (Poir.) K. Schum.	Large liana	Draining logs from stems	+
	Landolphia mandrianambo Pierre	Liana	Draining logs from stems	nd
	Landolphia myrtifolia (Poir.) Markgr.	Large liana	Draining logs from stems	++
	Mascarenhasia arborescens A. DC.	Tree/shrub	Felling and cutting /stripping	+++
	Mascarenhasia lanceolata A. DC.	Small tree	Uprooting and stripping bark from stems and roots	++
	Mascarenhasia macrosiphon Baker	Tree	nd	nd
	Mascarenhasia rubra Jum. & H. Perrier	Tree	Felling and tapping	+++
		Western deciduous forests		
Apocynaceae	*Landolphia mandrianambo* Pierre	Liana	Draining logs from stems	+
	Landolphia myrtifolia (Poir.) Markgr.	Liana	Draining logs from stems	+++
	Landolphia tenuis Jum.	Thin stemmed liana	Draining logs from stems	++
	Mascarenhasia arborescens A. DC.	Tree/shrub	Felling and cutting /stripping	+++
	Mascarenhasia lisianthiflora A. DC	Tree	Uprooting and stripping bark from stems and roots	+
	Plectaneia elastica Jum. & H. Perrier	Liana	Draining logs from stems	+
	Plectaneia thouarsii Roem. & Schult.	Liana	Draining logs from stems	+
Asclepiadaceae	*Cryptostegia madagascariensis* Bojer ex Decne.	Liana	Draining logs from stems	++
	Gonocrypta grevei Baill.	Liana/shrub	Bark stripping	++
	Marsdenia verrucosa Decne.	Liana	Tapping fruit	+
	Pentopetia elastica Jum. & H. Perrier	Liana	Draining logs from stems	+
	Pentopetia grevei (Baill.) Venter	Liana/shrub	nd	+
	Secamonopsis madagascariensis Jum.	Liana/shrub	Tapping stems and fruit	++
Euphorbiaceae	*Euphorbia pirahazo* Jum.	Large tree	Tapping, felling and cutting	++
		Southern scrubland		
Asclepiadaceae	*Cryptostegia grandiflora* (Roxb.) R. Br.	Liana	nd	+
	Gonocrypta grevei Baill.	Liana/shrub	Bark stripping	++
	Pentopetia grevei (Baill.) Venter	Liana/shrub	nd	+
	Secamonopsis madagascariensis Jum.	Liana/shrub	Tapping stems and fruit	++
Euphorbiaceae	*Euphorbia intisy* Drake	Small tree	Tapping, cutting trunk and roots	+++

nd: not determited

Table 1: Taxonomy (updated by MBG, 2006), biological types, latex extraction method and rubber qualities (+: low; ++: medium; +++: high) of the main rubber species exploited in Madagascar (according to Jumelle, 1901, 1903; Dubard, 1906; Constantin and Galland, 1907; Hamet and Josse, 1913; Perrier de la Bâthie, 1910, 1912; Fauchère, 1911; Jumelle and Perrier de la Bâthie, 1908, 1909, 1912; Loisy, 1914; Boiteau, 1943; Léandri, 1952).

Figure

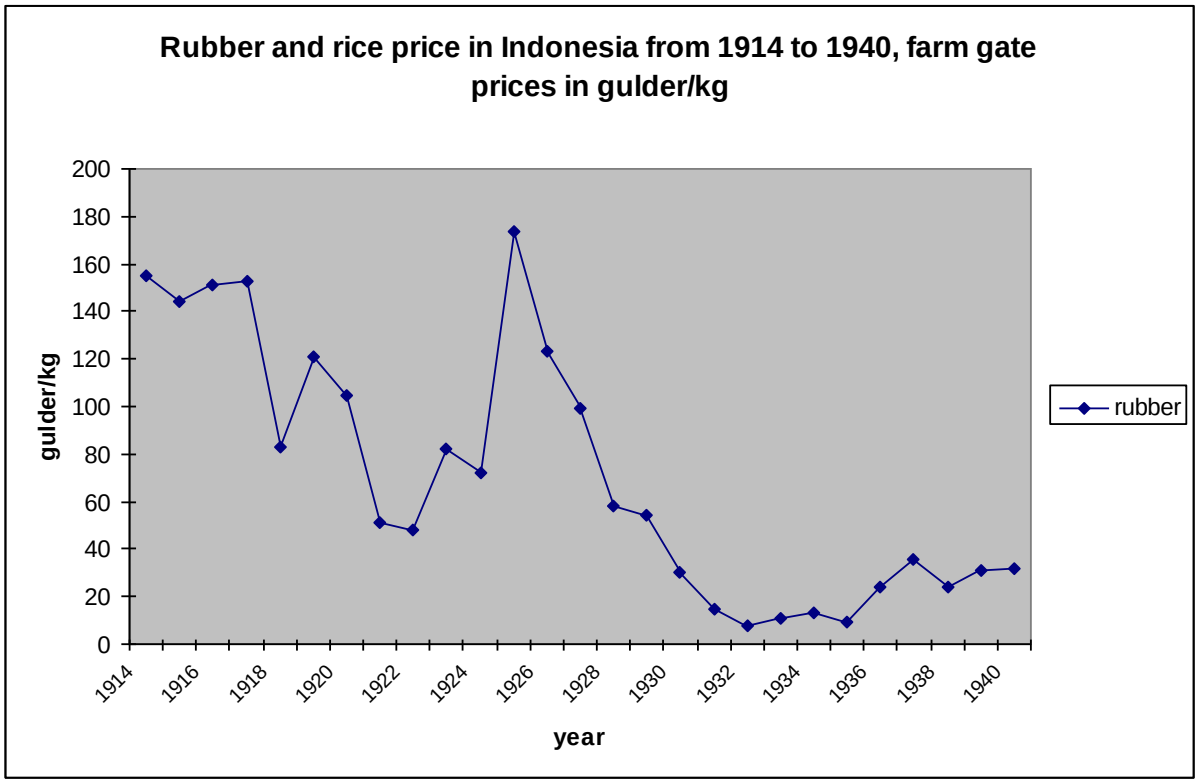
Rubber and rice price in Indonesia from 1914 to 1940, farm gate prices in gulder/kg
gulder/kg
200
180
160
140
120
100
80
60
40
20
0
1914
1916
1918
1920
1922
1924
1926
1928
1930
1932
1934
1936
1938
1940
year
rubber

Table XXX. World Natural Rubber Production

	Thailand	Indonesia	Malaysia	India	China	Sri Lanka	Viet Nam[a]
Production ('000t)							
1910	-	3 (3)b	6 (6)	-	-	2 (2)	-
1930	4 (1)	245 (29)	467 (56)	9 (1)	-	77 (9)	11 (1)
1950	114 (6)	707 (37)	761 (40)	16 (1)	-	116 (6)	92 (5)
1970	287 (9)	815 (26)	1,269 (40)	90 (3)	46 (1)	159 (5)	28 (1)
1990	1,271 (25)	1,262 (25)	1,291 (25)	324 (6)	264 (5)	113 (2)	103 (2)
1995	1,786 (31)	1,420 (24)	1,085) (19)	500 (9)	360 (2)	103 (2)	95 (2)
High-yielding trees, 1995 (%)[e]	52	17	95	92	100[f]	75	15

	Nigeria[g]	Ivory Coast	Philippines	Cameroon	Kampuchea	Others[h]	World
Production ('000t)							
1910	14 (14)[b]	g	-	g	-	70 (65)	98
1930	5 (1)	g	-	g	a	20 (2)	838
1950	56 (3)	g	1 (-)	g	a	27 (1)	1,890
1970	65 (2)	11 (-)	20 (1)	12 (-)	3 (-)	172 (5)	3,140
1990	152 (3)	69 (1)	61 (1)	38 (1)	35 (1)	136 (3)	5,120
1995	93 (2)	77 (1)	60 (1)	55 (1)	44 ( )	142 (2)	5,820
High-yielding trees, 1995 (%)[e]	10	90	30	70	10	na	na

Notes:

a. Kampuchea and 'other' Southeast Asian production included in Vietnam up to 1970.
b. Figures in parentheses along production lines are shares of each country's NR production in total world production.
c. Figures in brackets along this line are percents of smallholdings in total planted area of early 1990s.
d. Probably about 30 percent, with the balance being under state farms.
e. Estimated by author, using best available information.
f. The smallholder area in particular is poorly managed.
g. All African production included under 'Nigeria' up to 1990.
h. Mainly Brazil and Guatemala up to 1970. Subsequently including Myanmar, Liberia, Zaire and several other small producers.
i. Percent of holding less than 5 ha. j. All African consumption included under Ivory Coast.

Source 1: Barlow, Jayasuriya and Tan (1994); International Rubbers Study Group, 1946-96.
Source 2: Working Papers Trade and Development.