Travelling Plants - Cinchona , the Fever Tree

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Summary- *Tracing the journey of the miraculous drug quinine from the Andean flowering plant to a potent agent in the transcontinental colonising process of European powers.*

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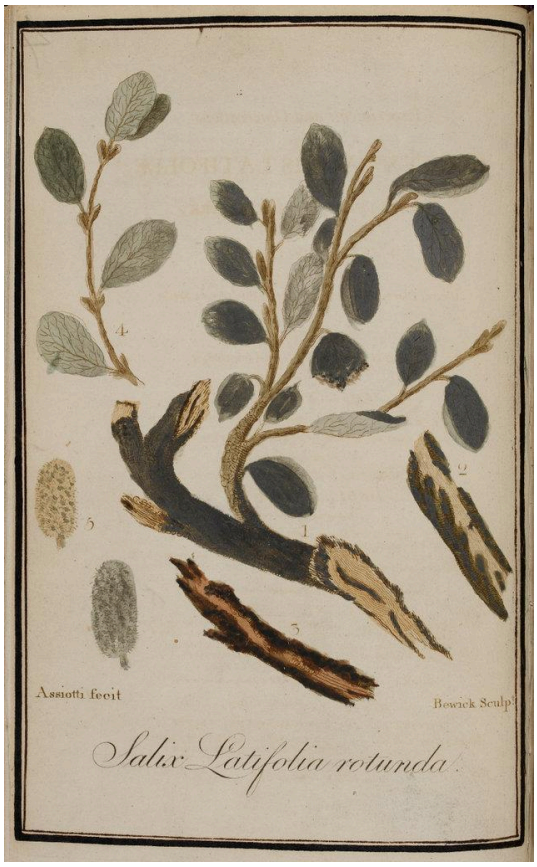
Gin and Tonic

Quinine is an alkaloid extracted from the bark of the Cinchona, or 'fever' tree (Cinchona spp.) and if you ever had the 'tonic water' with or without the gin, you will be familiar with the bitter taste of the tonic which is provided by quinine. Gin and tonic had their origins from the officers of Presidency armies of the East India Company as a remedy to malaria. The bitter flavouring of tonic water comes from an alkaloid called quinine extracted from the Andean fever tree (Cinchona spp.). Originally, quinine powder was added to water and drank as a remedy, but its bitterness soon led to adding sparkling water and sugar, or was mixed with wine, gin, rum or locally available spirits such as arrack. The tonic of that time could contain approximately 100 times more quinine than the tonic that you currently drink. So if you find the tonic bitter, imagine drinking that drink![1]

Cinchona's value soared during the 19th century, when malaria was one of the greatest threats faced by European troops deployed in overseas colonies. Obtaining adequate supplies of quinine became a strategic advantage in the race for global domination, and cinchona bark turned into one of the world's hottest commodities. The myth of gin and tonic as a potent anti-malaria prevention led Winston Churchill to claim that the drink had saved "more Englishmen's lives, and minds, than all the doctors in the Empire."[2] European soldiers engaged in colonial wars frequently died of malaria, and drugs like quinine enabled soldiers to survive in tropical colonies and win wars. This miraculous drug became a potent agent in the colonising process of European powers.[3]

Figure 1. Salix Latifolia Rotunda, Cinchona



(Quinine) . Image - Wellcome Images. Wikimedia Commons. 2023.

To the untrained eye, the thin, 15 m-tall Cinchona Officinalis tree may blend into the thicketed maze. But the flowering plant, which is native to the Andean foothills, and appearing as the national tree of Peru and Ecuador, has shaped human history for centuries. Quinine is a corruption of the word 'Kinakina' or 'bark of

[1] Soportehans. "ORIGIN OF THE GIN TONIC (English) – Licores & Gins Bull Terrier," n.d. https://licoresbullterrier.es/origin-of-the-gin-tonic/.

[2] Traverso, Vittoria. "The Tree That Changed the World Map." BBC Travel, February 25, 2022. https://www.bbc.co.uk/travel/article/20200527-the-tree-that-changed-the-world-map.

[3] Deb Roy R. *Malarial Subjects: Empire, Medicine and Nonhumans in British India, 1820–1909*. Cambridge: Cambridge University Press; 2017. doi:10.1017/9781316771617

the barks' in the Quincha language of Incas, and its virtues were probably known to the American Indians before the arrival of the Spanish.[4] It is currently believed that malaria was not present in the Americas before European colonisation, and was introduced by seafaring Europeans.[5] By the time Europeans reached the Andes, the indigenous population were already using the bark of the cinchona tree to treat malaria and other fevers, the disease spreading faster than the European colonists. The locals introduced the bark to Spanish Jesuits, who in turn crushed the cinnamon-coloured bark into a thick, bitter powder that could be digested. The European colonisers first sent the bark to Europe around the 17th century, probably by way of Jesuit missionaries, marking it as a "popish" medicine in the minds of many protestants. Nevertheless it provided a superior cure to a variety of fevers prevalent in Europe, particularly in its swampish regions.

The use of cinchona bark was firmly established in England by Robert Talbor (or Tabor), apprenticed to an apothecary in Cambridge, where he learned about the Peruvian bark. Later in London, Talbor produced a highly successful remedy for the disease, revealed after his death as carefully sourced Peruvian Cinchona bark mixed with rose leaves, lemon juice, and wine. Quality control of the bark arose as a major obstacle, leading two French chemists, P.J. Pelletier and J.B. Caventou, to isolate in 1820 the 'active principle' or chemical compounds called alkaloids of complex structure: quinine and cinchonine from cinchona bark, responsible for its curative properties.[6] Note that at this stage the bark itself was used as a medicine, the chemical processes to extract the quinine from the bark were only invented later. The findings of Pelletier and Caventou also made it possible to assess accurately the quinine content of the bark of any given species of cinchona tree.

Origins of Colonial Transplantation

Cinchona's value soared during the 19th century, when malaria was one of the greatest threats faced by European troops deployed in overseas colonies. Obtaining adequate supplies of quinine became a strategic advantage in the race for global domination, and cinchona bark turned into one of the world's hottest commodities.[7] Colonial powers like Britain and the Netherlands began to collect seeds and saplings, which led to the competition and exploitation of the cinchona trees from the cinchona-growing region of Peru known as the Caravaya forest that bordered Bolivia's cinchona regions. After their independence from Spain in the early 19th century, they inherited the monopoly on the exploitation of the cinchona tree. Aware of the global interest in quinine by the mid-1850s, the governments of Peru and Bolivia banned the export of cinchona. With the colonisation of 'malarious' parts of the world demanding large amounts of quinine, collectors had to travel to more and more remote regions to find trees with any bark left, paving the way for smuggling of the bark and the plants. Cinchona was especially used by the Dutch in Indonesia; by the French in Algeria; and most

[4] P., Priya. 2016. 'Review of Medicine and Modernity.' *Proceedings of the Indian History Congress* 77: 16. https://www.jstor.org/stable/10.2307/26552688.

[5] Marcia Caldas de Castro, Burton H. Singer. 'Was malaria present in the Amazon before the European conquest? Available evidence and future research agenda'. *Journal of Archaeological Science* 32, no. 3, (2005): 337-340, ISSN 0305-4403, https://doi.org/10.1016/j.jas.2004.10.004. (https://www.sciencedirect.com/science/article/pii/S0305440304001505)

[6] Butler, A R, S Khan, and E Ferguson. 2010. Review of *A Brief History of Malaria Chemotherapy*. *J R Coll Physicians Edinb* 40, no. 7: 142-143.

[7] Deb Roy R. *Malarial Subjects: Empire, Medicine and Nonhumans in British India, 1820–1909*. Cambridge: Cambridge University Press; 2017. doi:10.1017/9781316771617

famously, by the British in India, Jamaica, and across South-East Asia and West Africa.

Charles Ledger, a botanical explorer in South America, thanks to a local named Manuel Incra Mamani, managed to procure seeds from the Peruvian/Bolivian border for a species of cinchona whose bark contained up to 10% quinine (a significant improvement over other species). In 1865, these were sent to London, where the British government showed little interest in them. They were eventually sold to the Dutch who cultivated and improved the species in their colony of Java (now Indonesia). This species was called Cinchona Ledgeriana in honour of Charles Ledger, and formed the subsequent basis of much of the world's supply of quinine. The story of Manuel Incra Mamani ends on a more depressing note: he did not get a plant named after him and during a seed-collecting trip in 1871 was arrested, imprisoned, and savagely beaten by the police. A beating from which he died some time after his release.[8]

Worried at the South American monopoly over the quinine trade, British colonial administrators and scientists put together an ambitious plan that was to result in the establishment of an enormous global network of exploration, collection, and systematisation of botanical knowledge, a centralised array of botanical gardens, and a colonial science of natural resource management. Without quinine, it would be difficult for the colonisers to dwell in the tropics. The influx of British troops to India during the 1857 Rebellion emphasised the political urgency of a stable cinchona supply.[9] Along with the soldiers, British civilians and their families in India were also susceptible to the deadly fever. To add to the urgency were the complications faced by the British explorers and colonists in Africa. In fact, between 1848 and 1861, the British government spent the equivalent of £6.4 m each year importing cinchona bark for its colonial troops. As a result, quinine is frequently cited by historians as one of the major "tools of imperialism" that powered the British Empire.[10] Thus, frantic efforts were made by the British to seek new places to plant trees and harvest for quinine production.

At this time, the key resources for creating plantations of quinine were located on three continents: South America had the plant, but South America was not under British control. Britain however controlled India, which geographers estimated had a climate that would be hospitable to the plant. And in London itself was a pivotal resource, the Kew Gardens. This botanical nursery and garden would serve as an incubator for the plants uprooted from their native South American soil, nursing them to a state sufficiently vigorous enough to withstand a second voyage and a subsequent transplanting in foreign soil on another continent.

The Wardian Box

The culture of moving plants across the world dates back as early as 1450 BCE, with the movement of millets from Asia to Africa and vice versa.[11] Medicinal plants and trees yielding revenue were smuggled from one colony and planted in another in order to serve the commercial requirements of imperial companies, and the English East

[8] Cassauwers, Tom. 'The global history of quinine, the world's first anti-malaria drug.' *The Medium.com*. Dec 30, 2015. .https://medium.com/@tcassauwers/the-global-history-of-the-world-s-first-anti-malaria-drug-d1e11f0ba729.

[9] Nair, Gopakumar, ed. 2019. *Reimagining Histories*. 1st ed. Vol. 1. Kerala, India: Current Books.

[10] Traverso, Vittoria. 'The tree that changed the world map.' *BBC: Travel*. May 28, 2020 .https://www.bbc.co.uk/travel/article/20200527-the-tree-that-changed-the-world-map

[11] Luke Keough, 'A Brief History of the Plant Box,' in *The Wardian Case* (Chicago; Kew Publishing, 2020), 37-53

India Company was successful in capitalising on plant transfers. In the mid-nineteenth century, the British took cinchona seeds and saplings from Peru, nurtured them in Kew Gardens where they were analysed, and their cultivation experimented, before transplanting them to the Nilgiri hills of South India. With its professional gardeners, greenhouses, and scientific expertise India lacked, Kew also marked cinchona's transition from uncultivated rainforest growth to commercial cash crop.

Clements Markham, later knighted for his contribution, took credit for this transcontinental transplantation. With a gardener, John Weir, he obtained “Grey Bark” (Cinchona Calisaya) from the forests of Caravaya in Bolivia and Peru. Another team consisting of Richard Spruce, who had been in the Amazon since 1849, and a gardener, Robert Cross, collected young plants and seeds of the Loxa (Cinchona Officinalis Linn) and “Red Bark” (C. Succirubra Pavon) species from Ecuador.[12]

Just keeping plants alive on a long sea voyage was a challenge for early travellers. While some plants were sent as seeds or cuttings, many plants had to be transported as live specimens. In addition, the cinchona tree was moved in secret from Bolivia by the British to be transplanted to India. For naturalists this amounted to a great challenge. The P&O Steamship Company, which transported the plants to India from England was instructed by the India Office to pay special attention to the safety and well-being of the four Wardian cases destined for Bombay. The Wardian case, a wood and glass box shaped like a small, moveable greenhouse which allowed light to enter, was used for transporting live plants and seeds. This created an airtight system in which transpiration inside the case provided sufficient moisture to keep the plants alive for extended periods, up to two years at times, similar to a terrarium of today.

Cinchona in South India

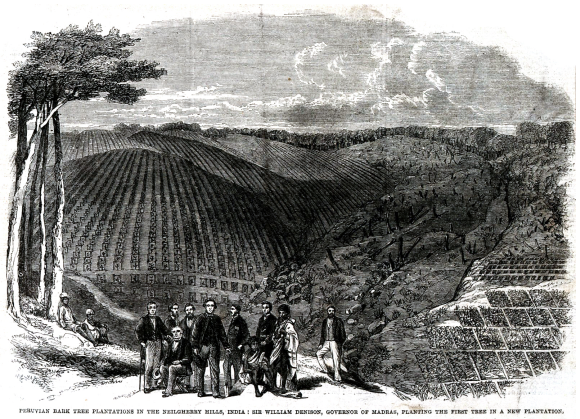


Figure 2. Cinchona Tree Plantation in the Nilgiri Hills, 1862. Image - Wikimedia Commons. 2023.

Cinchonas were designated as feminine plants, which required careful handling by imperial men almost at every step. The imperial projection of cinchonas as invaluable commodities was sustained and invigorated by the recurrent description of the physicality of these plants as distant, rare, and delicate in myriad sources. The circulation of this ‘Peruvian maid’ to distant corners of the colonial world was advertised as an accomplishment more glorious than even the introduction of tea from China into India in 1849.[13]

To the British colonial imagination, cinchona appeared to be part of a longer history of continuous travel of commodities from South America and elsewhere, and their subsequent domestication in India. “India owes to South America the aloes which line the roads in Mysore, the

[12] Philip, Kavita. 1995. “Imperial Science Rescues a Tree: Global Botanic Networks, Local Knowledge and the Transcontinental Transplantation of Cinchona” 1 (2): 183. https://doi.org/10.3197/096734095779522645.

[13] Deb Roy R. *Malarial Subjects ibid.* p 40

delicious anonas, the arnotto-tree, the sumach, the capsicums so extensively used in native curries, the pimento, the papaw, the cassava which now forms the staple food of the people of Travancore, the potato, tobacco, Indian corn, pine-apples, American cotton, and lastly, the cinchona: while the slopes of the Himalayas are enriched by tea-plantations, and the hills of Southern India are covered with rows of coffee trees."[14]

Seeds collected by both parties arrived at Kew and were sent to Calcutta for distribution to Ootacamund and Ceylon. Once at Ootacamund, W.G. McIvor, Superintendent of the Government Gardens, assisted in establishing the first plants.[15] Spruce's investigations into the various types of "Red Bark" became the foundation of cinchona plantations in India and Ceylon, and a plaque was installed in his memory at Ootacamund Botanical Garden. From 2973 plants in the Nilgiris on 9 July 1861, the total rapidly rose to 117,706 on 31 December 1862.[16] In 1866, Markham could proudly survey acres of cinchona plantations where there had previously been dense jungle.

Timeline of Major Developments in the Nilgiri Cinchona Experiment.[17]

1860	First cinchonas arrive at Ootacamund in October, but are dead by the end of the year.
1861	More cinchona seeds and plants arrive at Ootacamund, Macpherson reports on the plantation sites prompting a Government Order (GO) to be issued ordering further propagation to be stopped and for the Doddabetta site to be abandoned (the G.O. is later modified). McIvor begins to plant out small numbers of cinchona in the open, orders begin to be taken for cinchona plants, work is begun on the plantations at Doddabetta and Naduvattam.
1862	Anderson delivers plants and seeds from Java to Ootacamund and attacks McIvor's methods, propagating house is completed, official arrangement with Royal Botanic Gardens Kew (UK) terminated, two limited companies formed to grow cinchona on the Nilgiris, Markham publishes *Travels in Peru and India*.
1863	Cinchonas offered for public sale from the Government Gardens, Ootacamund, resolution made to plant 150 acres of cinchona annually on the Nilgiris for at least ten years, work begins on three new plantation sites during the year (Wood and Hooker plots at Pykara, and a plot at Mailkoondah), results from the first chemical analysis of Nilgiri bark made available, McIvor publishes *Notes on the Propagation*.

[14] Markham, 1862. *Travels in Peru and India*, p 61.

[15] Veale, Lucy, "An Historical Geography of the Nilgiri Cinchona Plantations, 1860-1900." Accessed December 30, 2023. http://eprints.nottingham.ac.uk/13041/1/523463.pdf.

[16] Veale, Lucy,. n.d. 210.

[17] Veale, Lucy,. Ibid pp 136

1864	After labour shortages McIvor applies for 500 convicts to work the government plantations.
1865	Convicts arrive on the Nilgiris, Howard finds Nilgiri bark to be low in quinine, but rich in other alkaloids, Cinchona Ledgeriana arrives in Java.
1866	Markham revisits the Nilgiri plantations and constructs a map to illustrate progress, John Broughton is appointed as government Quinologist on the Nilgiris.
1867	Commission appointed to inquire into the effectiveness of the cinchona alkaloids other than quinine and concludes that they are no less effective.
1868	Propagation efforts now to be limited, instead seed is distributed gratuitously to interested parties.
1869	Convict labour is discontinued, government plantations now cover 1,200 acres (the amount originally fixed as the limit), McIvor and Broughton asked to consider the future of the plantations and the best method for manufacture, Pykara and Mailkoondah plantations are offered for sale but no buyer is found.
1870	Broughton begins manufacturing a portion of the Nilgiri bark in his manufactory to produce 'amorphous quinine', with which he supplies the medical stores, the first bark auctions are held in Amsterdam.
1871	McIvor's ‘mossing’ system of removing the bark from the tree (higher alkaloids being derived by depriving the bark of exposure to light) was now being widely applied. Regular consignments of government and privately grown bark being sent to the London market from the Nilgiris.
1874	High prices are achieved at the London auctions for Nilgiri bark as a result of increased demand owing to the Franco-German war.
1875	Government concludes that Broughton'S 'amorphous quinine' is being produced at a considerable loss and orders its abandonment, Broughton resigns and disappears.
1876	McIvor dies unexpectedly and the government cinchona plantations are left without a Superintendent, control passes

	to the Commissioner of the Nilgiri District.
1877	Famine in much of South India means that plantation labour is plentiful on the Nilgiris, record prices are achieved for Nilgiri bark in London as a result of civil war in New Grenada but fall once South American imports resume.
1878	Campbell Walker surveys the government plantations and finds only half the number of trees it was believed they contained, accusations of neglect on the government plantations proliferate.
1879	Jamaican bark enters the London market, Mailkoondah plantation abandoned.
1880	Acreage of cinchona in Ceylon surpasses that in the Madras presidency, Markham publishes *Peruvian Bark*.
1881	Control of the government plantations passes to the Forest Department.
1882	First auction of government bark held in Madras.
1883	Professor Lawson takes up his position as Superintendent of the plantations and begins to renovate the plantations, Henry Trimen reports on the plantations, Ceylon bark dominates the London market.
1884	Mr Hooper is appointed as the new Quinologist and begins to undertake analysis for private producers as well as manufacturing alkaloid and quinine sulphate.
1887	Factory equipment arrives and the grinding of bark commences.
1890	Packets of quinine sulphate begin to be sold through District Collectors.
1893	Packets of quinine sulphate begin to be sold by Postal Department Officers.
1896	Professor Lawson dies at Madras, Standen is appointed in his place as Director of the newly constituted Cinchona Department, the remains of the Wood plantation at Pykara are abandoned.

1897	Position of Quinologist was abolished.

Private investments in cinchona experiments began in 1862 in Ceylon and extended subsequently to Kangra valley, Assam, Darjeeling, and Malabar. The supposedly exclusive status of cinchonas was compromised when in the private estates these thrived in the intimate company of tea, teak, and coffee plants. Realising cinchona's popular demand and monetary value, the Travancore Government opened a plantation in Peermade in 1862 and later another in Munnar in 1878. In 1870, the Malabar Collector reported that cinchona had grown abundantly in Wayanad and large plantations in the vicinity of Mananthawady would be a great boon to the surrounding coffee plantations in Wayanad and Coorg. Thus, Nilgiris and Wayanad became two major centres of cinchona production.

The usual method of harvesting the bark was the coppice system; the tree was cut down close to the ground in about its 15th year, and the bark was sliced off and dried in the sun or by artificial heat. Quinine was not manufactured in the district, and all the bark was either sent to the Nilgiri factory or Europe. Only three species of the genus Cinchona contained a sufficient percentage of alkaloid to be worth cultivating—C. Ledgeriana, C. Succirubra and C. Officinalis. In their bark, these species contain varying percentages of quinine and the other alkaloids, which differs not only with the species but with the individual tree, the locality, age and portion of the tree from which the bark is taken.

In preparing a site for cinchona plantation, the forest was felled during the cold season—from November to March—and the debris was burned in March. If steep, the land is usually terraced and then staked to mark the future position of the trees. Before planting out, seedlings would have been in the nursery for at least six months.[18] Seedlings were twice transplanted, first when the seed leaves were just fully expanded, at a spacing of 1 in. by one in., and later, at the age of three to four months, in May or June, when the seedlings were two or three inches high and then at a spacing of 3 ins. by three ins. The soil for the nursery beds had to be carefully prepared, sheltered by a watertight sloping roof of thatch, and the plants were carefully watered with a fine spray. Planting began in May in specially prepared "tullies" or pits.

For the first two or three years, the young plantations were cleared by hoeing two or three times per year. Later, periodical hoeing around the trees was enough. Harvesting of the bark began from the fourth year, as before this age, there was very little bark and quinine in it. The harvest in the fourth year consisted of the bark from thinnings and prunings, but mainly from plants that died. The uprooting of the whole tree is made about the tenth year, and the bark stripped from the root, stem and branch. The bark is dried, stored and then passed on to the factory.

In 1866, a new type of scientist appeared, equally able to handle botanical and chemical data: the Quinologist. The appointment of an analytical chemist, John Broughton, at Ootacamund was to support and advance the analyses performed in Kew.[19] The druggist buyers disposed of their bark in small lots among chemists on the continent who used it for producing

[18] Veale, Lucy, n.d. 280.

[19] Veale, Lucy, 245.

tinctures and tonics. In contrast, the quinine manufacturers bought entirely on the results of chemical analysis. This led to the production of quinine sulphate, which was more powerful and easier to digest than the powdered bark used to treat the fever.

Of the 16 known manufactories of quinine in the world, there were two in London, two in Philadelphia, one in Milan, one in Genoa, five in Germany, four in Paris and one in Amsterdam.[20] In 1890, packets of quinine sulphate began to be sold through District Collectors, at one rupee for a packet containing 100 such powders, and the name and directions for use had to be printed on the wrappers in the vernacular language of the district to which the packages were sent. Sales increased only slowly over the next two years, and in August 1893, the government approved the measure of using Postal Department officers as an agency for their sales. Postmasters proved to be a successful agency for selling quinine to the poorest classes. By 1897, 1,550 post offices throughout the Madras Presidency were serving as depots for the sale of quinine.

However, this new product also did not save the planters' plight as the overproduction of cinchona from Sri Lanka and Java greatly reduced the item's price in the international market, and overtook Nilgiri bark in terms of quantity and, subsequently, quality.

The planters deserted cinchona cultivation. Dutch plantations eventually dominated trade after the Quinine Agreement 1913 created the first global pharmaceutical cartel. This resulted in a situation where, for many years, the Netherlands East India Cinchona plantations produced 97% of the total production of quinine in the world while British India had grown 2.5% and the rest of the world 0.5%. Bandung in Java became known as the Paris of Java, as cinchona cultivation converted the sleepy town to a port at the centre of quinine trade.

Private planters also took over the cultivation; the profits remained low, the Indian cinchona was restricted to military and governmental use, reducing its value as a commodity.

Quinine Substitution

During the First World War, Germany could not obtain quinine sourced in Java, and, as a consequence, German soldiers fighting in southern Europe suffered badly from malaria. German pharmaceutical chemists were commissioned during the 1920s to find a synthetic alternative and by 1932, had produced mepacrine, a simplified version of quinine with some structural features changed. During the Second World War, it was extensively used as an antimalarial agent, with substitutes developed in British colonies.

While quinine was eventually replaced by mepacrine, synthetic chloroquine and hydroxychloroquine, the production dwindled post-war with the subsequent shutdown of cinchona plantations by the 1980s. While quinine still serves as a significant cure in parts of Africa, it lost its significance in India. Quinine was eventually pushed aside in the 1970s by artemisinin, a drug derived from the sweet wormwood plant, as the world’s go-to malaria remedy.

Lately, during the early phases of COVID-19, cinchona and its alkaloids and their medical derivatives were at the centre of another heated global debate. Synthetic versions of quinine—such as chloroquine and hydroxychloroquine—have been touted and largely disputed as possible treatments

[20] Veale, Lucy, and Bse Mse. n.d. 301.

for the novel coronavirus. Finally leading to the World Health Organization halting studies of quinine's synthetic descendant, hydroxychloroquine, as a possible coronavirus treatment amid safety concerns.

Over the last one and a half centuries, the 'fever tree' bark and the wonder drug it produced drew new trade connections and led to the development of new colonial cities like Bandung in Java. The process involved in developing and commercialising this drug became a signifier of colonial power. The cinchona transplantation project made quinine available for military and administrative personnel in all the tropical British colonies. Still, cinchona plantations failed as a profit-making cash crop and a public health measure in India. However, it was spectacularly successful as a symbol of the benevolence of both science and empire. As a result, this legitimised the influence of the imperial botanical expert in colonial agricultural activity and made Kew Gardens the powerful centre of a whole network of colonial botanical gardens by the late nineteenth century. The collections at Kew contain samples of packets of quinine and "Cinchona febrifuge" together with an extensive series of the quinine barks of commerce and illustrations of the cultivation in the East and production in South America; they are especially representative of British India and experiments in various colonies, including Ceylon, Jamaica, St. Helena, Tanganyika, and the Cameroons.

Conserving Cinchona in the Wild

While it is now mainly used to add flavour to liquor and in cocktails, the cinchona tree bark once held a place as one of the most important drugs in history—a five century legacy of global, colonial powers in violent search for the elusive cinchona plant of South America, the cure for malaria. Stolen by the Jesuits in the seventeenth century, smuggled abroad by Britain and Holland during the eighteenth century, mapped by German explorer Alexander von Humboldt in the nineteenth century, and exploited by global pharma in the twentieth century, the story of the cinchona plant, and of its powerful quinine extract, not only lies at the base of modern civilisation but traces the deep roots of Indigenous, territorial resistance back to the Amazon and the Andes.

The centuries-long demand for cinchona bark has left a visible scar on its native habitat. In 1805, explorers documented 25,000 cinchona trees in the Ecuadorian Andes. The same area, now part of the Podocarpus National Park, counts just 29 trees. While it is to plants that we owe some of the major medicinal breakthroughs in human history, biologists tracing the genetic history of cinchona have found that the removal of quinine-rich species from the Andes has changed the genetic structure of cinchona plants, reducing their ability to evolve and change.

Even though drugs are now developed in labs instead of being extracted from forests, the protection of the biodiversity in the wild is essential to prevent endangering the "pharmacy of the world", crucial for the discovery of new drugs in the future.

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