Coffee —riches and sorrows

How diseases and pests contributed to science, technology and innovation at the turn of the twentieth century in São Paulo, Brazil

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Introduction

Brazil has been the largest world producer of coffee for the last 150 years. It arrived to the country—then a Portuguese colony—in the mid-eighteenth century, initially grown for private consumption. This shrub from the family *Rubiaceae* found ideal climate and soil to develop, to the point that in 1854 the country—independent from Portugal since 1822—had become the largest global coffee producer, surpassing also the traditional exports, tobacco and sugar. By 1890, Brazil accounted for three-fifths of the global production.[1] However, this was no simple success story. Many obstacles hindered the vigorous path of expansion of coffee from the Northeastern region, where it was first introduced, to Rio de Janeiro, the Imperial capital, and the then province (now state) of São Paulo, which became the main national producer still before the close of the 1800s (Fig. 1).

The basic source of the wealth which funded the development of the Paulista industry—to this day São Paulo is the industrial powerhouse of Brazil—intensive coffee farming was undoubtledly favoured by its vast and fertile land. Yet, several challenges had to be overcome, such as unknown

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or hard-to-combat pests, which recurrently threatened the coffee plantations. Then, following abolition in 1888, the slave manpower had to be replaced, which was done with European immigrants, mainly from Portugal, Spain, Italy and Germany. As might be expected, this freshly arrived population took time to adjust to their new home, and their health soon became a major source of concern. A young country, Brazil, naturally including also São Paulo, had few scientific or technological resources or institutions prepared to cope with this problem. As we shall argue, the health of the immigrants brought to the country to work in the coffee fields, and the pests which devastated plantations were some among the main triggers for the early development of science and technology in Brazil.

Coffee cultivation and the culture of coffee

For a good part of the nineteenth century, coffee production in São Paulo was small compared to that of the province of Rio de Janeiro. Not only the first seedlings were planted much later,[2] but coffee was grown as a subsistence crop side side by side with beans, cotton and manioc, since the focus of all attention was sugar, the main source of exports. As Affonso de E. Taunay observed, mere 1,060 *arrobas* had left the main Paulista port, in Santos, for Lisbon in 1806.[3] A more vivid picture was painted by the French naturalist Auguste de Saint-Hilaire (1779–1853), while on a trip from São Paulo to Rio de Janeiro in 1819:

> Yesterday I had [just] begun seeing coffee plantations, today [they are] more numerous [...]. This alternation of coffee plantations and virgin forest, maize fields [...] valleys and mountains, these ranches, these small shops, these small buildings surrounded by the blacks' shacks, and the caravans which come and go, endow this region with much variety [...]. It was just some twenty years ago that coffee, now the source of the local wealth, began to be grown here. Before, these farmers only concerned themselves with sugarcane and swine production.[4]

Yet, if in 1859 São Paulo's represented only 12% of the Brazilian coffee production, it gradually replaced both subsistence agriculture and sugarcane to become the main crop in the last quarter of the 1800s.[5] Among the factors which contributed to the development of coffee production in São Paulo and its new leading role, one was its favourable climate and soil—while monoculture had already begun to exhaust the land in Rio de Janeiro. Then, there was the increasing demand for coffee from developed countries, allied to the introduction of the steamship, which substantially facilitated long-distance trade and the integration of the Brazilian with the North American and European markets.[6] The focus on exports and the inflow of capital from abroad afforded the financial conditions required for technical development, including infrastructure, services, and modernisation of the production and trade systems.[7]

However, the continued expansion of the coffee industry in São Paulo demanded ever increasing manpower, which the local producers sought to supply by funding foreign immigration—at a later time, also the Paulista government actively contributed to bring European workers. Thus about 130,000 immigrants came along the 1850s, and their number dramatically increased starting in the mid-1880s. During the last decade of the century, the destination of 65% of the immigrants arriving in the port of Santos was São Paulo.[8]

These substantial and abrupt demographic changes had dramatic impact on the labour relations, land occupancy, cultivation practices, diet and nutrition in the province of São Paulo.[9] As relevant as these new social configurations also were the epidemiological, health and sanitation consequences of the massive arrival of foreign workers. To begin with, all the immigrants disembarked at a single port, that of Santos, where they had to wait for several days before they could be transported to the coffee plantations. The obvious result was overcrowding, a well-known factor associated with outbreaks of epidemics, made even worse by the lack of immunity of Europeans against tropical diseases. To illustrate this point, an Immigrant Inn was built in 1886–1888 in the Bras neighbourhood of São Paulo, close to the railway station, to lodge up to 4,000 individuals. Yet, the number of guests in 1888 more than doubled to about 9,000.[10]

This mention to the railway is not fortuitous. This period was also characterised by increasing resource to the train as mode of transportation. The growth of exports compelled the government of São Paulo to develop efficient infrastructure to link the coffee production sites to the port of Santos—until the mid–1800s all goods had been transported by mules.[11] The construction of the Paulista railway began in 1860, funded by the wealthy local coffee producers as a means to streamline the production,[12] to gain momentum along the 1880s, precisely the period of emergence of the large coffee production centres, consequently attended by the highest immigration rates.[13] It is thus not by chance that epidemic outbreaks became increasingly more frequent in the 1890s—of yellow fever, in particular, which is thus our focus in the present study. Epidemics recurred with each new railroad track built, to the point that the health authorities did not take long to become aware of the unequivocal relationship between railway expansion and health situation.[14]

Overcoming obstacles: yellow fever at the turn of the twentieth century

Yellow fever had not been a public health concern in Brazil during the first half of the nineteenth century. As the French physician Joseph F.X. Sigaud (1796–1856), the founder of the Medical Society of Rio de Janeiro, observed, cases were only sporadic, and the conditions for occurrence of epidemic outbreaks did not seem to be met.[15] Yet a severe outbreak did indeed take place in Rio de Janeiro in the summer of 1849/1850, which affected more than one-third of its 266,000 inhabitants, and caused more than 4,000 deaths.[16] Of particular interest for the present study, yellow fever appeared that same year in Santos—the entry point for immigrants and the departure point of coffee—apparently brought by a ship arrived from Rio.[17] The disease quickly extended across the coffee growing areas, giving rise to an endless succession of outbreaks.[18]

Among the victims, the European immigrants, unprotected against tropical diseases and living in overcrowded conditions, represented a particularly susceptible group.[19] The high mortality among this population did not pose a public health problem only, but also to trade and to the distribution of people across the urban areas of a province then undergoing dramatic demographic expansion. The series of epidemic outbreaks further interfered with the relations between the Brazilian government and the European countries which had formulated strong migration policies, to the point that immigration was entirely banned on several occasions. For instance, in 1886 the Italian Ministry of the Interior published a notice in which it forbade all travels to Brazil, to São Paulo in particular, as it was rated one of the "most unhealthy and inhospitable provinces in the Empire."[20] In addition, a large part of the foreign ships refused to dock in the ports of Santos and Rio de Janeiro, compelling the immigrants to disembark at Buenos Aires, Argentina, to then travel on land to Brazil.[21]

The situation became so severe that in the 1890s transmissible diseases accounted for one-third of all the deaths in São Paulo.[22] To rise to the challenge, scientific institutions were created, many of them devoted to health care and research. A State Health Service, replacing the older Province Hygiene Inspection Office, was established in 1891 to advise the government on public health matters. This service coordinated several institutions, such as the recently created Bacteriological Institute, Vaccine Institute, Isolation Hospital (present-day Emilio Ribas Institute), Laboratory of Chemical Analysis, and General Disinfection Centre. All these institutions were the fruit of the dynamics involving the economy and health management in São Paulo, both oriented to the production of coffee.[23]

The close relationship between migration flows, railway system extension, and expansion of yellow fever epidemics across the coffee production areas was very clear to physicians and health authorities. The point in debate was the aetiology of disease, which elucidation would change the face of public health in Brazil, in addition to contributing to the global development of the then incipient field of microbiology.

Miasma theory—i.e. the ages–old idea that disease was communicated through contamination of the air—was still advocated by Brazilian physicians for a good part of the 1800s.[24] However, the new ideas on transmission of diseases formulated from the end of the nineteenth century onward—such as the germ theory and the role of vectors—triggered discussions among the Paulista physicians and investigators, which in turn influenced the policies formulated by the health authorities to combat epidemics.[25] Of particular interest, some doctors reported having identified an alleged 'yellow-fever germ' (*germe amarílico*) which contaminated the environment around patients. This microbiological perspective might have derived from the strong contemporary interest in the study of microorganisms, such as those which caused cholera, malaria and plague, among other diseases.[26] As an illustrative example, in 1892 Louis Pasteur (1822–1895) sent Félix Le Dantec (1869–1917) to São Paulo to conduct research on yellow fever, who was immediately appointed director of the Bacteriological Institute.[27]

The resulting uncertainty as to the mechanism of transmission of yellow fever led to the adoption of eclectic preventive practices, often combining those recommended by the advocates of miasma theory, and the ones deriving from the emerging germ theory and the assumption of a *germe amarílico*.[28] As a result, measures included disinfection of clothing, personal objects, furniture and households, as well as the isolation of the sick, in the attempt to reduce the odds of contact with sources of infection. At the same time, major sanitation projects were developed, including cleansing and channelling of creeks, construction of water supply networks, wastewater removal, and waste disposal systems.[29] As epidemics spread together with town residents fleeing urban outbreaks, the sanitation measures also targeted the railway system, including heaters at stations to disinfect clothes and luggage, and eventual isolation of passengers.[30]

These measures succeeded for a while, but failed to prevent the recurrence of outbreaks along the following years, which moreover tended to occur always in the same locations. This fact led the health authorities to consider other mechanisms of transmission of yellow fever.[31] The first hints came from the identification of the mosquito-borne transmission of malaria and lymphatic filariasis in the second half of the 1890s.[32] Soon after, also a significant part of the Paulista medical community began considering yellow fever as a vector-borne disease.

Such approach was strongly advocated by the physician Emilio Marcondes Ribas (1862–1925) who chaired the State Health Service from 1898 to 1917. As health inspector, Ribas had succeeded in controlling malaria in several municipalities in the state of São Paulo, as well as a severe outbreak of yellow fever in Campinas in 1895.[33] Previously an adherent to the microbiology view, Ribas had actively promoted disinfection and isolation to hinder contact with infecting matters, such as the alleged *germe amarílico*. However, field experience began to undermine his beliefs.

During a visit to Jau, a town in the interior of São Paulo, in 1896, Ribas noticed that the children of immigrants killed by yellow fever did not develop the disease. This observation raised in him the suspicion that yellow fever did not spread through direct contact, as was the necessary corollary of germ theory.[34] A few years later, from the end of 1899 through the beginning of 1901, Ribas observed that health officers transferred to the town of Sorocaba developed yellow fever, which had not occurred while they were in São Paulo, the state capital and disease free, even after having been exposed to direct contact with patients.[35]

By this time, Ribas took notice of the work performed by the Cuban physician Carlos J. Finlay (1833–1915) and a United States Army medical team chaired by Walter Reed (1851–1902) in Havana. In 1881 had Finlay run several tests to prove the hypothesis that yellow fever was transmitted by mosquitoes. About twenty years later, in the attempt to protect soldiers allocated to Cuba from yellow fever, the government of the United States sent a medical team to the island to acquaint themselves with Finlay's work. Chaired by Reed, this team conducted experiments with mosquitoes, which allowed confirming they were, indeed, the vectors of yellow fever. This perception led to spectacular success in the combat of disease by protecting the sick from mosquito bites and eliminating mosquito breeding sites.

The results were communicated in February 1901, during a Pan American conference in Havana,[36] and soon reached Ribas. The vector-borne transmission hypothesis clearly fit with the epidemiological data collected during outbreaks in São Paulo, including the observation that mosquitoes were abundant in epidemic sites.[37] In addition, it provided an explanation for the dramatic success Ribas had attained in the aforementioned outbreak in Campinas: for no particular reason, among the cleaning actions implemented, he had made all sites with stagnant water be dried, thus hindering mosquito breeding.[38] Ribas did not need further proof: from 1902 onward he became strongly persuaded that yellow fever was transmitted by mosquitoes.[39]

Yet, not all were similarly convinced,[40] and Ribas set himself to replicate the Havana tests from December 1902 through May 1903 at the Isolation Hospital, in the city of São Paulo, which was held to be disease free. The aim of the first phase of the study was to confirm vector-borne transmission. For this purpose, six volunteers—including Ribas and Adolpho Lutz (1855–1940), the director of the Bacteriological Institute—were exposed to infected mosquitoes; three of them developed the disease. Then, transmission through the alleged *germe amarílico* had to be refuted: a group of freshly arrived Italian immigrants without any previous contact with the disease were exposed to contaminated clothing, objects, and even urine, vomiting and body fluids of individuals with yellow fever, but none of them fell ill. To Ribas and colleagues these results were conclusive: both the miasma and the germ theories had been refuted.[41]

Vector-borne transmission implied that the control and eradication of yellow fever required efficient strategies to eliminate the mosquitoes.[42] Still in 1903 Ribas had an occasion to test this hypothesis. That year, 810 cases of yellow fever occurred among the 15,000 residents of Ribeirão Preto, a large part of whom were Italian immigrants working at coffee plantations. Ribas banned disinfection, but commanded the sanitation agents to exclusively implement mosquito elimination procedures. The outbreak was immediately stopped, which provided confirmation of the experimental results relative to the role of vectors in the transmission of yellow fever.[43]

Ribas' work became a national reference. Just one month after his tests at the Isolation Hospital, the Sanitation Service Board presented *Prophylaxis of yellow fever* at the 5th Medicine and Surgery Conference in Rio de Janeiro, where following strong debate, the new theory was accepted as valid.[44] Ribas further launched a broad scoped mosquito elimination campaign across the entire state of São Paulo,[45] which succeeded in reducing incidence from 2,000 to just two cases from 1901 to 1903. The shift in the focus of prophylaxis later served as model for other Brazilian states, resulting in the complete elimination of disease for a long period of time. As for São Paulo, it lost its reputation as a 'foreigners' grave': the immigration flow was restored, with the additional advantage that 'acclimatisation' became no longer needed, but the immigrants could be immediately transported to the coffee plantations upon arrival, thus reducing urban overcrowding and its harmful consequences for public health.

Overcoming obstacles: pests in coffee plantations

The extraordinary development of the coffee industry in Brazil made the problem posed by agricultural pests particularly acute. As early as 1861, plantations were attacked by the moth *Leucoptera cofeela* (Guérin-Méneville) which, popularly known as 'coffee leaf miner,' is considered one of the worst pests of coffee. At that time, control could only be achieved by destroying entire plantations in Rio de Janeiro, São Paulo and Minas Gerais, i.e. the main cultivation areas (Fig. 1).[46]

Identification of the causative agent, therefore, did not ensure success in the control and eradication of pests. This is why investigators and farmers became understandably concerned when, in the last three decades of the nineteenth century, coffee leaf rust, a devastating disease caused by the fungus *Hemileia vastatrix* (Berk. and Broome) practically annihilated the lush plantations in Ceylon to rapidly extend across the Indian and Pacific coastland.[47] The Swiss-Brazilian naturalist, Émil August Goeldi (1859–1917), for instance, devoted an entire article to the perplexity coffee leaf rust caused to scholars all across the world in the 1880s.[48] The response, in Brazil, was to establish institutions devoted to natural and agricultural resources. Open to receive and exchange experiences with foreign experts, these institutions considerably contributed to the transit of science and technology between well-known international centres and the incipient Brazilian ones.[49]

The concern with coffee, e.g., led to the creation in 1887 of the Imperial Agronomic Station of Campinas, in the interior of São Paulo. Since its foundation and along its first decade of existence, the Station was ran by Franz W. Dafert (1863–1933), a respected Austrian scientist who had received expert training in Germany.[50] Dafert soon established well-equipped laboratories for chemical and biological analyses, as well as greenhouses for experimental cultivation. He also hired a highly qualified staff, including Brazilian and foreign experts, to develop original research systematically adjusted to the local conditions. The consistency and success of the work done in both fundamental and applied research was not hampered when Brazil became a republic in 1889. On the contrary, the end of the Empire and the transferal of the Station to the government of São Paulo did not mean a mere change in name—Agronomic Institute of Campinas—but further reinforcement of research, which was crucial to the coffee industry.[51] As an offshoot, a short while later the state government created the powerful Secretariat of Agriculture, Trade and Public Works to oversee crop transport, management, control and research.[52]

While at the turn of the century epidemics, particularly of yellow fever, had remained as the main focus of attention, signs of a new pest threatening the coffee plantations became evident in the 1910s. Retrospective analysis allows inferring that the pest in question was the coffee berry borer, *Hypothenemus hampei* (Ferrari),[53] which effectively devastated the coffee plantations in the 1920s. Although this beetle had called attention at Agronomic Institute of Campinas for some time, following its spread across Brazil and other parts of the world, the development of effective measures of control eluded all attempts. For this reason the Secretariat of Agriculture created a special Committee for Study and Combat of the Coffee Berry Borer (1924–1927) including experts from many research institutions in the country.[54]

The Committee soon succeeded in identifying contaminated sites and, more important, conducted studies leading to effective methods of pest control. The results were widely divulgated among coffee farmers, and facilities were established to help in disinfestation.[55] All this process took just three years, and the outcomes were internationally acknowledged. For instance, by the German entomologist Karl L. Escherich (1871–1951) in a paper published after a trip to São Paulo and Minas Gerais to observe the work done, and by Karl Friederichs (1879–1969), a German entomologist hired by the Dutch government to lead the combat of the coffee berry borer in Java.[56]

Having accomplished its main goals, in 1927 the Committee was replaced by the recently created Biological Institute of São Paulo for Agricultural and Animal Protection,[57] larger and better equipped. As chair of the corresponding section was appointed the American-Brazilian entomologist Adolph Hempel (1870–1949) who had actively participated in the Committee's activities, in addition of being a staff member at Agronomic Institute of Campinas and the Museum of São Paulo.[58] When the Great Depression hit the Paulista coffee industry, threatening the continuity of the successful coffee berry borer control program, Hempel lost no time in looking for new and less expensive alternatives. By this time Dutch researchers had conducted interesting experiments in Java with the African wasp *Prorops nasuta* Waterston, a parasitoid of the coffee berry borer, and thus an excellent tool for biological control of the pest. Commissioned by the Biological Institute, in 1929 Hempel brought about 1,000 live wasps from Uganda, which quickly reproduced at the Institute's laboratory to reach a population of 30,000, and were distributed among about forty coffee farms.[59] With the Institute's support, wasp farms were established all across the coffee growing areas, ensuring the production of coffee in São Paulo all throughout these turbulent years.[60]

Final considerations

Coffee brought incredible riches to Brazil, but also tremendous challenges—including agricultural pests and human diseases—which in the end proved to be opportunities for scientific and technological development. Interestingly, the relations between science and politics were quite similar in the cases of yellow fever and the coffee berry borer. Within a global and local scenario characterised by profound social and economic transformations, the threats to coffee production—involving both manpower and the plants—were the immediate trigger for the creation, starting in the Imperial period, of important science and technology institutions.

The Brazilian investigators were aware, made thorough use of, and adapted innovations developed abroad. They also sought to create local conditions to overcome scientific and technological challenges, which in some relevant cases resulted in substantial contributions to global efforts to eradicate epidemics and pests. Ribas' confirmation of the vector-borne nature of some diseases led to effective eradication practices, and also contributed to the then emergent microbiology and entomology. Both sciences were also crucial to the approach to pests which decimated coffee plantations.

The aspect of the global-local integration of science, technology and innovation is patent in the case of the Brazilian coffee industry, for which reason we chose it to illustrate the dynamics of the transit of knowledge. The demonstration of the fundamental role of science and technology in the solution of practical health and agricultural problems led to the creation, in São Paulo, of several institutions, which in the first decades of the twentieth century were mature enough not only to translate and cross-culturally adapt the voice of foreign science, but also to have a voice of its own on the global stage.

Notes

1. Ana L. Martins, *História do café* (São Paulo, 2008), 79.

2. André Argollo, *Arquitetura do café* (Campinas & São Paulo, 2004), 27.

3. Ibid., 27. *Arroba* was a unit of weight used in Portugal (= 32 pounds or 14.7 kg) and Spain (= 25 pounds or 11.5 kg).

4. Augusto de Saint-Hilaire, *Segunda viagem do Rio de Janeiro à Minas Gerais e à São Paulo—1822*. 2nd ed. (São Paulo, 1938), 193.

5. Martins, *História do café*, 78.

6. Ibid., 79.

7. Argollo, *Arquitetura do café*, 27.

8. Rodolpho Telarolli Jr, "Imigração e epidemias no Estado de São Paulo" in *História, Ciência, Saúde–Manguinhos* 3:2 (1996), 268.

9. Martins, *História do café*, 129.

10. Rodolpho Telarolli Jr., *Poder e saúde: as epidemias e a formação dos serviços de saúde de São Paulo* (São Paulo, 1996), 269; Maria do Rosário R. Salles & Luís A. de Castro Santos, "Imigração e médicos italianos em São Paulo na Primeira República" in *Estudos de Sociologia* 6:10 (2007), 74.

11. Guilherme Grandi, *Estado e capital ferroviário em São Paulo: a Companhia Paulista de Estradas de Ferro entre 1930 e 1961*, PhD thesis, University of São Paulo (São Paulo, 2010), 45.

12. Odilon N. Matos, *Café e ferrovias: a evolução ferroviária de São Paulo e o desenvolvimento da cultura cafeeira* (Campinas, 1990), 74, 78–79.

13. Ibid., 94; Emília V. da Costa, *Da senzala à colônia* (São Paulo, 2010), 232.

14. Telarolli Jr., "Imigração e epidemias", 268, 275.

15. Joseph F. X. Sigaud, *Du climat et des maladies du Brésil* (Paris, 1844), 258.

16. Sidney Chalhoub, *Cidade febril, cortiços e epidemias na corte imperial* (São Paulo, 1997), 61; Jaime Benchimol, "Adolpho Lutz: um esboço biográfico" in *História, Ciência, Saúde–Manguinhos* 10:1 (2003),17.

17. Odair Franco, *História da febre amarela no Brasil no Século XVII* (Rio de Janeiro, 1969), 30.

18. Carlos E. Ortiz, *A identificação do mosquito como agente da transmissão da febre amarela e o reflexo nas ações determinadas pelo Serviço Sanitário do Estado de São Paulo no início do século XX*, PhD thesis, Pontifical Catholic University of São Paulo (São Paulo, 2016), 16; Telarolli Jr., "Imigração e epidemias", 267.

19. Telarolli Jr., "Imigração e epidemias," 267.

20. Ibid., 270; Lucy M. Hutter, *Imigração italiana em São Paulo (1880–89): os primeiros contatos do imigrante com o Brasil* (São Paulo, 1972), 118.

21. Ibid., 271.

22. Ibid., 270.

23. Marta Almeida, "São Paulo na virada do Século XX: um laboratório de saúde pública para o Brasil" in *Tempo* 10:19 (2005), 78, 80.

24. Cristiana L.M. Couto, *Alimentação no Brasil imperial: elementos para um estudo de questões dietéticas, químico-médicas e da fisiologia do gosto*, PhD thesis, Pontifical Catholic University of São Paulo (São Paulo, 2011), 51. Besides air, also food was associated to the occurrence of diseases; on the influence of diet, including coffee, on health in nineteenth-century Brazil, see Cristiana L.M. Couto & Ana Maria Alfonso-Goldfarb, "A cup o' controversy: coffee and health in 19th century Rio de Janeiro" in *Circumscribere* 17 (2016), 41–53.

25. Carlos E. Ortiz, *Febre amarela nas Américas: uma comparação das concepções médicas e procedimentos experimentais de Carlos Juan Finlay e Emílio Marcondes Ribas*, master dissertation, Pontifical Catholic University of São Paulo (São Paulo, 2008), 67–68.

26. Ibid., 67–68; Ilana Löwy, *Vírus, mosquitos e modernidade: a febre amarela no Brasil entre ciência e política* (Rio de Janeiro, 2006) , 53.

27. Pasteur also exchanged correspondence with the Emperor, D. Pedro II, who expected to bring him to Brazil to develop a vaccine against yellow fever; Franco, *História da febre amarela*, 52–55.

28. Ortiz, *A identificação do mosquito*, 39–42, 44–51.

29. Ibid., 31, 39.

30. Telarolli Jr., "Imigração e epidemias", 275, 276.

31. Ortiz, *A identificação do mosquito*, 36.

32. Lymphatic filariasis, also known as elephantiasis, represents another relevant example of the dynamics involved in the global transit of knowledge, and the ties between so-called 'central' and 'peripheral' countries. Microfilariae were first identified in 1863 by Dr Jean-Nicole Demarquay in a Cuban national in Paris. Two years later, Otto Wucherer detected the 'threadlike worms' in the urine of a patient in Brazil, and published the results in *Gazeta Medica da Bahia* in 1866, which eventually reached Joseph Bancroft — an English physician sent to a British colony, Australia—who also succeeded in locating the worms and suggested vector transmission. The following year, Victorino Pereira,

Julio de Moura and Silva Araujo replicated Bancroft's work in Brazil. Finally, in 1899 Thomas Bancroft, the son of Joseph, infected a mosquito with filaria by allowing it to feed on an infected patient, and described the full cycle of disease. To commemorate the work of these Brazilian and colonial British scientists, the parasite was named *Wuchereria bancrofti*. See Catherine A. Gordon, Malcolm A. Jones & Donald P. McManus, "The history of Bancroftian lymphatic filariasis in Australasia and Oceania" in *Tropical Medical Infection Disease* 3:2 (2018), 58; Adaílton Santos, *Escola Tropicalista Baiana: registro de uma nova ciência na Gazeta Médica da Bahia (1866–1889)*, master dissertation, Pontifical Catholic University of São Paulo (São Paulo, 2008), 70–81.

33. José Antônio A. dos Santos, "Em memória de Emilio Marcondes Ribas" in *Arquivos da Faculdade de Higiene de São Paulo* 18 (1964), 133–152, 135, 140–141.

34. Franco, *História da febre amarela*, 147.

35. Ortiz, *A identificação do mosquito*, 73.

36. Jaime L. Benchimol, *Dos micróbios aos mosquitos*: *febre Amarela e a revolução pasteuriana no Brasil* (Rio de Janeiro, 1999), 407.

37. Ortiz, *A identificação do mosquito*, 70.

38. Santos, "Em memória," 141.

39. Ortiz, *A identificação do mosquito*, 70.

40. For instance, Dr Nuno F. de Andrade (1851–1922), a former advisor to the Emperor, D Pedro II, actively advocated disinfection, on the grounds that mosquitoes became infected with and passed on the *germe amarílico*, i.e. a mixed theory of disease spread. See Nuno F. de Andrade, "A prophylaxia da febre amarela" in *Revista Médica de São Paulo* 8 (1902), 319.

41. Marta Almeida, "Tempo de laboratórios, mosquitos e seres invisíveis" in Sidney Chalhoub, Vera R. Marques, Gabriela R. Sampaio & Carlos R.G. Sobrinho (eds.), *Artes e ofícios de curar no Brasil* (Campinas, 2003), 123–162.

42. Ortiz, *A identificação do mosquito*, 99.

43. Ibid., 73.

44. Almeida, "São Paulo," 85.

45. As he stated in a lecture delivered at the Society of Tropical Medicine and Hygiene, in London, on February 19th 1909. For more details, see Carlos E. Ortiz, *Febre Amarela*, chapter 3, item 3.2.

46. Afonso de Taunay, *Pequena história do café no Brasil* (Rio de Janeiro, 1945), 52–53; Maria A. Gonçalves, *Institucionalização da entomologia no Brasil: dos trabalhos na década de 1920 à criação da Sociedade Brasileira de Entomologia (SBE)*, master dissertation, Pontifícal Catholic University of São Paulo (São Paulo, 2016), 43–45, 52, 66.

47. Stuart Mc Cook, "Crônica de uma praga anunciada: epidemias agrícolas e história ambiental do café nas Américas" in *Varia Historia* 24:39 (2008), 90 et seq.

48. Emílio Goeldi, "O Hemileya vastatrix na ilha de Java" in *Revista Agricola do Imperial Instituto de Agricultura* (1888), 71–72.

49. As e.g. the Imperial Institute of Agronomics (Rio de Janeiro, 1860), Museum of Para (Belém do Pará, 1871, later Emilio Goeldi Museum), Museum of São Paulo (1895). On the initial fragility of these institutions see Gonçalves, *Institucionalização da Entomologia*, 17–18.

50. Tamás J.M.K. Szmrecsányi, "Origens da liderança científica e tecnológica paulista no século XX" in *Revista Gestão & Conexões* 2:2 (2013), 189; Pedro Ramos & Fabrício J. Piacente, "O Instituto Agronômico de Campinas: sua criação, importância e um pouco de sua história" in *Revista Brasileira de Inovação* 15:2 (2016), 365–392.

51. Szmrecsány, "Origens da liderança," 188–189; Roseli de A. Vargas, *A produção científica brasileira em ciências agrárias indexada na Web of Science: características e redes de Colaboração (2000–2011)*, master dissertation, Federal University of Rio Grande do Sul (Porto Alegre, 2014), 32; Ramos & Piacente, "O Instituto Agronômico," 366–371.

52. State Law no. 15, from 11 November 1891, Decree no. 28, from 1 March 1982, and Decree no. 251, from 3 August 1894. Cited 22 January 2019. Available at: http://icaatom.arquivoestado.sp.gov.br/ica-atom/index.php/secretaria-de-agricultura-comercio-e-obras-publicas;isaar

53. P. Fonseca & M. Autuori, *Principaes pragas do café no estado de São Paulo* (São Paulo, 1932).

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Abstract

Coffee—riches and sorrows: how diseases and pests contributed to science, technology and innovation at the turn of the twentieth century in São Paulo, Brazil. Cristiana Loureiro de Mendonça Couto, PhD in History of Science, Centre Simão Mathias of Studies in History of Science (CESIMA), Pontifical Catholic University of São Paulo, Brazil, criscouto@criscouto.com; Ana Maria Alfonso-Goldfarb, PhD in Social History, Centre Simão Mathias of Studies in History of Science (CESIMA), Pontifical Catholic University of São Paulo, Brazil, aagold@dialdata.com.br

Coffee became one of the main sources of wealth in Brazil, the state of São Paulo in particular, from the second half of the nineteenth century onwards. However, several problems threatened production, including diseases—mainly infectious—which decimated the workforce, and devastated agricultural pests. In the present study we argue that these factors were some of the triggers for the development of science and technology in Brazil. The local investigators made thorough use of innovations developed abroad, and also sought to create local conditions to overcome scientific and technological challenges. In some relevant cases they contributed to global efforts to eradicate epidemics and pests, and thus to the emergent microbiology and entomology. The case of the coffee industry in São Paulo clearly illustrates aspects of the global-local integration of science, technology and innovation, and of the dynamics of the transit of knowledge.

Keywords: Coffee, Brazil, nineteenth century, science and technology, microbiology, entomology