

The Franco-American Race for the Yellow Fever Vaccine

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Abstract

This paper looks at the cooperation and rivalry between the Rockefeller Foundation and the French Pasteur Institute during the development of the 17-D and Dakar vaccine strains for inoculation against yellow fever. Using sources held at the Rockefeller Archive Center, this paper recovers the tenuous relationship between the researchers funded by the two institutions, and shows how their work was shaped by national, imperial, and scientific rivalries. In the race to the yellow fever vaccine, the Pastorians, in particular, utilized their imperial network, which allowed them to bypass ethical concerns raised by researchers in Paris and elsewhere, and proceeded to human trials using a vaccine that had been criticized for its adverse neurological effects on certain subjects.

Introduction

Following a yellow fever outbreak in West Africa in 1928, the French Pasteur Institute and the American Rockefeller Foundation (specifically, its International Health Division), established research programs in Dakar, French West Africa (*Afrique Occidentale Française*, AOF) and Lagos, British Nigeria, respectively, with the goal of developing a vaccine for this deadly tropical disease. The vaccines developed in this race, the Dakar strain and the 17-D strain, both fell under criticism for causing adverse neurological effects in some patients. However, the Dakar vaccine, in particular, was linked to the confirmed deaths of hundreds of vaccine recipients in Nigeria and Senegal in the 1950s and 1960s, and possibly thousands more, as a consequence of wartime vaccination campaigns which counted over 14 million vaccinations.

My larger project, *Pasteur's Empire* surveys the colonial history of the French Pasteur Institute. I argue that the scientific prestige of the Pasteur Institute came to depend on its colonial laboratories, and how, conversely, the institutes themselves became central to colonial politics. *Pasteur's Empire* argues that decisions as small as the isolation of a particular yeast or the choice of a laboratory animal could have tremendous consequences on the lives of Vietnamese and African subjects, who became the consumers of new vaccines or industrially fermented intoxicants. Simultaneously, global forces, such as the rise of international standards and American competitors pushed Pastorian to their imperial laboratories, where they could conduct studies that researchers in France considered too difficult or controversial. I follow not just Alexandre Yersin's studies of the plague, Charles Nicolle's public health work in Tunisia, and Jean Laigret's work on yellow fever in Dakar, but also the activities of Vietnamese doctors, African students and politicians, Syrian traders, and Chinese warlords. In this project, I argue that a specifically Pastorian understanding of microbiology shaped French colonial politics across the world, allowing French officials to promise hygienic modernity, while actually committing to little development.

Central to the Pastorians' self-image was their status as the world's foremost microbiologists, a title that became increasingly wobbly after World War I. The

Pasteur Institute itself was suffering from a number of maladies: underfunding, inflation eating away at its endowment, and a scientific capacity that had been diminished by war losses. Meanwhile, the biomedical world had acquired a new, powerful player. The Rockefeller Foundation left its imprint on France with its tuberculosis prevention campaign, which took off as the US entered in 1917. Americans created traveling exhibits, puppet shows, instructional films, and awareness-raising posters designed to educate the French, and particularly their children about the virtues of washing hands, containing spit, and other aspects of good hygiene – all the while, reminding them of the role of “the American mission sent to France by Mr. Rockefeller” in this campaign.¹ Over 200 dispensaries employed “social welfare nurses” (*visiteuses d'hygiene*) who were tasked with collecting data on TB rates and spreading public health knowledge on how to avoid contagion and keep proper hygiene. Rockefeller Foundation experts also trained nurses and physicians, and led coordination efforts between dispensaries, attempting to establish a national public health system, which the French had tried, but failed, to achieve during the war.² While the initiative acknowledged the role of microbes in causing TB, it ultimately continued the prewar focus on “soil” over “seed,” an epidemiological vision that emphasized environmental and social conditions, as well as the health of the individual body over a focus on limiting contact between the tubercle microbe and the human agent. This contrasted with the Pasteur Institute’s strictly immunological and therapeutic vision, which emphasized the potential of a possible vaccine. Over the course of the 1920s, many Pasteurians came to see themselves as competitors of the Rockefeller Foundation, even as they received grants from the RF and became close collaborators with many Rockefeller Foundation scientists.

The following discussion looks at one such instance of competition mixed with collaboration: the isolation and culturing of the yellow fever virus leading to the development of the Dakar vaccine strain. I argue that as Pasteurians and Rockefeller Foundation scientists navigated the tensions between scientific collaboration and imperial rivalry, biological exigencies – an unexpected infection, a problem of transportation, a difficulty in cultivation – determined the shape of the researchers’ relationship. A thorough accounting of the Pasteur-Rockefeller rivalry must include the yellow fever virus itself as an actor in the process.

The Pasteur-Rockefeller Rivalry: An Imperial Genealogy

The Pasteur Institute and the Rockefeller Foundation had a long history of both cooperation and competition. Beyond the uneasy relationship around tuberculosis prevention, which was explored in chapters four and five of my book, the RF and the Pasteur Institute had also crossed paths in yellow fever research. For decades, the main French reference point for bacteriology in the Americas had been Brazil. In 1898, Oswaldo Cruz, a prominent Brazilian bacteriologist trained at the Pasteur Institute, established a microbiological laboratory in Rio de Janeiro in order to produce Yersin's plague serum and the Haffkine lymph, with the goal of protecting the country against the spreading plague pandemic.³ In 1900, following an outbreak of yellow fever in Senegal, prominent Pastorian, Paul-Louis Simond, Albert Salimbeni, and Émile Marchoux traveled to Rio de Janeiro in the hopes of learning more about the disease during an active epidemic. That mission established the already prevalent prejudice of black “racial immunity” as a virtual fact in French medical science.⁴ Nearly two decades later, the Oswaldo Cruz Institute found new collaborators at the Rockefeller Foundation, and began an extensive public health campaign to eradicate mosquito habitats, improve sanitation, and install mosquito nets, together greatly decreasing incidents of yellow fever infection in Rio. Pastorians in the AOF, who traced their research back to the work of Simond, Marchoux, and Salimbeni, were more than aware of the Rockefeller Foundation's success in Brazil – and were they to forget, critics of the AOF government's indecisive response would not hesitate to remind them of the comparison.⁵

Much like the Pastorians, the Rockefeller Foundation's interest in yellow fever grew out of imperial politics. The US South, most notably New Orleans, regularly suffered yellow fever outbreaks, and although most long-time residents had acquired immunity through childhood exposure, new populations were exposed to the risk of disease as migration to the US increased. Mariola Espinosa has argued that fear of Cuban outbreaks spreading to the US South in part motivated

the US war with Spain and the occupation of Cuba in 1901. There, US medical forces undertook a massive campaign to eradicate mosquito breeding grounds in hopes of halting the spread of the disease. The Platt Amendment to the Cuban constitution, which ended the occupation, mandated that the island nation retain the sanitary standards put in place by the US. This set a model for the practice of US involvement in the sanitary politics of nearby states, as well as a model for yellow fever eradication – the destruction of mosquito breeding grounds.⁶ This model was adopted by General William Gorgas, one of the early figures at the Rockefeller Foundation, who further tested the efficacy of eradicating yellow fever by destroying “key centers” of mosquitos before the opening of the Panama Canal in 1914. Finding the exercise successful, he directed the International Health Board (IHB - soon to become the Foundation’s International Health Division - IHD) to the cause, and took the eradication campaigns first to Guayaquil, Ecuador, and then to Brazil. Drawing from high-profile successes in Cuba and Panama, Gorgas was confident that yellow fever campaigns would establish the Foundation as a major player on the international stage.⁷

Yellow fever quickly became the central focus of the IHD, consuming between 40 to 60 percent of its budget in the interwar years. After campaigns in Ecuador, Mexico and Peru, and Brazil, the IHB looked towards West Africa. In 1920, the IHB commissioned a report to study potential sites for establishing a research commission. Dr. Juan Guiteras, the lead investigator, proposed three locations: Dakar in the AOF, Freetown in Liberia, and Lagos in British Nigeria. All three were close to sites of minor outbreaks, but Dakar and Lagos offered additional advantages. Both were “great commercial centres of the Coast,” with already existing laboratories, good communication with the interior and the exterior, and had large white populations, which the Rockefeller scientists assumed were more susceptible to the disease.

Dakar, in particular, was attractive, since it was well-stocked, easily accessible by sea, and had a large population of mixed-race citizens whom Guiteras considered “a better touchstone than the Negro.”⁸ At the same time, yellow fever outbreaks were markedly more common in British colonies, particularly in Nigeria and the Gold Coast, which recorded an epidemic almost every year from 1910 onwards.⁹

In 1925, Dr. Henry Beeuwkes traveled the three cities, meeting with colonial officials, local bacteriologists and other elites, hoping to secure a site for the new project. Yet the enthusiasm of AOF administrators had waned. Dr. Lasnet, the head of the sanitary service, in particular, dismissed Beeuwkes' interest, suggesting that the disease was mostly a problem for the British, and that the AOF had not suffered a single major outbreak in the twentieth century.¹⁰ Beeuwkes also corresponded with Calmette, who had just unveiled the BCG vaccine, an early treatment for tuberculosis, and had similarly limited interest in working with his primary rival.¹¹

The British were more accommodating. Having secured the support of the Colonial Office in London, Beeuwkes, together with his partner Henry Hanson, approached authorities in Nigeria, and soon set up a settlement of six well-equipped buildings, six acres of land, and around ten American bacteriologists with many more local subalterns in a compound on the outskirts of Lagos.¹² From there, Beeuwkes and his collaborators organized missions inland. They observed epidemics in progress, charted the endemicity of the disease, and studied whether other mosquitoes, besides the *Aedes aegypti*, could transmit the illness.¹³ The region quickly became the largest recipient of Rockefeller yellow fever funding, after Brazil. From 1925 to 1928, the Foundation dedicated about half of its roughly \$500,000 yellow fever budget to West Africa.¹⁴ When new cases were reported in 1926, the Rockefeller West Africa Commission, which at the time was led by the ambitious British bacteriologist, Adrian Stokes, was ready to investigate.

The Pastorian vaccine program, then, was a late arrival. Indeed, Rockefeller Foundation scientists were generally unimpressed with the French response. When Beeuwkes attended the French yellow fever conference in Dakar following the 1927 epidemic, he wrote back to the director of the IHD with a blunt critique of health officers' "sketchy" epidemiology, "deplorable" sanitary conditions, and in particular the lack of antilarval work of the sort promoted by the RF in South America. In terms of vaccine development and bacteriological research, Beeuwkes was skeptical as well: "The papers read by the French were not particularly illuminating, and as we did not wish to ask embarrassing questions, we are not clear as to all steps taken to combat the epidemic."¹⁵ Beeuwkes, Stokes, and others

in Nigeria did indeed seek greater cooperation with the Pastorians, expressing hope that “one or more of their better men might visit [Lagos] at our expense”. However, higher-ups in New York cautioned against an overly cavalier exchange of information, reminding the scientists in Lagos that it was “unfortunate that news of your work has spread by the grapevine telegraph to the French in advance of its publication.”¹⁶ While taking an interest in their work, Rockefeller Foundation scientists considered Pastorians inferior competitors. The feeling, no doubt, was mutual.

The Period of Cooperation

Two unexpected biological problems brought the two institutions closer into each other’s orbits. The connecting link was A. Watson Sellards, a Harvard bacteriologist who had rejected a position at a Rockefeller Foundation-funded public health laboratory in Manila on the account that the work there was too “routine” and “practical.”¹⁷ After a brief stint in Brazil, he traveled to Dakar, in search of the biggest epidemic, and began working with Laigret and Mathis on a potential vaccine. The three bacteriologists soon successfully isolated the yellow fever virus from samples taken from a Syrian patient, François Mayali, in 1928. Quickly, however, they faced a new problem: The Dakar facilities were not properly equipped for developing a vaccine. The virus had to be transported to Paris for further study. But how could the scientists keep the virus alive for the duration of the trip?¹⁸

Alas, the only man with the answer was a direct competitor. In Lagos, Adrian Stokes struggled with the same problem. Yellow fever outbreaks often occurred far from Lagos, and access to patients was limited. In order to study the virus, and to develop a vaccine, it would have to be preserved and cultivated – but how? Stokes’ answer was to have “as many varieties of monkeys as he could” shipped over from Hamburg and London, in the hopes that one of the species would be susceptible to yellow fever, and could therefore be used as a vehicle for cultivating the virus. His experiment was a success; the Indian rhesus monkey, *Macacus rhesus*, was successfully infected, both with injections of contaminated blood, and

by way of captured mosquitoes who had recently fed on yellow fever victims. Soon, more specimens were shipped to Lagos to keep the Rockefeller Foundation experiments going.¹⁹

Handling monkeys was a dangerous business. It may have been a chimpanzee bite that Stokes suffered when handling the monkey, or a later bite by one of the Indian monkeys that was subsequently exposed to infected material. It might have even been a stray mosquito feeding on one of the lab animals making it past the nets, or quite simply, a laboratory accident. What is certain, is that on September 16th, 1927, Stokes came down with high fever, headache, joint pain, and, soon after, jaundice. His colleagues immediately suspected yellow fever, sent him to the hospital, and isolated the laboratory in order to protect other scientists and workers. Stokes himself, ever the scientist, demanded that his blood be injected into monkeys, so that new strains of the virus might be recovered. Two days later, his health seemed to have improved. Stokes asked for new reading material, and planned for returning to work in the coming days. Knowing the standard progression of yellow fever, though, his colleagues remained cautious – and alas, their concerns were founded. Less than a day later, Stokes began vomiting blood, and died, quietly on the night of September 19th.²⁰

During his illness, Stokes managed to write one letter. He sent it to his friend in Dakar, A. Watson Sellards, describing in detail the process by which the yellow fever virus could be transmitted to, and then cultivated in rhesus monkeys. Building on Stokes' research over the next few months, Sellards, Laigret, and Mathis acquired monkeys first from Paris, and then from the Institute's zoological station in Pastoria, Guinea, and infected them either through injections of blood drawn from infected patients, or through subcutaneous insertions of organ tissue drawn from the autopsies of patients who did not survive the infection.²¹ Using rhesus monkeys as vessels, Pastorians then transported the virus back to Paris, where the full power of the *maison-mère* could be brought to bear on its study.

The Paris team, which expanded to include Auguste Pettit and his student, Georges Stefanopolou, experimented with a number of different ways of inducing immunity in test animals. Ultimately, they succeeded thanks to the help of

another Rockefeller Foundation scientist, Max Theiler, an old friend of Sellards. Theiler discovered that the virus could be cultivated in the brains of lab mice - a cheaper, faster, and altogether more successful alternative to other, larger animals, such as rhesus monkeys. Sellards quickly wrote his colleagues at the Pasteur Institute in Paris, and invited them to New York, to learn from Theiler's technique firsthand.²² Armed with the Dakar strain and Theiler's technique, Sellards, Pettit, Laigret, and Stefanopolou cultivated a murine yellow fever virus, which at its 125th passage conferred immunity to rhesus monkeys with only mild neurological side effects. Sellards' international connections had once again allowed the Pasteur Institute to move their research on the Dakar strain one step forward.

Excited by the prospects of a viable vaccine, Sellards volunteered to be the first human test subject of the vaccine. Here, however, he hit a wall: Émile Roux, the director of the Paris Institute, unequivocally denied him permission. This was not an unreasonable assumption, given that several researchers in the anglophone world, from Stokes to Theiler, had contracted yellow fever in the laboratory. The disease had a reputation for getting out of control.

Institutional and national rivalries then motivated Sellards, Laigret, and others to proceed without Roux's consent. In the US, Sellards was finding increasingly less support for his research, as the Rockefeller Foundation concentrated yellow fever researchers in New York, while Sellards was unwilling to leave his job as the head of the Harvard Medical School. As Constant Mathis explained to his friend Mesnil in early 1931:

Harvard is humoring Rockefeller, who wants to have *exclusive monopoly* on the studies of yellow fever, and has indicated to Sellards that he should not be counting on getting research funds in the future. [...] It is for this reason that he wants to return to Paris²³

The Pastoriens, too, felt the ongoing rivalry between them and the Rockefeller Foundation, as well as the importance the project had for France's imperial prestige. At one conference in 1935, Laigret gently corrected a delegate who suggested that the yellow fever vaccine was at the heart of an “Anglo-French

rivalry” by saying that the competing process was “not English, but American,” and adding that “the time is near when even the Central and Southern American countries will follow the lead of French colonies.”²⁴ Those were, of course, countries that had collaborated with the Rockefeller Foundation, and where Pastorian superiority would have to be reasserted. As Sellards and others were looking for a colonial location where to carry out the human trials that Roux had vetoed, one man, ever keen to enter into conflict with the *maison-mère*, was happy to oblige. In 1931, Charles Nicolle invited the yellow fever researchers to experiment in his laboratory in Tunis, kicking off the next phase of development.

The Rivalry Revived

In the following years, both Rockefeller Foundation-funded scientists and Pastorians inched closer to a prototype vaccine. In London, RF-sponsored scientists George Findlay and Ernest Hindle arrived at their own method of serovaccination in the early 1930s. Unlike Roux, however, officials at the Wellcome Laboratories allowed them to proceed to human trials, and by 1934, Findlay and Hindle had successfully vaccinated over 200 volunteers in London, and published several articles. Both the specialist and general press in France were outraged by what they perceived as an excess of caution, which had almost robbed the French of an important discovery. An opinion piece titled “A discovery the French did not wish to... discover”, published in the popular magazine *Le Nouveau Cri*, succinctly summarized the implications of Roux's caution:

Here is the news..., a French scientist discovered and developed a vaccine for yellow fever. The effects of this serum are undisputable. [...] I sincerely believe that this news has some importance [...] We would stop discussing the principles of “colonialism”, if these “imperialists”, the colonizers knew how to save the colonized from all the scourges, the miseries, the hereditary slavery which burdens them... One can colonise to empower, and not to subjugate.²⁵

The writer blamed both the AOF government and the scientific community for being overly cautious, holding back a clearly viable vaccine for two years. As a

result, “we are now using English materials and paying them their price. But these are vaccines, not candy we are talking about.”²⁶ The approval of the vaccine for human trials and subsequent use in the colonies was not only a question of medical ethics, but also a question of national prestige and imperial autonomy.

With the help of Nicolle in Tunis and the administrators of the AOF, Laigret was able to proceed, first, to isolated human trials and then to larger trials involving thousands of colonial subjects in French West Africa and French Equatorial Africa by the mid-1930s. The first series of human trials with the Laigret-Sellards vaccine strain were successful: all five volunteers tested positive for antibodies and showed no harmful reactions to the vaccine. The second round of testing was more problematic: three out of seven volunteers in Tunis developed severe side effects, which included high fever, neurological symptoms (meningitis), and bloody sputum.²⁷ Laigret made efforts to further reduce the virulence of the neurotropic virus, and the side-effects became increasingly rare in trials using the method of three consecutive injections with vaccine-viruses of increasing virulence. The vaccine nevertheless remained very unreliable: in the first round of trials in Dakar, which involved 2,164 European volunteers, test subjects regularly experienced high fevers of up to 40C. Two patients, developed serious symptoms: intense headaches about a dozen days after vaccination, followed by a loss of movement in the extremities, stiffness of the back, and delirium.²⁸ Once Laigret began using the neurotropic vaccine coated in egg yolk, he proudly reported a complete loss of side effects, but neglected to mention that he had only tested the coated vaccine on a small number of people – 89 subjects in Paris, far too few to conclusively show that the vaccine's potential dangers had been abated.²⁹ Meanwhile, Mathis, who continued testing the same, coated vaccine in Dakar, was not nearly as successful. He tested the vaccine on 450 subjects, 50 of whom were African. In Europeans, the coated vaccine produced mild side effects in 17 cases out of 100, moderate side effects in 13 cases, and severe reactions – fevers of up to 40C and meningoencephalytic symptoms - in 9 out of 100 cases (all in all, over a third of European test subjects had some sort of adverse reaction).³⁰ These effects, assured his friend Mesnil, were “nothing but normal reactions,” yet concerning enough that he warned his Parisian colleagues to expect the Laigret-Sellards vaccine to fall under heavy criticism.³¹

Though Charles Nicolle, Laigret, and others defended the safety of their new vaccine, arguing that the adverse reactions were caused by production errors and were no cause for concern, some metropolitan Pastorians and Rockefeller Foundation researchers were concerned. Stefanopolou, in particular, was very troubled, since the apparent success of Laigret's vaccine and the lack of attention to its defects was rendering his own serovaccination project obsolete. "[The vaccine] is unfortunately supported [...] by the authority of Mr. Nicolle, a member of the Institute, and by characters who are not afraid to kill some of their fellow creatures to gain experience and particularly to infect [N]egro populations who remain outside of 'statistics,'" wrote the researcher to his colleagues at the Rockefeller Foundation in 1934.³² He highlighted the severity of neurological reactions in lab animals. (Nearly all rhesus monkeys who developed encephalitis after receiving the pure vaccine had ultimately died.) He feared that the vaccinations may have caused unrecorded deaths, and wanted to take up the issue with the Office international d'hygiène publique, headquartered in Paris. As the AOF's plans to expand human trials in Senegal advanced, Stefanopolou became ever more concerned. "My dear Doctor Sawyer," he wrote to his Rockefeller Foundation colleague (his own salary at the Pasteur Institute was partly funded by a Foundation grant), "please, I beg you, come over here to support me for a few days. Alone, my voice is too feeble."³³ His RF colleagues rebuffed him, suggesting that he focus on a different line of research and leave developing an alternative vaccine to the Rockefeller Foundation team. Sawyer, director of the RF's yellow fever laboratory, responded that "it begins to look as if the danger of the [Laigret] method in the experimental animal is much greater than the danger in man," and promised that the Foundation was making progress in developing even safer strains.³⁴ Years later, RF scientists acknowledged (and quite possibly shared) the sense that the success of Laigret's vaccination campaign depended on a colonial relationship to the recipients of the vaccine. One report on the potential uses of the Dakar vaccine in South America read as follows:

In dealing with native populations in Africa [...] vaccination by the French method and with the French neurotropic strain may be permissible. It is the feeling, however, in Brazil that it would not be advisable to apply a method, which might, though rather rarely, give rise to encephalitis. A strong feeling of the rights of man prevails in Brazil, as I believe it does in most South American countries, and if

serious reactions were prone to occur as a result of the vaccinations, it might readily become impossible to vaccinate.³⁵

In colonial West Africa, the ethical calculus was rather different. There, scientific prestige and projection of imperial power trumped strong feelings for the rights of man.

Conclusion

Whatever concerns Stefanopolou, Sawyer, and others had about the Dakar vaccine, those were rendered moot by 1939, when the AOF began a wide-scale vaccination campaign using Laigret's concoction. The yellow fever vaccine program was one of the few Pastorian initiatives that continued during World War II, when the AOF was under the control of Vichy France. The campaign concluded in 1946, when the Pasteur Institute claimed 14,300,735 successful vaccinations – close to total coverage in the colony with an estimated population of 16 million.³⁶ The Rockefeller Foundation's 17-D vaccine strain, developed concurrently in the 1930s, from a virus sample recovered in the Gold Coast, produced similar, although milder complications: encephalitis in the case of one set of subcultures, and delayed jaundice in some vaccinated subjects. These harmful effects delayed its mass production until the war (although limited campaigns were conducted at the supervision of the Oswaldo Cruz Institute in Brazil). During the war, outbreaks of yellow fever in North Africa accelerated its use.³⁷ Despite the existence of this alternative in the postwar years, governments in French Africa continued to use the Dakar strain, which was better suited for delivery in a colonial setting, claiming over 42 million inoculations by 1953.³⁸ Neighboring regions – British Nigeria and the Belgian Congo – also began using the Dakar strain. Laigret's project was a success.

Over the course of the 1950s, however, more and more doctors began to notice serious, sometimes fatal complications, particularly in young children, following injections of the Laigret-Sellards vaccine. One vaccination campaign in Nigeria, conducted in 1952, produced 83 serious cases of meningoencephalitis and 32

fatalities, mostly children under the age of ten. Another vaccination campaign in post-independence Senegal in 1965 led to 235 hospitalizations and 23 deaths, without accounting for those who did not seek medical attention when the neurological symptoms appeared. Reactions to the Laigret-Sellards neurotropic vaccine turned out to be particularly severe in small children. Experts have estimated that a child had a one in five hundred chance of developing meningoencephalitis from the Laigret vaccine.³⁹ The scholar Hervé Bazin has extrapolated that mass vaccination campaigns in the AOF may have led to the deaths of up to 3,000 Africans.⁴⁰ In 1958, the World Health Organization officially recommended the improved Rockefeller 17-D strain as the preferred vaccine, and most countries stopped using the Laigret strain, particularly in children under the age of ten. By 1982, the Pasteur Institute of Dakar stopped manufacturing the vaccine altogether.

There were many reasons for why the French insisted on using the Dakar vaccine strain, even as evidence of its adverse effects mounted. Here, I have focused on one such reason: the ongoing semi-collaboration, semi-rivalry with the Rockefeller Foundation. At stake in the yellow fever vaccine project was not simply the health and safety of France's citizens and colonial subjects. It was a matter of prestige: the conviction that France should not depend on foreign powers for its public health needs for administrators of the AOF, and that the Pasteur Institute was capable of delivering a public health victory over the Rockefeller Foundation, even as Pasteurians received grants and collaborated with RF scientists.

¹John Farley, *To Cast Out Disease* (New York: Oxford University Press, 2003), 48-50; school assignment cited on p. 50.

²Farley, *To Cast Out Disease*, 51-54.

³For a history of the Oswaldo Cruz Institute see Nancy Stepan, *Beginnings of Brazilian science. Oswaldo Cruz, medical research and policy, 1890-1920* (New York: Science History Publications, 1976).

⁴Ilana Löwy, *Virus, moustique et modernité: la fièvre jaune au Brésil entre science et politique* (Paris: Édition Archives Contemporaines, 2001), 70-79.

⁵The most common reference point for critics was Cuba – where the disease had been effectively eliminated in Santiago and Havana. Brazil was also frequently referenced. "Chronique médicale: la fièvre jaune," *Le Temps*, 1 Nov. 1927, "La fièvre jaune

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- en France,” *Paris*, 9 Oct. 1927, for the campaign in Cuba see Mariola Espinosa, *Epidemic Invasions: Yellow Fever and the Limits of Cuban Independence, 1878-1930* (Chicago: University of Chicago Press, 2009).
- 6Espinosa, *Epidemic Invasions*, 117-124.
- 7Farley, *To Cast Out Disease*, 88-92.
- 8Robert E. Noble to the general director of the International Health Board, undated report; Juan Guiteras to General R.E. Noble, “Report on the General Situation on the West Coast of Africa, with respect to Yellow Fever with Suggestions as to Subsequent Investigations,” October 1920, Folder 328, Box 52, Series 2, RG 5 IHB/D, Rockefeller Archive Center (RAC).
- 9“List of Localities in West Africa where Yellow Fever Has Occurred and Years in which Reported,” 28 March 1924, Folder 329, Box 52, Series 2, RG 5 IHB/D, RAC.
- 10Henry Beeuwkes, diary entry, volume 1, 15 April 1925, Folder 27, Box 4, Series 495, RG 1.1, RAC.
- 11Henry Beeuwkes, diary entry, volume 1, 24 April 1925, Folder 27, Box 4, Series 495, RG 1.1, RAC.
- 12 *The Rockefeller Foundation Annual Report, 1926* (New York: The Rockefeller Foundation, 1927), 40-41.
- 13Henry Hanson, diary entry, 9 January 1926, Box 196, RG 12, RAC.
- 14“West Africa – Yellow Fever – Additional Appropriations”, 13 April 1928, Folder 4950, Box 1.1, Series 495, RG 1.1, RAC.
- 15Henry Beeuwkes to F.F. Russell, 3 May 1928, Folder 4950, Box 1, Series 495 RG 1.1, RAC.
- 16F. F. Russell to Henry Beeuwkes, 10 January 1930, Folder 4950, Box 1, Series 495 RG 1.1, RAC.
- 17F. F. Russell to A. W. Sellards, 15 January 1926; A.W. Sellards to F.F. Russell, 25 January 1926, Folder 3487, Box 275, Series 1.2, RG 5 IHB/D, RAC.
- 18Constat Mathis, A. Watson Sellards & Jean Laigret, “Sensibilité du *Macacus Rhesus* au virus de la fièvre jaune,” *Comptes rendus des séances de l'academie des sciences* 186, 1928, 604-606.
- 19F.F. Russell to W. G. McCallum, 14 Oct. 1927, Folder 1632, Box 120, Series 1.1, RG 5 IHB/D, RAC.
- 20Henry Beeuwkes, diary entries, 16-19 September 1927, Folder 4950, Box 5, Series 1.1, RG 5, RAC.
- 21“Rapport annuel de l'Institut Pasteur de Dakar,” 1928, 2 G 28-27, National Archives of Senegal (ANS); A. Watson Sellards, Constant Mathis, “Expériences de transmission du virus amaril au “*Macacus Rhesus*”, *Conférence Africaine de la fièvre Jaune* (Paris: Imprimerie Militaire Universelle, 1928), 10-11.
- 22Sellards to Émile Roux, personal letter, 1 July 1931; Sellards to Roux, 9 February 1932, CAL.B6, Archives of the Pasteur Institute (AIP).
- 23Mathis to Mesnil, personal letter, 13 Sept. 1931, MES.6, see also Sellards to Roux, personal letter, 9 Feb. 1932, CAL.B6, AIP.
- 24Laigret, “La vaccination de la fièvre Jaune,” *Conférence faite le 22 mars a l'Union Colonial Française*, 10-11, LAI, AIP.
- 25Maurice Prax, “Une découverte que les français ne voulaient pas... découvrir”, *Le Nouveau cri*, Sept. 8 1934.
- 26Maurice Prax, “Une découverte que les français ne voulaient pas... découvrir”, *Le Nouveau cri*, Sept. 8 1934.
- 27Pierre Mollaret, *Le Traitement de la fièvre Jaune* (Paris: Librairie J.-B. Bailliere et fils, 1936), 113-114.
- 28Mollaret, *Le Traitement de la fièvre Jaune*, 115.
- 29Laigret to Minister of the Colonies, official report, 3 Aug. 1935, IP.SER.1, AIP; Jean Laigret & Charles Nicolle, “La vaccination contre la fièvre jaune par le virus amaril vivant, desséché et enrobé,” *Comptes rendus des séances de l'Académie des Sciences*, 29 July 1935, p. 312.

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- 30 Rigollet, *Prophylaxie de la fièvre Jaune Notamment par la Vaccination anti-Amarile*, 36.
- 31 Mathis to Mesnil, personal letter, 14 Sept. 1936, MES.6, AIP.
- 32 Georges Stefanopolou to Dr. Sawyer, 16 Oct 1934, Folder 313, Box 28, Series 4 IHB/D, RG 5, RAC.
- 33 Georges Stefanopolou to Dr. Sawyer, 16 Oct 1934, Folder 313, Box 28, Series 4 IHB/D, RG 5, RAC.
- 34 W. A. Sawyer to Georges Stefanopolou, 1 Nov 1934, Folder 313, Box 28, Series 4 IHB/D, RG 5, RAC.
- 35 Richard G. Hahn to Dr. Strode, 7 Nov 1946, Folder 404, Box 36, Series 4 IHB/D, RG 5, RAC.
- 36 M. Peltier, "Vaccination anti-amarile, simple ou associée a la vaccination antivariolique..." undated, IP.DIR.5, Archives of the Pasteur Institute of Dakar (AIP-Dakar).
- 37 J. Gordon Frierson, "The Yellow Fever Vaccine: A History," *Yale Journal of Biology and Medicine* 83(2), June 2010, 77-85.
- 38 Hervé Bazin, *Vaccination: A History from Lady Montagu to Genetic Engineering* (Esher: John Libby Eurotext, 2011), 437.
- 39 Bazin, *Vaccination: A History*, 441.
- 40 Bazin, *Vaccination: A History*, 452.