


# The Rockefeller Foundation's International Health Board and the Attempt to Eradicate Yellow Fever

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## **Abstract**

Beginning in 1914, the Rockefeller Foundation's International Health Commission (which became the International Health Board in 1916 and the International Health Division in 1927) committed itself to the project of eradicating yellow fever. Its efforts were modeled on the sanitary techniques deployed by US sanitarians in Havana in 1901 and, more importantly, during the construction of the Panama Canal between 1904 and 1914, with mosquito control preeminent among them. William C. Gorgas, who led these campaigns and then came to work for the Rockefeller Foundation, argued for a key center approach to yellow fever eradication that targeted the remaining urban endemic foci of infection, with the assumption that once these seed beds of the disease were eliminated, yellow fever would fade from the planet. But as the IHB conducted campaigns in South America, Central America, and West Africa during the late 1910s and 1920s, they discovered that yellow fever's ecology and epidemiology were more complicated than they had assumed, and that a "key center" approach would not work to eradicate the disease. By the 1930s, and particularly with Fred Soper's discovery of sylvan or jungle yellow fever, the Rockefeller Foundation gave up on their eradicationist dream.

On July 14, 1914, Surgeon General William C. Gorgas met with Wickliffe Rose, the director-general of the Rockefeller Foundation's International Health Commission (IHC), in Washington, DC, to discuss the possibility of a program to eradicate yellow fever. Gorgas had led the US effort to rid Havana of yellow fever in 1901, in the wake of the Reed Commission's confirmation of the disease's mosquito vector. He then oversaw the sanitary campaign that eliminated yellow fever (and reduced the incidence of malaria) in the Canal Zone and its terminal cities during the construction of the Panama Canal, which was scheduled to open just a few months after his meeting with Rose. Rose had served as executive secretary of the Rockefeller Sanitary Commission starting in 1910, overseeing their efforts to eradicate hookworm from the US South. Then, in June 1913, several months after the creation of the Rockefeller Foundation, Rose assumed charge of the IHC. The top priority for the IHC at its creation was to continue hookworm eradication efforts in other parts of the world, but the meeting between Gorgas and Rose was crucial to extending that work to yellow fever. As the Rockefeller Foundation's *Annual Report* of 1915 put it:

Under the inspiration of the success which has attended the efforts of the United States to eradicate yellow fever from Cuba and Panama, a work the indirect result of which has been to protect the southern United States and Central America from the danger of recurrent epidemics, the International Health Commission decided to study the feasibility of eradicating the disease from the remaining endemic foci.<sup>1</sup>

This dream of eradicating yellow fever – one of several such eradicationist global public health efforts across the twentieth century – sprang not merely from the successful sanitary model perfected in Havana and Panama. It also grew, as Rose put it, from “the sanitary needs and responsibilities resulting from the opening of the Panama Canal.” While touring Asia as part of his new duties with the IHC, Rose heard fears that the canal, by putting Asian ports in much closer contact with parts of the Americas where yellow fever still prevailed,

might spread the disease to that continent, threatening its dense urban populations. Fearing such an outcome, and in cooperation with Gorgas and a number of other sanitary officials who had made their reputations in the sanitary campaigns in Cuba and Panama, the IHC (which would become the International Health Board in 1916 and the International Health Division in 1927) embarked upon an effort to eliminate the remaining endemic foci of yellow fever, a campaign that would extend throughout the Americas and into West Africa over the next several decades. That campaign had its successes, perhaps most importantly in the elimination of yellow fever from Guayaquil, Ecuador, its most persistent remaining endemic focus in the Americas. But the eradicationist dream would fade away by the 1930s, as researchers, many of them affiliated with the Rockefeller Foundation, discovered that yellow fever's ecology and epidemiology were more complicated than key figures such as Gorgas had assumed them to be.

This essay provides a brief history of the Rockefeller Foundation's efforts to control yellow fever between 1914, the year that the US completed the Panama Canal and Gorgas and Rose extended Panama's sanitary lessons to the rest of the world, and the 1930s, when the International Health Division gave up on the goal of eliminating yellow fever through traditional methods of mosquito control. It particularly focuses on the "key center" model for yellow fever control pioneered by Gorgas, one that targeted a small number of endemic urban areas as the keys for eradicating yellow fever. Over the previous several centuries, yellow fever had been a disease of port cities in the Atlantic world for two important reasons. First, the vector for urban yellow fever, *Aedes aegypti*, is a domestic mosquito that breeds almost exclusively in artificial containers, and it abounded in tropical and subtropical port cities whose residents collected and stored rainwater in barrels and cisterns. Second, the commerce through such port cities not only reintroduced and spread the virus with frequency but, in several key cities, also provided constant streams of non-immunes who kept the virus circulating between humans and mosquitoes. Havana, for instance, received a constant flow of migrants from Spain, including occasional influxes of military personnel, while the construction of the Panama Canal relied on the importation of a huge labor force. Importantly, those who survive a bout with

yellow fever gained lifelong immunity, and so long-time residents of cities frequented by yellow fever were mostly immune. But constant streams of migrants, soldiers, and workers provided fuel for continuous or recurrent outbreaks. With the confirmation of the mosquito vector in 1900, urban yellow fever became relatively easy to control, as sanitarians focused on eliminating mosquito breeding in tropical and subtropical port cities that experienced constant in-migration.

The Rockefeller Foundation's efforts to control yellow fever focused on those remaining key centers. In a memo that Rose prepared in the months after his meeting with Gorgas, titled "Yellow Fever: Feasibility of Its Eradication," he highlighted several such key centers. Guayaquil, Ecuador was the most prominent one, but he also cited Merida and Campeche in Mexico's Yucatan, several cities in northeastern Brazil, and South American ports on the Caribbean littoral. He also wondered about potential foci in West Africa, though the disease's status there was less certain in 1914. "Endemic centers," Rose wrote, "are the seed-beds without which there can be no epidemics." The assumption driving the campaign was that once yellow fever was eliminated from those endemic centers, it would disappear from the rest of the region and, eventually, the world.<sup>2</sup>

Over the next two years, Rose laid the groundwork for the campaign by consulting with and securing the services of many of the most experienced yellow fever sanitarians. One was Joseph H. White of the US Public Health Service (USPHS), who had overseen successful yellow fever control efforts in New Orleans in 1905. He was then loaned to the Rockefeller Foundation and served as the IHC's director for Latin America.<sup>3</sup> Rose also consulted with Henry Rose Carter, who had worked with the Reed Commission in Havana, had then served as director of hospitals in the Panama Canal Zone, and who also was working for the USPHS by the mid-1910s. Carter recommended Dr. Juan Guiteras, a Cuban physician and yellow fever expert with decades-long ties to US yellow fever control efforts.<sup>4</sup> But Gorgas was the key figure, and Rose was intent on getting the surgeon general as the leader of the effort. At a series of Rockefeller Foundation meetings in the spring of 1915, the Board approved

hiring Gorgas to lead an initial exploratory commission. Gorgas agreed, though it would take some time before he could turn his attention to the task.<sup>5</sup>

Before the IHC could launch its campaign against yellow fever, it would need to investigate the geography of yellow fever's presence and negotiate the delicate questions of national sovereignty, or how a US-based foundation, which often worked in partnership with the US government, would gain access to foreign nations to conduct the sanitary campaigns necessary for yellow fever eradication. This latter question was broached at the Second Pan-American Scientific Congress held in Washington, DC in December 1915, which Gorgas attended as a delegate appointed by President Woodrow Wilson. Gorgas was appointed to chair the Sanitary Section of the Congress, and, in that capacity, he introduced a resolution that asked nations in the Americas where yellow fever was still present to pass laws or ordinances empowering national and municipal public health authorities to undertake sanitary campaigns against yellow fever. Such a resolution was indeed passed by the Sanitary Section and then adopted by the Congress as a whole, providing Gorgas and his Yellow Fever Commission with the entrée that they needed to meet with government officials and urge action during their forthcoming survey of the region.<sup>6</sup>

The Rockefeller Foundation's newly appointed Yellow Fever Commission set off from New York City in June 1916 to conduct a South American reconnaissance. Officials were also concerned about endemic foci in Mexico, but the ongoing Mexican Revolution made a trip there difficult. The traveling commission included Gorgas as chair, Guiteras, and Carter. Also along were Dr. Theodore Lyster, who had worked on the Havana and Panama campaigns as well as in Vera Cruz, Mexico (and was Gorgas's nephew); Major Eugene Whitmore, an experienced pathologist; and William Wrightson, a sanitary engineer who had also worked in Panama and was then with the USPHS. They had also asked Joseph LePrince, who had been instrumental to the mosquito control work in Panama, to join the Commission, but he was unable to do get a leave from the army to do so.<sup>7</sup> The Commission headed first for Panama and then on to Guayaquil, Ecuador, where they arrived in late June and found both yellow fever and plague to be prevalent. The Commission next headed for Callao, Peru,

Lima's port and also a point of concern, and then back through Panama for an inspection of the north coast of South America. Among their stops was Bogota, Colombia, to meet with officials there. One of the curious things they discovered during this trip was a reported outbreak of yellow fever at the mining town of Muzo, in the mountains and distant from both the coast and Bogota. Commission members went to inspect and, finding no active cases or *Aedes aegypti* mosquitoes, assumed the report was spurious. But the mystery of yellow fever at Muzo, and at several other points in Colombia, would later play a major role in developing an increasingly complex portrait of yellow fever's ecology.<sup>8</sup> After Colombia, the Commission visited Venezuela and Brazil before returning to the US in December, when the Commission disbanded.<sup>9</sup>

In a series of reports that followed, the International Health Board (IHB) prioritized Guayaquil as the most important endemic center remaining in South America and began planning for a sanitary campaign there.<sup>10</sup> On January 23, 1917, Gorgas was appointed to lead the IHB's yellow fever work. But US involvement in World War I delayed those plans for more than a year, as Gorgas turned his attention to the war effort. Only when the war was over, and Gorgas had retired as surgeon general, was he able to return to heading up the IHB's yellow fever work.<sup>11</sup> The IHB sent an initial commission to Guayaquil from July to September 1918, led by Dr. Arthur Kendall, to conduct scientific disease investigations there with the goal of identifying the disease agent that caused yellow fever. Even though the confirmation of the *Aedes aegypti* vector had allowed for highly effective yellow fever control, the cause of the disease remained a mystery. The work of this first Guayaquil commission is most famous for giving birth to Hideyo Noguchi's theory, later discredited, that yellow fever was caused by the spirochete *Leptospira icteroides*. The Kendall Commission also engaged in initial discussions with the Ecuadorian government over a sanitary campaign to be led by the IHB, and it contended with anti-American sentiment there that complicated its mission. The key to the arrangement, IHB leaders thought, would be to design a campaign that would be nominally under the authority of Ecuador's national health authority but that would be led by a representative of the IHB who would have full authority. It

would become a model for Rockefeller Foundation yellow fever campaigns throughout the region.<sup>12</sup>

As they were planning this commission in the summer and fall of 1918, the IHB got word from Dr. William Deeks of the United Fruit Company that there was a yellow fever outbreak in Guatemala. They responded by enlisting Joseph White of the USPHS to investigate and attempt to control the situation. While the IHB positioned the yellow fever eradication effort as one of broad humanitarian importance, it quite frequently intersected with major US commercial interests in Latin America and was often aimed at protecting such US interests. In the case of the Guatemala outbreak, Deeks was a former sanitary official in the Canal Zone who had subsequently gone to work as United Fruit's medical superintendent, bringing the sanitary lessons of Panama to the fields and enclaves of their massive tropical fruit plantations. And one motivating fear for controlling the Guatemala outbreak was that yellow fever might be reintroduced into the US South at a moment when troops were mustered there for World War I. The IHB sent in Joseph White to conduct a mosquito control campaign, which the Guatemalan government funded, and together they successfully controlled the outbreak. White speculated that the disease had been imported from Mexico via rail.<sup>13</sup>

The IHB-supported sanitary campaign in Guayaquil began in November 1918 with the arrival of Dr. Michael E. Connor as the IHB's representative. Connor had also been a prominent part of the sanitary team during the construction of the Panama Canal and then had gone to work for the United Fruit Company before joining the IHB.<sup>14</sup> The Ecuadorian government appointed Connor as an assistant to Ecuador's chief health officer, Dr. Leon Becerra, and he was charged with mosquito control work throughout the city and its hinterland.<sup>15</sup> Guayaquil's bad reputation for yellow fever stemmed in part from the mosquito breeding conditions that were common to port cities in the region, but it was greatly exacerbated by a constant flow of non-immune migrants, known as "Serranos," from the highlands of Ecuador. This was not the first time that the city had seen anti-yellow fever work. Gorgas had visited the Guayaquil in 1913, when he was still working in Panama, to consult with public health officials



there.<sup>16</sup> City officials then undertook a campaign that had some success in reducing yellow fever, but when funding declined in the mid-1910s the situation deteriorated. The IHB filled that breach.

Connor and his men targeted the water tanks and barrels in the city that provided ideal breeding habitat for *Aedes aegypti*, screening or otherwise covering them and cleaning them out when larvae were found within them. They also experimented with the use of larvae-eating fish, which would become a favored IHB technique throughout the region. It was left to the municipal and national governments to handle other aspects of the campaign, including patient care and isolation and, eventually, the provision of piped water and sewer services to eliminate breeding places. In the end, the campaign was a success, dramatically reducing yellow fever in the city and surrounding regions. Indeed, by May 1919, yellow fever seemed to have disappeared from Guayaquil. As Rockefeller official Wilbur Sawyer later concluded of the campaign:

In Ecuador the principles laid down by the first Yellow Fever Commission seemed to hold in their entirety. The suppression of mosquito breeding in the principal city was followed by the complete disappearance of yellow fever there and this resulted in the spontaneous elimination of the disease from the surrounding towns and villages.”<sup>17</sup>

The Guayaquil campaign reinforced the efficacy of the key center approach.

After the successful Guayaquil campaign, IHB efforts focused on other areas perceived to be “seed beds” of yellow fever, but the IHB also found themselves deployed to places where the disease flared up. Indeed, the original systematic plan for treating endemic foci developed in the wake of the Gorgas Commission’s work in 1916 was often interrupted by the need to address surprise outbreaks. As the IHB’s Yellow Fever Commission became something of a rapid response unit, their sense of the efficacy of the key center theory began to waver.

Gorgas and the IHB next went to Piura, in northern Peru, in 1919, where an

outbreak had developed, likely spread there from Guayaquil. So impressed with Gorgas were the Peruvian authorities that they offered him a position as Peru's director of sanitation. Gorgas begged off because of his commitment to the IHB, but he did accept an honorary position and appointed IHB officials to represent him there.<sup>18</sup> In the end, the Piura outbreak was controlled with the help of Henry R. Carter, then with the USPHS. An IHB group later went back to Peru in 1920 and 1921 and, in cooperation with the government, rid the country of yellow fever, with the last case reported in 1921. In 1919, cases were also reported in Brazil, Honduras, El Salvador, and Mexico. In Honduras and El Salvador, IHB representatives joined special government commissions in successfully controlling the outbreaks, mostly through mosquito control. In 1920, yellow fever reappeared in Central America – in El Salvador, Guatemala, Honduras, and Nicaragua – as well as in Mexico. Again, IHB representatives joined government commissions in these countries to help stamp out the disease. Yellow fever would continue to flare up in Central America through the mid-1920s.<sup>19</sup>

By 1920, officials with the IHB felt confident that most of Central and South America was either free of yellow fever or heading in that direction, but there were two important exceptions. The first was Brazil. IHB officials, though itching to get involved, also expressed confidence that Brazilian officials were on the case and doing effective work. Brazilians under the leadership of Dr. Oswaldo Cruz had provided one of the formative examples of yellow fever control in their successful campaign to rid Rio de Janeiro of the disease between 1904 and 1909. Lyster visited Brazil in 1920 and was able to arrange for the IHB's Yellow Fever Commission to serve as technical advisors there. Mexico was a different story, as yellow fever seemed a persistent problem, particularly in the Yucatan. Mexico had experienced a decade-long revolution, and relations with the United States were tense, but IHB officials hoped that they might be able to make inroads there, particularly as they feared that Mexico had often been the source for recurrent outbreaks in Central America. Such a breakthrough also came in late 1920, when the IHB accepted an invitation from the president of Mexico to cooperate in yellow fever control. Theodore Lyster was made director of the yellow fever work in Central America and Mexico and

charged with going to Mexico as the IHB's representative to plan for cooperative work there.<sup>20</sup>

With control efforts seemingly moving along nicely in the Americas, Gorgas and the IHB planned a 1920 trip to West Africa to investigate the yellow fever situation there. While we today understand that both virus and vector originated on the African continent, the predominant belief in the late 1910s was that yellow fever was of American origin, and that any yellow fever in West Africa had thus spread there from the Americas. And while there had been plenty of documented cases and outbreaks during previous decades, it was unclear whether yellow fever was an active problem in West Africa after World War I. The IHB's first West Africa Yellow Fever Commission set out to answer that question. Another question they would face was the relationship between yellow fever and race. Most scholars today reject any connection between race and immunity or resistance to yellow fever, but before the discovery of the mosquito vector, when yellow fever was largely understood to be miasmatic in origin, there was a frequent belief that Black people were somehow immune to the disease, despite significant evidence to the contrary. Experts had jettisoned this belief by 1920, but many still often assumed that Blacks experienced much milder cases, which allegedly made yellow fever more difficult to diagnose among them. As such, sanitarians tended to see Black populations as what Henry Rose Carter called "invisible links" in the transmission of the disease. Such racial ideas would shape the work of the first and second West African Yellow Fever Commissions.<sup>21</sup>

The first IHB foray to Africa was marked by tragedy. While in London, where he and his party had stopped to consult with colonial officials before heading to Africa, William Gorgas was hospitalized with an apparent stroke. Robert Noble, one of the Commission members, stayed behind in London to watch over Gorgas while the rest of the Commission – which included Juan Guiteras, Adrian Stokes, and W.F. Tytler – shipped out from Liverpool on June 30. By the morning of July 4, Gorgas was dead. After arranging and attending Gorgas' funeral and handling other business, Noble headed for Lagos, Nigeria, on July 14, where he met up with the rest of the party to begin their work. The

Commission struggled to find active cases in and around Lagos, or in the many other parts of West Africa that they visited. But they studied medical records of past outbreaks that showed patterns quite unlike the urban epidemic outbreaks in the Americas, particularly in their seeming absence of foci of infection. Much of this they chalked up to the reticence of the “natives” to report cases of yellow fever and some to the assumption that West Africans suffered mild and often unrecognizable cases, making urban foci harder to see. But they also sensed that yellow fever in West Africa did not quite follow the urban patterns in the Americas. The IHB recalled the Commission in October. In the end, their major recommendation was that a second commission be sent for a longer-term residence to fully study the disease there. They urged that such a commission be equally staffed by epidemiologists and bacteriologists with modern lab conditions, and that they consider locating in one of three urban locations: Dakar in Senegal, Freetown in Sierra Leone, or Lagos. The IHB began preparing for such a second commission the following year.<sup>22</sup>

As the first West Africa Yellow Fever Commission was at work, the IHB was also finally gaining entrance to Mexico, where yellow fever remained widespread. They partnered with the Mexican government to form the *Comision Especial para la Campaña contra la Fiebre Amarilla* (Special Commission for the Campaign against Yellow Fever), which also included the IHB’s Theodore Lyster as director, Dr. Angel Brioso Vasconcelos as subdirector, Drs. Enrique Osornio and F. Castillo Najera as additional Mexican representatives, and Drs. Emmett Vaughn, M.E. Connor, and Bert Caldwell as additional IHB representatives. The *Comision*, which was under the authority of Mexican public health officials, was formalized in an accord with President Obregon of Mexico on January 19, 1921. The *Comision* concentrated its work in Veracruz, where Mexican officials had already done mosquito control work, as well as in Merida and the rest of the Yucatan. That July, they also took over work in the oil fields of Tampico, where Joseph LePrince, as an employee of the Oil Managers’ Association (a group representing the oil companies working in the region), had worked on a short-term mosquito control campaign relying heavily on larvae-eating fish. Here was another example of IHB efforts serving the interests of US commercial interests in the region. Mexican officials were to pay

most of the costs while the IHB covered the costs of its representatives. Joseph White took over for Lyster, who left the IHB and went into private practice in 1922, and, after more than a year there without any confirmed cases, the IHB cooperation in Mexico ceased in 1924.<sup>23</sup>

By 1923, IHB yellow fever efforts shifted to the last part of the Americas where yellow fever cases still appeared: northeastern Brazil. The Brazilian government finally invited the IHB to participate in effort to eradicate yellow fever in that part of the country, after several IHB efforts to get such an invitation were met by resistance from Brazilian officials. The IHB worked out a plan with Dr. Carlos Chagas, of the Instituto Oswaldo Cruz, that allowed IHB officials wide latitude in their activities, while still lodging them under Brazilian authority.<sup>24</sup> Joseph White was initially put in charge, and he shipped out for Brazil in October 1923 with a new commission of five staff members.<sup>25</sup> He was later succeeded by Michael E. Connor and then Fred Soper. These cooperative campaigns, which lasted into 1925, were successful in the bigger cities of the region, but yellow fever kept popping up in small neighboring communities as well as in interior towns. These patterns raised yet more concerns about key center theory and its applicability Brazilian patterns of yellow fever. There were also concerning outbreaks in 1923 in Bucaramanga and Cúcuta, Colombia, inland cities near to each other. The IHB sent Joseph White to inspect and then Dr. Henry Hanson to oversee control measures there. Again, this outbreak did not fit the key center pattern.<sup>26</sup> The year 1924 also saw an unexpected outbreak in El Salvador that IHB officials scrambled to address, and they again made efforts to keep yellow fever out of Central America.

The IHB launched a second West Africa Yellow Fever Commission in 1925, with Dr. Henry Beeuwkes in charge.<sup>27</sup> Commission members left New York City in May 1925, and they established their base of operations in Yaba, a suburb of Lagos, where they set up a lab to study the disease. The Commission was responsible for several important scientific discoveries. First, in 1927, Commission members successfully transmitted yellow fever from humans to rhesus monkeys. This not only proved that monkeys could harbor the disease, an important realization to which we will return, but it allowed them to disprove

Noguchi's then-teetering theory that the agent of the disease was *Leptospira icteroides*. Instead, they showed that a filterable virus caused yellow fever. The research on rhesus monkeys also led to the first serological methods for yellow fever detection, which allowed researchers to test human populations to see if they had yellow fever antibodies. Such surveys showed widespread but also spotty experience with, and thus immunity to, yellow fever among West African populations, patterns which again did not match the key center theory and its assumption that yellow fever was a predominantly urban disease. Indeed, in subsequent years serological surveys would show evidence of widespread recent infections in interior regions of both West Africa and South America, places where yellow fever was not supposed to exist. Finally, the second West African Yellow Fever Commission, through the work of entomologist Lawrence H. Dunn, began to recognize that other mosquitoes aside from *Aedes aegypti* could spread yellow fever and that *Aedes aegypti* had different breeding habits in West Africa.<sup>28</sup>

Studies by Rockefeller scientists and affiliated researchers in the late 1920s and early 1930s slowly undid the hope of eradicating yellow fever through the key center approach. In 1933, the International Health Division's (IHD) Wilbur Sawyer concluded that "the recent studies have removed all hope of the early eradication of yellow fever from West Africa. Unfortunately, the perpetuation of the disease does not seem to depend entirely on a very few endemic centres which could be sought out and controlled by an intensive anti-mosquito campaign."<sup>29</sup> And Fred Soper later noted that, "The isolation of the yellow fever virus led to a switch in the Foundation's major interest from anti-mosquito campaigns to laboratory research on yellow fever virus and the development of a vaccine."<sup>30</sup> By the early 1930s, as the IHD's yellow fever research became more laboratory-oriented, their dream of the global eradication of yellow fever through mosquito control began to fade.

The traditional end to this story has been Fred Soper's landmark 1936 article that established the existence of sylvan or jungle yellow fever – that is, that the yellow fever virus circulated among non-human primates as a result of another group of mosquito vector species, and that it had the potential to spill over into

human populations. Soper discovered such a reservoir in South America, and researchers soon realized that a sylvan reservoir existed in West Africa as well. These discoveries suddenly made sense of the isolated outbreaks in places such as Muzo and Bucaramanga, Colombia, as well as the confounding results of early serological surveys. “Jungle yellow fever,” as Soper called it, both explained the anomalies that the IHB and IHD had begun to encounter in both South America and West Africa and made the hope to total eradication of yellow fever through the key center approach all but impossible, though urban mosquito control would remain critical to preventing spillover epidemics.<sup>31</sup> But this emphasis on jungle yellow fever as the end of the story of the Rockefeller Foundation’s two-decade long fight against yellow fever through coordinated mosquito control campaigns has not accounted for the complexity of West African transmission dynamics, and particularly of the existence in Africa of an intermediate cycle of yellow fever transmission that has no analogue in the Americas. Yellow fever researchers are still trying to make sense of that complexity.

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<sup>1</sup> Wilbur A. Sawyer, “History of the Activities of the Rockefeller Foundation in the Investigation and Control of Yellow Fever,” *American Journal of Tropical Medicine* 17, 1 (1937): 35; *The Rockefeller Foundation Annual Report 1915* (NY: The Rockefeller Foundation, 1916): 13; Wickliffe Rose, “Yellow Fever: Feasibility of Its Eradication,” Rockefeller Foundation Archive (RFA), Record Group (RG) 5, Series 1, Box 9, Folder 143.

<sup>2</sup> Rose, “Yellow Fever: Feasibility of Its Eradication.”

<sup>3</sup> See, for instance, Joseph H. White to Wickliffe Rose, August 4, 1914, RFA, RG 5, Series 1.1, Box 4, Folder 65. For White’s bio, see E. Flanders, “Joseph Hill White,” *New Georgia Encyclopedia*, last modified May 20, 2013. <https://www.georgiaencyclopedia.org/articles/science-medicine/joseph-hill-white-1859-1953/>.

<sup>4</sup> Henry R. Carter to Wickliffe Rose, August 22, 1914, RFA, RG 5, Series 1.1, Box 4, Folder 65.

<sup>5</sup> “Extracts from the Minutes of the Rockefeller Foundation, April 4, 1915”; Letter, Jerome D. Greene to William C. Gorgas, April 13, 1915; Wickliffe Rose to William C. Gorgas, May 28, 1915; Gorgas to Rose, June 2, 1915; Rose to Gorgas, September 28, 1915, all found in RFA, RG 5, Series 1.1, Box 4, Folder 65.

<sup>6</sup> W.C. Gorgas to Jerome D. Greene, December 7, 1915; “Address of Major-General W.C. Gorgas, Surgeon General, U.S. Army, before the Sanitary Section of the Second

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Pan-American Scientific Congress at Washington, D.C., December 27, 1915,” both in RFA, RG 5, Series 1.1, Box 4, Folder 65. For the resolution, see “The Yellow Fever Commission: Appointment—Personnel—Itinerary, with Map,” RFA, RF Records—Field Staff—RF Program Reports, Series 6; Field Staff Reports, Surveys, and Papers Blue Volume Subseries 6.2, Volume 34 – Yellow Fever Commission.

<sup>7</sup> On the make-up of the Commission, see “Suggestions as to Organization for Board to Investigate Yellow Fever,” RFA, RG 5, Series 1.1, Box 4, Folder 65; “International Health Board Yellow Fever Commission,” RFA, RG 5, Series 1.1, Box 14, Folder 237. On LePrince, see Rose to Gorgas, February 28, 1916, RFA, RG 5, Series 1.1, Box 14, Folder 232.

<sup>8</sup> On Muzo, see Gorgas to Rose, August 11, 1916; Gorgas to Honorable Thomas Suri Salcedo, Ministro of Hacienda, Bogota, August 19, 1916; and Gorgas to Rose, August 23, 1916, all in RFA, RG 5, Series 1.1, Box 14, Folder 233; Sawyer, “History of the Activities of the Rockefeller Foundation in the Investigation and Control of Yellow Fever,” 37.

<sup>9</sup> For a full itinerary of the trip, see letters from Wallace Lund to Richard and Marie Gorgas contained in RFA, RG 5, Series 1.1, Box 14, Folder 231 – Gi-Go, 1916.

<sup>10</sup> See “Report of the Yellow Fever Commission (South America) Complete Report,” March 9, 1917, RFA, RF Records—Field Staff—RF Program Reports, Series 6; Field Staff Reports, Surveys, and Papers Blue Volume Subseries 6.2, Volume 34 – Yellow Fever Commission.

<sup>11</sup> On these arrangements, see Rose to Gorgas, November 8, 1918, and M.E. Connor, “Memorandum to Mr. Rose, October 2, 1918, RFA, RG 5, Series 1.1, Box 32, Folder 541.

<sup>12</sup> M.E. Connor, “Memorandum for Dr. Rose,” RFA, RF Program Reports, Series 6; Field Staff Reports, Surveys, and Papers Blue Volume Subseries 6.2, Volume 18 – Yellow Fever Vol. 1.

<sup>13</sup> Rose, “Memorandum on Yellow Fever Epidemic in Guatemala,” July 10, 1918; “Memorandum of an Interview with Doctor Deeks, Medical Superintendent, United Fruit Company, With regard to Yellow Fever in Guatemala,” June 26, 1918, both in RFA, RG 5, Series 2, Box 31, Folder 183. See also Emmett Vaughn, “Report of Yellow Fever Operations in the Republic of Guatemala from August 19, 1920, to March 1, 1921,” RFA, RG 5, Series 2, Box 31, Folder 185. “Report of Dr. Joseph H. White Covering Work of Yellow Fever Control in Guatemala During 1918,” October 1918, RFA, RG 5, Series 2, Box 31, Folder 188.

<sup>14</sup> The United Fruit Company had hired Connor out from under the IHC in 1914. See correspondence in RFA RG 5, Series 1.1, Box 10, Folder 167 – United Fruit Co., 1914.

<sup>15</sup> W.C. Gorgas, “Memorandum of Yellow Fever Word in Guayaquil, Ecuador,” no date, RFA, RF Records—Field Staff—RF Program Reports, Series 6; Field Staff Reports, Surveys, and Papers Blue Volume Subseries 6.2, Volume 18 – Yellow Fever Commission.

<sup>16</sup> W.C. Gorgas, “Report on the Sanitation of Guayaquil,” January 9, 1913; Arthur I. Kendall and Mario G. Lebrede, “Sanitation in Ecuador, with Special Reference to Guayaquil,” no date but likely 1918, both in RFA, RG 5, Series 2, Box 30, Folder 181.

<sup>17</sup> W.C. Gorgas, “Memorandum of Yellow Fever Word in Guayaquil, Ecuador”; M.E. Connor to Dr. Rose, January 27, 1919; Connor to Gorgas, February 17, 1919; L. Becerra, “Campaign Against Yellow Fever. Report of the Director of Sanitation,”



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March 29, 1919; M.E. Connor, "Yellow Fever Control in Ecuador," no date; Wenceslao Pareja. "Extracts from 'A Brief Account of Yellow Fever in Guayaquil,'" November 1919, all in RFA, RF Records—Field Staff—RF Program Reports, Series 6; Field Staff Reports, Surveys, and Papers Blue Volume Subseries 6.2, Volume 18 – Yellow Fever Commission. M.E. Connor, "Part Played by Fish in the Control of Yellow Fever at Guayaquil, Ecuador," RFA, RG 5, Series 2, Box 30, Folder 181. Sawyer, "History of the Activities of the Rockefeller Foundation in the Investigation and Control of Yellow Fever," 41. See also M.E. Connor, "Yellow Fever Control in Ecuador," *Journal of the American Medical Association* 75 (October 30, 1920): 1184-1187.

<sup>18</sup> "Journal of William C. Gorgas, Chairman, Yellow Fever Commission," RFA, RG 12 (RF Officers' Diaries), Box 172, Folder "Gorgas, William C., 1919-1920, 2 of 3"; Edwin R. Embree to Gorgas, January 17, 1920, RFA RG 5, Series 1.1, Box 47, Folder 707.

<sup>19</sup> Sawyer, 42-43. On last case in Peru, see Rose to Carter, July 12, 1922, RFA, RG 5, Series 1.1, Box 65, Folder 919.

<sup>20</sup> On the situation in Brazil and Mexico, see T.C. Lyster to W.C. Gorgas, April 20, 1920, RFA, RG 5, Series 1.1, Box 47, Folder 710. On breakthrough with Mexico, see Rose to Lyster, November 11, 1920, RFA, RG 5, Series 1.1, Box 47, Folder 711.

<sup>21</sup> For an example of such ideas in action, see Juan Guiteras to Wickliffe Rose, July 26, 1920, RFA, RG 5, Series 1.1, Box 47, Folder 705. For a good overview on the debate, see Mariola Espinosa, "The Question of Racial Immunity to Yellow Fever in History and Historiography," *Social Science History* 38 (Fall/Winter 2014): 437-453. For the Carter quote, see "Abstract of memorandum on the epidemiology of yellow fever in West Africa sent by Dr. Carter with his letter of January 25, 1924," attached to letter from Carter to F.F. Russell, January 25, 1924, RFA, RG 5, Series 1.1, Box 83, Folder 1191 – Yellow Fever Commission, Carter, H.R., Jan.-April 1924.

<sup>22</sup> Robert Noble to the General Director, International Health Board, no date but likely 1920. This letter is a lengthy report of the activities of the first West Africa Yellow Fever Commission. See also Juan Guiteras, "Report on the General Situation on the West Coast of Africa, with Respect to YELLOW FEVER with Suggestions as to Subsequent Investigations," October 1920. Both in RFA, RG 5, Series 2, Box 51, Folder 328; Sawyer, 44.

<sup>23</sup> Bert Caldwell to Rose, February 28, 1921, RFA, RG 5, Series 1.1, Box 55, Folder 803 – Yellow Fever Commission, Caldwell, B.W., Jan.-June 1921. Theodore Lyster to Wickliffe Rose, January 17, 1921; Lyster, "Circular Letter," January 20, 1921; and "Resolution by the President of the United States of Mexico," January 19, 1921, all in RFA, RG 5, Series 1.1, Box 56, Folder 807. Connor to Rose, January 26, 1921, RFA, RG 5, Series 1.1, Box 56, Folder 806. On IHB taking over campaign in oil fields, see Caldwell to Lyster, July 9, 1921, RFA, RG 5, Series 1.1, Box 55, Folder 804 – Yellow Fever Commission, Caldwell, B.W., July-Dec. 1921. On end game in Mexico, see Rose to Carter, July 12, 1922, RFA RG 5, Series 1.1, Box 65, Folder 919; G. Malda, Director of the Department of Public Health, Mexico, to F. F. Russell, April 9, 1924, and Connor to Russell, March 20, 1924, both in RFA, RG 5, Series 1.1, Box 83, Folder 1197.

<sup>24</sup> Joseph White to F. F. Russell, September 5, 1923, RFA, RG 5, Box 75, Folder 1064 – Yellow Fever Commission, White, J.H., Sept.-Oct., 1923.

<sup>25</sup> Florence Read to Connor, October 30, 1923, RFA, RG 5, Series 1.1, Box 74, Folder 1046 – Yellow Fever Commission, Connor, M.E., October 1923.

<sup>26</sup> Sawyer, 43-44.

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<sup>27</sup> On formation of the commission, see F.F. Russell to M.E. Connor, May 31, 1924, RFA, RG 5, Series 1.1, Box 83, Folder 1198.

<sup>28</sup> Sawyer, 44-47; F. F. Russell to W. G. MacCallum, October 14, 1927, RFA, RG 5, Series 1.1, Box 120, Folder 1632; Henry Beeuwkes, J. H. Bauer, and A. F. Mahaffy, "Yellow Fever Endemicity in West Africa, with Special Reference to Protection Tests," *The American Journal of Tropical Medicine* 10, 5 (September 1930): 305-333; Henry Beeuwkes and A. F. Mahaffy, "The Past Incidence and Distribution of Yellow Fever in West Africa as Indicated by Protection Survey Tests," *Transactions of the Royal Society of Tropical Medicine and Hygiene* 28, 1 (June 1934): 39-76; Lawrence H. Dunn, "Mosquitoes Bred from Dry Material Taken from Rot-Holes and Fork-Hollows in Trees," RFA, RG 5, Series 2, Box 51, Folder 330; L.H. Dunn, "Tree-holes and Mosquito Breeding in West Africa," *The Bulletin of Entomological Research* 18 (December 1927): 139-144; Johannes H. Bauer, "The Transmission of Yellow Fever by Mosquitoes Other Than *Aedes Aegypti*," *American Journal of Tropical Medicine*, 8, 4 (July 1928): 261-282. See also the West African Commission's annual reports for 1925-1927 in RFA, RG 5, Series 3, Box 214, Folders 2652-2654.

<sup>29</sup> W. A. Sawyer, "The Present Knowledge of Yellow Fever as It Relates to the Problem in Africa," *Quarterly Bulletin of the Health Organisation of the League of Nations* 2, 1 (March 1933): 29-40.

<sup>30</sup> John Duffy, ed., *Ventures in World Health: The Memoirs of Fred Soper* (Scientific Publication No. 355, Washington, DC: World Health Organization, 1977): 88.

<sup>31</sup> Fred L. Soper, "Jungle Yellow Fever: A New Epidemiological Entity in South America," *Revista de Hygiene e Saude Publica* 10, 4 (April 1936): 107-144.