"A Forest Full of Viruses!" Science and Development in the Frontiers of the Brazilian Amazon

"Uma floresta cheia de vírus!" Ciência e desenvolvimento nas fronteiras amazônicas

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English version: Thiago Dargains Rodrigues

Resumo

Baseado em extensa pesquisa de fontes primárias e secundárias em diferentes instituições, o presente artigo tem como objetivo estabelecer um panorama das ações voltadas a ciência e saúde nos projetos direcionados à região amazônica durante a chamada Era do Desenvolvimento, nos anos 1950 e 1960. Para demonstrar a associação pretendida entre as ações governamentais e a ciência, o artigo traz à luz pesquisadores e agências que lá estiveram no período, com destaque para o Laboratório de Vírus de Belém, instituição que fazia parte de um amplo programa global de pesquisa em virologia capitaneado pela Fundação Rockefeller.

Palavras-chave: história da Amazônia; história do desenvolvimento; história da virologia.

Abstract

From an extensive database of primary and secondary sources, deposited in several institutions, this article aims to establish a panorama of the actions taken to foster science and health in the Brazilian Amazon during the so-called Age Of Development (the 1950s and 60s). Researchers and institutions present in the region during the period looking to form the intended connections between science and governmental actions is the focal point of this article. Especial emphasis is put on "Laboratório de Vírus de Belém" (Belém Virus Laboratory) which was a member of a global virology research program led by the Rockefeller Foundation.

Keywords: History of the Amazon; History of development; History of virology.

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In January 2016, *O Globo* newspaper (O Globo, Jan. 7, 2016) published a piece of news describing a – almost unknown – disease, which was leading doctors to misdiagnosis. Patients and health professionals confused its symptoms to the ones associated with Dengue Fever, a widespread illness in Rio de Janeiro during summertime. They were actually dealing with Oropouche fever, a painful viral syndrome transmitted by the *Ceratopogonidae*, also known as *biting midges* or *no-see-ums*. Since the 1960s, 500,000 cases of this disease have been diagnosed and notified to authorities; nevertheless, the real number is suspected to be much higher. The inaccurate diagnosis could explain the incorrect notification due to similarities between the symptoms of Oropouche and Dengue Fever. The necessary conditions for the reproduction of the biting midges were present not only in the Brazilian Amazon but also in the west zone of Rio de Janeiro city. According to the specialists interviewed, this arboviral disease was the actual responsible for more than 50% of the cases diagnosed as Dengue fever. Arboviruses (short for *arthropod-borne-viruses*) are viruses that can be communicated to men by arthropods (insects). These viruses cause several diseases, some of them are mortal, and others are mild like encephalitis, mild fevers, hemorrhagic episodes, and other mild forms only cultivated in laboratories.

Scientists isolated this virus for the first time in Brazil in 1960. They found it in the blood samples of a sloth captured on the margins of the newly constructed, Belém-Brasília Highway. The relationship between the construction of the highway and the emergence of Oropouche fever aroused scientists' curiosity. Framing a mild – non-fatal at first sight – non-relevant disease brings to the surface fundamental features of the relationships established among health, politics, and natural environment in the Brazilian Amazon during the 1960s. This article investigates the sanitary impact of state actions, scientific institutions, specialized professionals, and field researches in the region. The historical context is first presented, followed by an outline of virology emergence in the 1950s. Finally, the article presents the conjecture in which the landmark institution of the cooperation agreements – Belém Virus Laboratory – was established: a partnership between local institutions and the *International Health Division* of the Rockefeller Foundation. The Belém Virus Laboratory was part of a global scientific network and an active member of international virology debates formed by other laboratories across the world established from similar partnerships. Although the Brazilian Amazon was considered a 'peripheral' region in developmentalism debates of the 1950s, its peers, locally and globally, held the Belém Lab in high esteem for its scientific work in virology.

Brazilian Amazon: An Underdeveloped Region and a Frontier to be Explored

During the period when the rule of law was established in Brazil, between the Estado Novo and Military dictatorial regimes, the government created the first regional development agency of the country "Superintendência de Valorização Econômica da Amazônia" (SPVEA, Superintendence of Economic Recovery Plan of the Amazon). This agency was established in 1946 by a bill stating that 3% of the Brazilian Federal Budget had to be invested in the region for the following twenty years. Many investigators follow a historiographic trend based on the failure of SPVEA, which the Military Regime and the ruling body of its successor – Superintendência de Desenvolvimento da Amazônia (SUDAM) (Superintendence for the Development of Amazon) – heavily influenced. (Batista, 1976; Cardoso; Muller, 1978). In spite of this being an interesting angle, this paper intends to broaden the investigation. Basing the analysis of the period only in 'successes' or 'failures' obliterates other relevant angles such as the insertion of the Belém Virus Laboratory in complex transnational networks, the initiatives of several other institutions, and the bilateral agreements signed during the period. D'Araújo (1992) pointed out that SPVEA was inspired by already established institutions like the Tennessee Valley Authority (TVA), founded after the 1929 Great Depression. The objective was to insert Amazon in state-of-the-art public-planning initiatives. The policy-makers of TVA not only shaped SPVEA but also trained its workforce. John Friedmann taught management of Amazon courses in the newly-established Fundação Getulio Vargas (Andrade, 2015).

This period was steered by state-planned development. Several other regional development agencies were established – "Comissão do Vale de São Francisco" (1948) (São Francisco River Valley Commission) and "Superintendência de Desenvolvimento do Nordeste" (1959) (Superintendence for the Development of the Northeast). It is essential to highlight that many ruptures, permanence, and intense debate about the intentions of SPVEA happened during these years. Nationalism was a significant aspect of Brazilian political conjecture in the period (Delgado, 2007, p. 362). In the second half of the 1950s, Brazilian society caught the "developmental modernization fever". One of its main goals was to overcome Brazilian structural underdevelopment, which prevented the country from entering the modern age, Paraphrasing Lucia Delgado: reformism, developmental modernization, and nationalism were all "tarred with the same brush" (Delgado, 2007, p. 362).

This time was referred to as the Development Era when the belief in technological development achieved by scientific institutions generated a discourse that established the categories of 'development' and 'underdevelopment' based on standards created by the wealthiest nations (Sachs, 1999; Escobar, 1997). Naming countries as 'underdeveloped' served as a tool to move them away from the Soviet influence area. Development went beyond discourse; it also promoted actions aiming to solve historical problems in peripheral regions. Western powers fostered the development of poor regions that later re-signified the concept of 'underdeveloped' fitting it to their needs (Love, 1998). Development and its counterpart, underdevelopment, were always being debated, locally and globally, during the 1950s and 60s. They heavily influenced the discussions over the choices and the course taken by the 'economic recovery' of the Brazilian Amazon and its unfolding (Andrade, 2015).

The construction of the Belém-Brasília Highway started in 1960 during the Juscelino Kubitschek administration, as part of an expansion program of the Brazilian road network. The government advertised the new link as a solution to 'incorporate' the region to the rest of the country (Silva, 2017; Andrade, 2018). At the time, the Brazilian Amazon, in the collective imaginary, was seen as a frontier ready 'to be braved'. Pádua (2000) states that the Brazilian Amazon, in the 20th century, was the geographical spectrum of Brazil. Several democratic governments of the time settled their policies for the region based on the rhetoric of 'demographic emptiness' and the 'manifest destiny' of the area. The second Vargas administration, tragically interrupted by the president's suicide, resized all projects for the region, centralizing them in a dedicated superintendence. It ended discussions that were open since the 1946 constituent assembly.

Nevertheless, the Juscelino Kubitschek administration, from 1956 onwards, presented an adaptation of old discourses about the Brazilian Amazon. The construction of the Belém-Brasília Highway is represented in historiography as the materialization of developmentalism. It transported to the region the Western industrial standard, establishing the milestone of the beginning of an urban era and, at the same time, ending the past dark ages. In the 1940s, the march to the West was searching for the real meaning of being Brazilian. In the 1950s, it was influenced by the symbolic system of developmentalism (Silva, 2009). It composed a sort of moving State, which built its legitimacy as it moved towards – what was believed to be – the empty spaces of the Brazilian territory. Maia states that the Fundação Brasil Central acted like

'neobandeirantes' (*bandeirantes* were the first group of people to systematically explore the interior of the Brazilian territory in the 17th and 18th centuries). They conceived the production of the State, in that particular historical conjecture, using the geographic imaginary of the nation, thus envisioning the expansion of the state as an adventure. Terms such as 'braving' and 'penetration' were part of the discourse which described it (Maia, 2010). From an institutional standpoint, the idea of an 'empty' and 'wild' region was purely rhetorical. At the time several institutions had been working in the area like SESP (Special Public Health Service), the National Institute of Amazonian Research, Evandro Chagas Institute, and Paraense Museum.

The two thousand kilometers of road built, in the heart of the Amazon and the Cerrado biomes, hugely impacted the local geography through the migration of workers, cities built and abandoned on the roadsides, and diseases. The main complaint was the existence of endemic malaria throughout the road. The Special Public Health Service (SESP) opened an ambulatory on Km 92 of the road the same year the highway was inaugurated. A partnership established between the Vargas administration and the Office of Interamerican Affairs in 1942 created SESP. This institution aimed to control malaria infections in the latex collection posts of the Brazilian Amazon. After World War II, this institution considerably broadened its activities, and also collaborated with the great development projects of the time (Campos, 2006). Leônidas Deane, a member of the institution since 1940, visited the Belém-Brasília Highway between May and June 1960. Aiming to draw a comprehensive nosologic chart of the region, assessing the sanitary impacts of the construction of the Highway, he collected blood samples to test for Chagas Disease, Toxoplasmosis, and Tegumentary Leishmaniasis. Deane found that all inhabitants were infected or had previously suffered malaria infections. The traditional elimination method of the disease – intensive use of DDT – was not effective because the houses were made of clay, and the substance did not stick on the walls. Therefore, the use of a mix of salt and chloroquine, an antimalarial compound, was the most recommended action to be taken in the region. The milder type of malaria (transmitted by the mosquito carrying the *Plasmodium vivax*) and the most severe type (caused by *Plasmodium falciparum*) were endemic among the highway construction workers and the inhabitants of the region.

Figure 1 – Community health center, collection, and research post of the Special Service of Public Health on Km 92 of Belém-Brasília Highway.

Source: Arquivo Leônidas Deane, 1961. DAD/COC/Fiocruz

Controlling the distribution of the chloroquine phosphate in a wild environment as the road construction site was very difficult.[1] A black market was established to sell this substance. The contraband routes would go through Tocantins river, the city of Bragança, and the Capital of Pará state – Belém. The traders would unload sacks and substitute the chloroquine for regular salt, selling it for higher prices afterwards. Out of ignorance and because of trading interests, people would pass on the information that chloroquine caused sexual impotence (Andrade, 2018). Therefore, the incidence of malaria was very high. Without the use of DDT or the salt of chloroquine, the *Anopheles Gambiae* would easily communicate the plasmodium, thus transmitting the disease. Emilio Dente, from São Paulo, told Deane that protected by a mosquito net, he would kill 30 birds a day to proceed with an inventory of the endemic species in the area. Besides approaching sanitary matters, Deane's report is a valuable source for the comprehension of the Brazilian Amazon region during the Age of Development. He registered there his impressions, distresses, the changes, and the permanence involved in the violent construction of the Belém-Brasilia Highway. Deane noticed, on the way to the community health center on Km 92, many newcomers holding shotguns. These men had recently settled in the

cities founded on the trail of the road construction, lived off hunting rats, tapirs, and jaguars (Deane, 1960, n. p.). In another entry, the car taking him got stuck in a vast mire. Help from truckers was necessary to remove the vehicle from the mud and continue the trip. Other misfortunes worth of mentioning are found in the report, like the tractor that sank into the river, almost killing two workers of the highway construction. Deane also narrated the fall of a tree in flames right behind the jeep that was taking him to Km 700 of the road. He also organized a field study with students from the Medicine School of the Universidade de São Paulo (USP). They visited a farm where workers faced 12-hour shifts, and the absurd levels of schistosomiasis incidence shocked them. It was the rainy period making it easier for diseases to spread. In the report, there is criticism of the terrible state of conservation of the worksite, the killing of kissing bugs (vectors of Chagas disease and subject of research) due to excessive use of DDT, and the poor conservation of animal skulls which made harder to identify its species. At the time, the standards used by the Rockefeller Foundation and other international agencies like FAO inspired a model for the presentation of reports, in which the activities described were not restricted to quotidian and laboratory practices. Deane's complaints about non-asphalted stretches of the road, getting stuck, and long traveling times are recurrent. On the other hand, in asphalted, well-conserved stretches, he would always ask himself: "Is this the Belém-Brasília Highway civilized?" (Andrade, 2018).

The community health center not only performed blood collection from more than 150 workers but also served as a lab to investigate wild animals captured in large numbers after the conclusion of the highway construction. Oswaldo Cruz Institute collaborated, establishing a collection post two kilometers down the road. Hugo Widmann Laemmert, an Oswaldo Cruz Institute researcher who had previously worked in the yellow fever department, was in charge of investigations seeking viruses and trypanosomiasis cultures. Laemmert spread more than 30 traps to capture wild animals on the research campsite, next to the community health center. Anteaters, sloths, bats, and Brazilian colilargos were captured and analyzed during the investigation. Ottis Causey, a researcher of Rockefeller Foundation, worked with Laemmert since 1954 in the Brazilian Amazon, following up yellow fever development cycles in the region. The disease continued to be endemic, therefore, several epidemics would occur in the region. They varied in intensity depending on the host's level of immunity, the penetration of non-immune individuals in the territory, and how abundant the disease vector (the *Aedes Aegypti*) was. The number of mosquitoes would change according to precipitation levels of each season

Figure 2 – Hugo Laemmert (center) performing an autopsy.
Source: Arquivo Hugo Laemmert, 1958. DAD/COC/Fiocruz

(Laemmert; Causey, 1962). During the research period, yellow fever was not found in the region. Nevertheless, there were cases reported in the woods close to the construction site of the Belém-Brasília Highway in 1960. From then on, only one death was registered, near Belém do Pará and the road, during an epidemy. Hence, the so-called 'end of isolation' of the Brazilian Amazon, now connected with the rest of the country via roads, would bring consequences (Laemmert; Causey, 1962).

Scientists from other parts of the country already discussed the impact of this new link on the local nosologic chart. In 1966 CNPq (National Council for Scientific and Technological Development) and Association for Tropical Biology organized the *Simpósio da Biota Amazônica* (Amazon Biota Symposium) to celebrate the 100th anniversary of Museu Paraense Emílio Goeldi. The

convention was divided into several panels, such as Geoscience, Anthropology, Botanic, Zoology, Pathology, Conservation of Natural Environment, and Natural Resources. Some debates about the development projects' impact on the endemic species and local health are noteworthy. Jean Dubois – at the time, director of the Center for Forestal Research in Santarém – published an article in the volume dedicated to conservation. Thanks to the collaboration between SPVEA and the Food and Agriculture Organization of the United Nations (FAO), it was possible to identify how the plantations established by the newcomers were extremely harmful to the local biome. Between 1960 (before the road construction) and 1974 (final paving stage), the local population grew from 100,000 to 2,000,000 inhabitants. Hence the number of cities and villages also increased from 10 to 120 in the same period (Rodrigues, 1978). Dubois argued that because of the increase of population and its permanent settlement, inhabitants used a kind of 'semi-permanent' agriculture, not respecting the crop rotation period in the agricultural cycles. The use of tools ignoring conservationist techniques was also reported (Dubois, 1967).

> The semi-permanent irrational crop system had already ruined many woodlands: a typical example is found in the region of Bragança. A similar problem threats the margins of the Belém-Brasília Highway. Throughout the road, the author observed 'capoeiras' [grass that grows after deforestation] emerging after one or two agricultural cycles. In the surroundings of Paragominas [city founded after the road construction], a 3 km vast stretch of land was destroyed by colonizers. The prohibition of nomad plantations is practically impossible to enforce in the Brazilian Amazon's current state of development. A substantial part of the population makes a living out of this activity. (Dubois, 1967, p. 130)

In 1954 "Instituto Nacional de Pesquisas da Amazônia" (National Institute for Amazon Research) was established, following the unfolding of two events: the failure of "Instituto Internacional da Hileia Amazônica" (International Institute of Hyletic Amazon), project directed by scientist Paulo Carneiro; and the establishment of the National Council for Scientific and Technological Development (CNPq) in 1951.[2] Djalma Batista, director of CNPq between 1959 and 1968, lectured about the Brazilian Amazon nosologic chart, delivering a fascinating historical panorama of the reasons that favored the existence of endemic diseases in the region. Batista, talking from an environmental standpoint, brings up an original take on local illnesses. Using the perspective of Pavlovsky's 'natural disease niches', Batista states that in the Brazilian Amazon,

there is a very close relationship between the parasites infecting the inhabitants, the disease vectors, the hosts, and the physical environment (Batista, 1967). He also links the geological, forestal, and climatic constitution of the region to schistosomiasis, malaria, and leishmaniasis. Despite being potent about the local parasitosis, he shows signs of optimism towards the future conditions of the area: "Science and civilization, serving social and economic development, sooner or later will remove the labor of 'unconquerable' from the Brazilian Amazon, henceforward men will dominate nature, truly becoming its landlords" (Batista, 1967, p. 19).

Domingos de Paula, professor of pathological anatomy in the Medical School of Rio de Janeiro, presented a paper about the viruses that assailed the Brazilian Amazon. It focused on newly-discovered viruses, especially the arboviruses present in the region. Among the reasons for such discoveries were the penetration of a large number of people into the jungle through the road network. The Belém-Brasília Highway communicated 'highly developed' urban districts to remote areas, thus integrating the population to the viral ecosystem (Paola, 1967, p. 28). In this frontier expansion through disorganized colonization, many were concerned about the morbidity of such viruses:

> Humans also became hosts, as a natural corollary mankind started contracting viral diseases of a broad spectrum of seriousness, so far not well known by medical and public health authorities. Theoretically, meanwhile ignorance is the rule, the possibilities of men being subjugated by such diseases are great and imponderable, as the contact between this new and complex host with viral agents is inevitable, every time plans are made for the development of less favored areas, particularly the humid tropics. (Paola, 1967, p. 26)

Domingos de Paola took into account that social, political, and economic integration favored the universalization of viral agents and the diseases they were capable of causing. In a way, it is an inversion of the arguments used by previous administrations, which stated that the Brazilian Amazon isolation was the real cause of its 'underdevelopment'. In a complete turn of events, the projects of 'integration' would be held responsible for local sanitary problems. Until 1966, outbreaks caused by the Oropouche and the Mayaro viruses were the main focus of scientists acting in the area. In Lábrea, a city of the Amazonas state, there had been outbreaks affecting mostly children, therefore increasing local infant mortality levels. By them, scientists had not isolated the viral agent yet. More resources were necessary to fight the problem. The Belém Virus

Laboratory took the point in dealing with the situation. A brief panorama of the debates involving health in the 1950s and the emergence of virology will be drawn in the next section. This initiative will help to clarify why a virology laboratory was established in a so-called 'underdeveloped' area.

Health Post-World War II and the Emergence of Virology in the Brazilian Amazon

> Humanity is, at the same time, the driver of development and also the profiteer of its benefits. [...] Health is the increasing aptitude for life-related issues as work, efficiency, and happiness [...] That is only achieved [...] as a consequence of the sweeping changes operated by global economic development. [...] Health and Economics are two terms of the same binomial equation; they cannot be destroyed or mutilated without tragic losses for the Faith of men. The livelihood and development of underdeveloped areas depend, substantially, on the work of sanitarists, nutritionists, and economists firmly performing in association. (Costa, 1963, p. 133)

Dante Costa was head of the Department of Science Cooperation and Communication of "Departamento Nacional de Endemias Rurais" (DNERU, National Department of Rural Endemic Diseases), and also a professor at the National University of Medicine in Rio de Janeiro. He was among the first nutritionists to investigate the diet deficits of the workers based on the Brazilian Amazon. The quote above was extracted from a speech he gave in Genebra, during the *United Nations Conference on Science and Technology for Development*. Costa was intimately linked to the emergence of nutrition and healthy eating in public policies. He sought to establish the relationship between health and economics, which he and his generation considered intrinsically connected to the social development of countries. As the profiteer of the benefits created by development, humankind – especially in underdeveloped areas – would benefit more from structural changes in the countries' economies. The materializing of developmentalism, not only affecting political and institutional planning, presented unfoldings in the health policies of the time. Global health institutions and its specialists, from the Second World War to the late 1950s, were convinced that disease eradication would be a sine qua non for the development of poor countries (Hochman, 2009). The best way to reach this goal would be campaigns, organized vertically, to combat diseases feasible

of eradication such as malaria, yellow fever, smallpox, and yaws. Science and technology became fundamental to the development of emerging countries (Hochman, 2009). Therefore, actions in the field of public health, in the Cold War conjecture, served as an obstacle for the proliferation of ideologies linked to communism. Public officials and technical staff reassured their beliefs in science and technology during the 1950s. Most of them thought scientific advancements of that time would control or eradicate diseases. Debates over the health of people living in areas considered to be underdeveloped were directly linked to the economic concerns of Western industrialized countries. Disease eradication, as a driver for social and economic change, was a direct consequence of the faith invested in Western science and its capacity to transform poor countries. Ideas and practices related to eradication were also a product of the post-war mentality: an approach to the problems caused by underdevelopment and how could a directed technological intervention be able to overcome them (Packard, 1997). Virology was establishing itself as a scientific discipline and becoming more institutionalized due to the ongoing advancements in virus isolation processes since the end of World War I. The discovery of the bacteriophage (viruses that infect only bacteria), the development of the ultracentrifuge, and the invention of the electron microscope caused a revolution in virology.

Trough all these tools, viruses and its structures were more accurately characterized. Therefore, after World War II, virology was not considered a branch of bacteriology anymore; by then, it was fully established as a discrete scientific discipline (Wilkinson, 2001). In the 1950s, thanks to technological advancements, the studies about human and animal viruses were better characterized. Also, the distinction between viruses and bacteria became explicit. (Van Helvoort, 1996). The milestones of this process are the book *General Virology* (1953), by S. E. Luria, and the periodical *Virology* (1955). In the same decade, the Rockefeller Foundation created the *Virus Program*, which sponsored the research of viruses and arboviruses in several regions around the world. Laboratories established in partnerships between the Foundation and local institutions performed the investigations. The International Health Division provided a significant part of the workforce. Its yellow fever combat program became a milestone in virology because it sponsored the first discovery of a disease caused by a virus and transmitted by arthropods. It served as a school for many scientists that would later work at Foundation's labs (Report..., 1955). The Virus Program investigations discovered that rats,

monkeys, and other animals were possible hosts of viruses. It investigated the distribution, incidence, hosts, vectors, and the infections caused by these pathological agents in several ecological niches around the world (Report…, 1955). According to Wilbur Downs – Rockefeller Foundation investigator and director of Yale's virus laboratory – there were strict criteria for the establishment of laboratories in partnership with local institutions such as political stability, good acceptance of external collaboration, excellent ecological characteristics, and open channels of communication with local staff (Downs, 1982). In the 1950s, the Foundation established other laboratories: Cairo (Egypt) and Poona (India) in 1952; Port of Spain (Trinidad and Tobago) in 1953; and Belém and Johannesburg. In the 1960s, Cáli (Colombia) and Ibadan (Nigeria) also took part in this partnership. These laboratories were all coordinated by a central lab in New York, which received all samples collected and was responsible for closing the diagnosis.

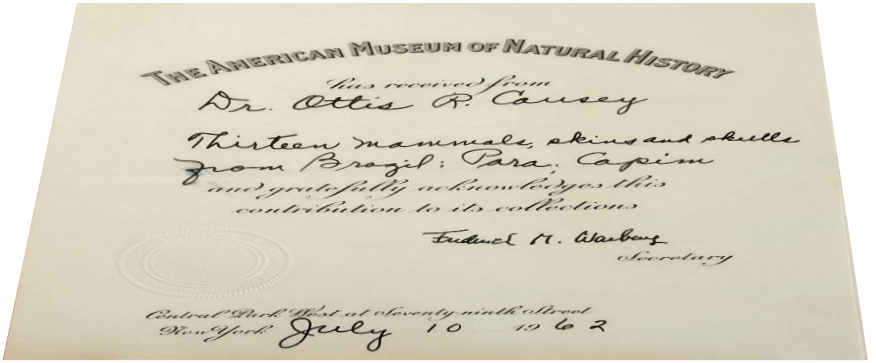
The Belém Virus Laboratory was founded in 1954. Here are some of the reasons why this particular location was chosen. Despite being established after Getúlio Vargas committed suicide, the Rockefeller Foundation through the International Health Division – had already collaborated with the Estado Novo regime when Fred Soper, director of the institution, led a successful campaign to combat yellow fever in the northeast of Brazil (Löwy, 2006).[3] The Foundation also had been helping in the combat of ancylostomiasis, malaria, yellow fever, and the formation of health professionals since 1916 (Benchimol, 2001). The couple Ottis and Calista Causey were in charge of the Belém Virus Laboratory, established in partnership with – already active in the region – "Serviço Especial de Saúde Pública" (SESP). The Causeys were – in Brazil – working in the Yellow Fever Service and the Northeast Malaria Service since 1940. Therefore, they were already experienced in the Brazilian problems and on how to deal with the local population. In an interview to *Workers in Tropical Medicine, oral history project,* Calista Causey stated that the Rockefeller Foundation had not commissioned enough funds to the construction of the laboratory, hence the necessity to use the traps and the installations of Instituto Evandro Chagas (Evandro Chagas Institute). As for the mice, they had to be requested from Rockefeller Foundation's central office in Rio de Janeiro and other laboratories like Trinidad and Tobago (Causey, 1979). Their first report highlighted the penurious conditions they were facing. There were not enough funds to pay for gas, transportation, and electricity (LBV Report, 1954). Instituto Oswaldo Cruz (Oswaldo Cruz Institute), already acting in the region,

offered a partnership to them; nevertheless, the Causeys decided to partner up with SESP. This choice is – partially – explained by the extreme financial and working autonomy the latter held, opposite from the first, which was subordinated to the Ministry of Health (Campos, 2006). Robert Shope, the successor of the Causeys, stated that "it was one of the greatest quests for viruses of all times" (Causey, 1979). In some cases, blood samples from the same specimen, recaptured several times, presented more than ten different viruses. Unknown viruses to science were commonly found in these tests, which led Robert Shope to state, "the forest was filled with viruses!" (Causey, 1979). In the interview above, Calista Causey describes how the routine was in Belém:

> Robert Shope: So, the eight thousand dollars that the Rockefeller Foundation invested paid off?
>
> Calista Causey: It soon grew to more, but we never had any trouble about getting enough to carry on. But we didn't use the money for the new things that other laboratories were investing in. Our problem there, we were dealing with a country, in a country, where the resources for scientific work were not very abundant. We didn't believe that it was right to buy these new [?] machines and things that had to have, ultracentrifuges that had to have expert care, because in the first place they couldn't be maintained, they couldn't be replaced by the, or even bought by the laboratories that wanted to use them. So we, for instance, we used a jar of sulfuric acid, made our own dry ice from carbon dioxide, imported the cylinders of carbon dioxide... [...] And a simple vacuum pump, and then we had a means of uh, freeze-drying. But we had to use a kerosene refrigerator because there wasn't the electricity to keep it going all the time. Yes, it was so low, the voltage, well, not only off, but the voltage so low that it couldn't maintain, we didn't have enough light in our labs. We would get these, well, you could buy lamps with lower voltage and then get a better light. But still it wasn't enough. So we did a lot of work by candlelight. And we isolated our first yellow fever by candlelight. (Causey, 1979)

The Causeys methodology was reasonably straightforward. They would capture specimens, and then re-state it to the wild. Later the subjects would be recaptured, and blood samples were drawn. Ottis Causey created an insect trap device, which became of regular use in other virus labs of the Rockefeller Foundation (Downs, 1982). After tests in the central laboratory in New York, it was possible to declare if the viruses found were known or unknown. The Rockefeller Foundation's reports and staff testimonials regularly

complement the scientific work of the Belém Virus Laboratory. Shope stated that the Foundation was surprised by the amount and the importance of viruses discovered in the Brazilian Amazon (Shope, 1998). In its early years, the laboratory identified, isolated, and made serological inquiries of many viruses, especially in the period when Ottis R. Causey, Ph.D. from the Johns Hopkins School and researcher of the Rockefeller Foundation, was the director (1954 to 1963). Robert E. Shope succeeded him (1963-1965), and later on, until its closing, John P. Woodal (1965-1971) was in charge of the institution. The main focus was investigating viruses transmitted by insects and arthropods. The Belém Virus laboratory sought to classify these viruses and examine the way they affected humans and domesticated animals. Scientists investigated blood samples – from household animals and living people – to identify what kind of viruses prevailed in each particular region. The laboratory established different methods for rapidly classifying pathological agents and new ways for monitoring the effects of such diseases. Fieldwork was fundamental for the comprehension of virus activity and life cycles. Over the years, the institution isolated more than 2,000 strains of arboviruses, establishing 48 serotypes, 18 serogroups, and 8 ungrouped viruses (Shope, 1998). They detected: Yellow Fever, Mayaro Fever, Encephalitis, Bussuquara fever, Guaroa Fever, and Oropouche Fever, among others (Shope, 1998). In the mid-1960s, the Rockefeller Foundation began to phase out its virus research program. The New York laboratory was incorporated into the Yale School of Medicine in 1964, becoming the Yale Arbovirus Research Unit. Evandro Chagas Institute incorporated the Belém laboratory assimilating its equipment and structure, whereas other foundation's field laboratories integrated with universities or government research agencies. In 1961 Oswaldo Cruz Institute signed an agreement with Evandro Chagas Institute due to the increasing arboviral disease-related problems on the Belém-Brasília Highway. Four sample collection posts were established, and these also served for investigation, medical assistance, and prophylaxis for workers and residents along 500 kilometers of the road, from São Miguel do Guamá (Pará state) to Imperatriz (Maranhão state). They sought to confirm the presence of yellow fever and encephalitis viruses in the region, especially the ones near Belém (Correio da Manhã, Aug. 25, 1961, p. 4).


THE AMERICAN MUSEUM OF NATURAL HISTORY

has received from

Dr. Ottis R. Causey

Thirteen mammals, skins and skulls

from Brazil: Para, Capim

and gratefully acknowledges this

contribution to its collections

Frederick M. Warburg

Secretary

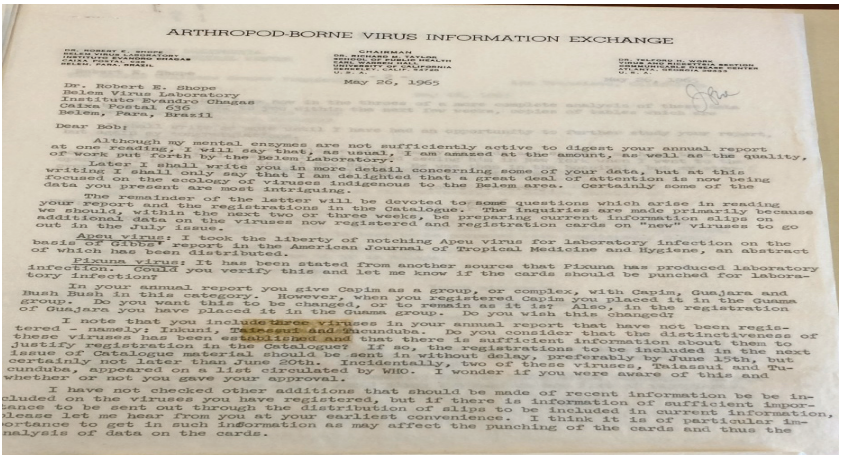
Central Park West at seventy-ninth Street

New York July 10 1962

Figure 3 – Correspondence from the American Museum of Natural History to Ottis Causey, director of the Belém Virus Laboratory. Source: Rockefeller Archive Center, July 7, 1962

Many actions were taken on demand. In 1958, an acute feverish disease followed by migraines affected workers of a farm near the Guamá river. The landlord engaged "Departamento Nacional de Endemias Rurais (DNERU)" for help. The director of DNERU-PA asked assistance from the Belém Virus Laboratory. Causey and his team collected blood from mice and workers, isolating six different virus strains. These samples were sent to the New York laboratory, where further testing showed they were identical to the Mayaro virus that had been insulated for the first time a year before. In September 1955, the Trinidad Regional Virus Laboratory had for the first time isolated the Oropouche virus from a blood sample from an inhabitant of the city of Vega de Oropouche. The Belém Virus Laboratory found, in the Brazilian Amazon, the same virus strain in 1960 in several blood samples collected from *Aedes Serratus* mosquitos and from one sloth (*Bradypus Tridactylus*). All these animals had been captured in the surroundings of Belém city, on the margins of the Belém-Brasília Highway. After the laboratory analysis confirmed the presence of the disease, the search for other cases started. In the following decades, the illness spread to other states of the Brazilian Amazon like Maranhão, Goiás, Amazonas, and Amapá. The Oropouche was an important legitimator for the investigations held at the Belém Virus Laboratory. According to Shope, fever outbreaks provided opportunities to find arboviral disease in humans and domesticated animals. The actions during the 1961 Oropouche outbreak was in Causey's opinion the coming of age of the laboratory. Thousands of people were affected; nevertheless, the institution was able

to provide a fast response despite the laboratory director being away on a business trip (Shope, 1998). Causey and his team's investigations in the Brazilian Amazon were responsible for linking people to the transmission of arboviral disease. The environmental impacts of the highway construction illustrate this assumption. The population living on the margins of the Belém-Brasília Highway increased more than 2000% in less than ten years due to the disorganized colonization undertaken by pioneers from several parts of the country (especially from the northeast region). These immigrants were generally not immune to local endemics, thus forming an extremely vulnerable group to the new diseases they were being exposed to. This population, especially the workers, became test subjects for the clinical trials of arboviral disease transmission and the effects of diseases caused by them. Causey used infected workers acting in the construction of the highway to confirm the theories related to the transmission and the symptoms caused by arboviral disease.



ARTHROPOD-BORNE VIRUS INFORMATION EXCHANGE

May 26, 1965

Dr. Robert E. Shope
Belen Virus Laboratory
Instituto Evandro Chagas
Caixa Postal 696
Belem, Para, Brasil

Dear Bob:

Although my mental enzymes are not sufficiently active to digest your annual report at one reading, I will say that, as usual, I am amazed at the amount, as well as the quality, of work put forth by the Belen Laboratory.

Later I shall write you in more detail concerning some of your data, but at this writing I shall only say that I am delighted that a great deal of attention is now being focused on the ecology of viruses indigenous to the Belem area. Certainly some of the data you present are most intriguing.

The remainder of the letter will be devoted to some questions which arise in reading your report and the registrations in the Catalogue. The inquiries are made primarily because we should, within the next two or three weeks, be preparing current information slips on additional data on the viruses now registered and registration cards on "new" viruses to go out in the July issue.

Apeu virus: I took the liberty of notching Apeu virus for laboratory infection on the basis of Table 7 report in the American Journal of Tropical Medicine and Hygiene, an abstract of which has been distributed.

Piscuna virus: It has been stated from another source that Piscuna has produced laboratory infection. Could you verify this and let me know if the cards should be punched for laboratory infection?

In your annual report you give Capim as a group, or complex, with Capim, Guajara and Bush Bush in this category. However, when you registered Capim you placed it in the Guama group. Do you want this to be changed, or to remain as it is? Also, in the registration of Guajara you have placed it in the Guama group. Do you wish this changed?

I note that you include three viruses in your annual report that have not been registered - namely: Inhumi, Tacaiuma and Tucunduba. Do you consider that the distinctiveness of these viruses has been established and that there is sufficient information about them to justify registration in the Catalogue? If so, the registrations to be included in the next issue of Catalogue material should be sent in without delay, preferably by June 15th, but certainly not later than June 20th. Incidentally, two of these viruses, Tacaiuma and Tucunduba, appeared on a list circulated by WHO. I wonder if you were aware of this and whether or not you gave your approval.

I have not checked other additions that should be made of recent information be included on the viruses you have registered, but if there is information of sufficient importance to be sent out through the distribution of slips to be included in current information, please let me hear from you at your earliest convenience. I think it is of particular importance to get in such information as may affect the punching of the cards and thus the analysis of data on the cards.

Figure 4 – A page of *Arthropod-Borne Virus Information Exchange*, the direct mail for information exchange among the Virus laboratories of the Rockefeller Foundation.

Source: Rockefeller Archive Center, May 26, 1965

The Laboratory also actively participated in the exchange of information with other similar institutions established by the Foundation trough the *Arthropod-Borne Virus Information Exchange,* a direct mail where several methodologies of collection techniques, animal trapping, and debates about new-found viruses were discussed and shared. Occasionally, some institutions

requested specimens, as seen in the mail from the American Museum of Natural History (Figure 3).

"It was a very exciting and interesting life."

These were Calista Causey's last words in her interview to Robert Shope. After the successful experience in Belém, The Rockefeller Foundation assigned the Causeys to establish a new laboratory in Africa. They could choose between Gana, Liberia or Nigeria. To make a decision, they stayed for one month in each location. Calista stated that in Gana, the local government was influenced by 'communists' that interfered in scientific activity. In Liberia, a dictator obstructed the autonomy of local scientists. They chose Nigeria due to its political stability. However, upon arrival they faced a general strike in the country, nevertheless they continued isolating viruses. The Causeys ended up discovering the Crimean-Congo Hemorrhagic Fever, which affected animals. Different from other programs of the Rockefeller Foundation, the Belém Virus Laboratory activities continued in the years to follow. In bilateral agreements, the Foundation financed most of the expenses in the beginning. As time passed, the host country was supposed to take responsibility for the costs involved in the operation. Right after the end of the program, the laboratories in Colombia and Nigeria closed.

On the other hand, the Belém laboratory was thriving. According to Pinheiro (1986), it identified 141 strains of arboviruses between 1954 and 1985, most of them completely unknown to science, thus establishing a world record in this discipline. Causey and his team developed operational concepts used in other laboratories of the Rockefeller Foundation network around the world (Pinheiro, 1986). Besides, Evandro Chagas Institute continued to establish partnerships, such as the one with the Welcome Trust in 1965. These agreements deployed investigators Jeffrey Shaw and Ralph Lanson to Belém, which served as a base for investigations on visceral and tegumentary leishmaniasis in the Brazilian Amazon, hence recovering an investigation tradition, established since the 1930s by Evandro Chagas (Shaw, 2016). In the years to follow, the institution continued developing projects. Francisco Pinheiro, who worked with the Causeys, led a comprehensive campaign during the Civil-Military Brazilian regime to control the Oropouche outbreaks. "Trópico Úmido" program, a partnership between CNPq and "Programa de Polos Agropecuários e Agrominerais da Amazônia" (Polamazônia), financed this initiative. Therefore, the viability of virus research in the Brazilian Amazon was closely linked to the

grand projects of the period, such as Transamazônica Highway, which served as a study subject for Francisco Pinheiro.

As mentioned before, several outbreaks of Oropouche Fever have been reported in different states of the Brazilian Amazon. This fever has been characterized as a 're-emerging disease'. Such a concept, which analyzes the interaction between humans and their environment, highlights a change in the epidemiologic behavior of known and previously controlled diseases that, somehow, bounced back and currently represent a threat to human health (Paz; Bercini, 2009). Economic development models enforcing environmental alterations, migrations, and uncontrolled urbanization are among the leading causes of illnesses re-emergence (Paz; Bercini, 2009). Pignatti (2004) states that Oropouche fever perfectly illustrates how a complex interaction of events may result in a new disease linked to environmental alterations. When the virus was isolated in the 1960s, it was not clear why the disease had moved from the country to the city. The answer was found after the discovery of the virus in the biting midges. Following the cacao plantation removal and deforestation,

Figure 5 – Ottis and Calista Causey demonstrating a trap to capture animals.
Source: Rockefeller Archive Center, no date

the mosquitos started reproducing fast in cacao peel. They spread the disease on humans inhabiting the region and passing through the road network of the Brazilian Amazon (Pignatti, 2004). Therefore, the disease that served to legitimate the campaigns of the Belém Virus Laboratory also serves as an example of how complicated the relationship among all living forms can be.

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RAC – Rockefeller Archive Center.

IEC – Instituto Evandro Chagas.

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NOTES

[1] Rostan Soares and Mario Pinotti developed the mix of salt and chloroquine. Also called 'med salt' or 'salt of Pinotti', it was broadly used in the country in the 1950s during the Malaria eradication campaign (see SILVA; HOCHMAN, 2011).

[2] The rich national and global conjecture that involved the establishment of INPA, was broadly investigated by contemporary authors: Rodrigo César Magalhães (articles and master thesis), Marcos Chor Maio, and Priscila Faulhaber (see: FAULHABER, 2005; MAIO; SÁ, 2000; MAGALHÃES; MAIO, 2007).

[3] Yellow fever combat campaigns in the 20th century – in Brazil and the rest of the continent – were broadly studied (ANAYA, 2016; BENCHIMOL, 2001; LOWY, 2006).

Article received on January 28, 2019.
Approved on April 22, 2019.