



Anopheles gambiae in Brazil: the background to a “silent spread,” 1930-1932

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Abstract

The article analyzes the arrival and identification of the African mosquito *Anopheles gambiae* in Brazil in 1930, and the initial reactions of scientists and public health authorities against the epidemics of malaria caused by this species. Although this mosquito was recognized as a dangerous vector of malaria, its presence in Brazil was neglected after initial emergency actions in the city of Natal in 1932; this encouraged it to spread silently, resulting in a major malaria epidemic in 1938. This article examines scientific and political issues which caused the fight against mosquitoes to be pushed into the background until 1937 in cooperative efforts between the Rockefeller Foundation’s International Health Division and the Brazilian authorities.

Keywords: *Anopheles gambiae*; malaria; Rockefeller Foundation; Rio Grande do Norte.



The arrival of the first African mosquito in the Americas was recorded in March of 1930; this dangerous vector had never been seen in the New World. *Anopheles gambiae* was found by Rockefeller Foundation entomologist Raymond C. Shannon,¹ who worked for the Cooperative Yellow Fever Service (Serviço Cooperativo de Febre Amarela, SCFA) in Natal, capital of the state of Rio Grande do Norte. After a brief study of the new routes used by boats and seaplanes, Shannon (1932) discovered that this species most likely originated in Dakar, the capital of Senegal.

At a specific juncture which included scientific, political, and ecological elements, the arrival of the African mosquito led to the inevitable and immediate need for services to mitigate the effects caused by its proliferation. During the early decades of the twentieth century, *Anopheles gambiae* was already recognized as one of the most efficient transmitters of malaria, and was also the main vector of its most dangerous form, falciparum malaria, on the African continent (Gomes et al., 2011). Against this backdrop, this article analyzes some aspects that preceded the “silent spread” (after frustrated activities aimed at control), as well as the lack of monitoring of this mosquito in Brazil from 1932 onward.

The first epidemics in Natal in early 1930 were sufficient to draw the attention of the governor of Rio Grande do Norte at that time, Juvenal Lamartine de Faria (1930, p.71), who needed to organize resources and additional staff to mitigate the effects of the malaria transmitted by *A. gambiae*. Along with federal assistance, the governor received help from Rockefeller Foundation staff who worked in the region through the SCFA. The mosquito was eliminated from the Natal urban area in 1932 through a rapid, palliative response by this service, although no further activities followed this initial campaign. In the six years before it was driven out of Natal, *A. gambiae* spread throughout the interior regions of the states of Rio Grande do Norte and Ceará, causing the largest epidemic of malaria in the twentieth century in the Americas (Cueto, 1996, p.198). Only in 1939 (nine years after this dangerous vector of malaria was identified in Brazil) was the Northeastern Malaria Service (Serviço de Malária do Nordeste, SMNE) created, and in 1940 an ambitious and controversial project to eradicate this mosquito drew to a close. This endeavor was the subject of criticism that continues to echo to the present day (Stepan, 2011, p.100). This mosquito which spread silently and was invisible among the public health priorities of the early 1930s took on unprecedented importance in the 1940s; for example, in 1941 Afrânio Peixoto described it as “the worst immigrant that could reach us from the north. Not even an invasion of heretics, Communists, or Nazis could compare to an invasion of *Anopheles gambiae*, the ferocious African mosquito” (Peixoto, 1941, p.1227).²

The early moments of perplexity when *A. gambiae* arrived in the early 1930s have received little recognition, since in the universe of historical studies on efforts to exterminate this mosquito, the emphasis has mostly been placed on events after 1939. This may be explained by the fact that these events also correspond with a period of vacillating agreements between governments and the International Health Division (IHD) of the Rockefeller Foundation, amid progress, setbacks, and changing priorities. Here my objective is to observe these very events from this early period marked by uncertainties.

More specifically, historical analysis of the presence of *A. gambiae* in Brazil is generally related to the activities carried out by the SMNE starting in 1939, notably considering

a political approach and the institutional role in mosquito eradication plans (Stepan, 2011; Magalhães, 2016). I also address the successes and challenges in the campaigns to eliminate this mosquito, and how it intertwined with the populations who fell victim to the epidemics, emphasizing the interventionist nature of the SMNE (Silva, 2012).

It is important to stress that most of the studies on the work of the Rockefeller Foundation in Brazil with regard to mosquito-borne illness center around combating yellow fever and the work of the SCFA. In many cases, the SMNE is described as a service within a more comprehensive narrative of the SCFA, as if it were a chapter describing the fight against mosquitoes within institutional efforts against yellow fever and its own principal vector, *Aedes aegypti* (Löwy, 2006; Benchimol, 2001; Magalhães, 2016). This historiographic approach is justified, since (in administrative terms) the history of the SMNE is presented as a continuity of the SCFA. This is particularly true with regard to the activities of Fred Lowe Soper,³ who in the 1930s headed the SCFA and later (from 1939) planned and led the SMNE, maintaining its limits as exclusively fighting *A. gambiae*. The continuity between the two services is widely known, since resources provided by the SCFA were vital in making the SMNE viable. But despite this administrative continuity, two fundamental elements ensured a strong distinction between the two services: the stated plan to exterminate *A. gambiae*, which restored the credibility of eradication approaches, and the wide autonomy and flexibility which the Brazilian authorities granted the SMNE (Cueto, 1996, p.196-197).

Work by Randall Packard and Paulo Gadelha (1994, p.213) addressing specifics of the Northeast Yellow Fever Service was important in gathering useful insights for this study, since it suggested that eradication of *A. gambiae* from Brazil must be viewed from a broader analytical perspective. More specifically, the article by these authors which reexamines the history of Fred Soper's efforts to eliminate *A. gambiae* in Brazil is the most representative analysis of the surrounding context and the trajectory of this mosquito, with a special focus on Soper's work as a plan for extermination. While they emphasized factors that led to the major malaria epidemic beginning in 1938, Packard and Gadelha (1994, p.200) superficially address the early history of *A. gambiae* in Natal, stating that the disappearance of this mosquito from the official reports during the years of the "silent era" resulted from the lack of attention to this problem on the part of Fred Soper and the IHD. My goal here is to question this affirmation, expanding part of Packard and Gadelha's argument about prioritizing efforts against yellow fever to the detriment of malaria caused by *A. gambiae*, while at the same time emphasizing factors that remained outside these authors' scope of analysis through presenting specific details about the arrival and spread of this invasive mosquito in the early years.

Here I will not address issues related to the SMNE, its establishment or activities, but rather focus on some elements of the first phase of the arrival and spread of *A. gambiae*, more specifically from 1930 to 1932. I intend to describe the historical process from the first appearance of this mosquito in light of the scientific and political authorities as a local emergency to be addressed in a palliative manner, followed by neglect and a series of political and scientific disconnects. The remedial measures taken in 1932 and the lack of monitoring of this species were important factors that allowed the *A. gambiae* problem to take on larger proportions, requiring the creation of the SMNE (the product of an agreement

between the Rockefeller Foundation and the Brazilian government) in 1939. This agency was the successor to the Anti-Malaria Service (Serviço de Obras Contra a Malária), which was established in 1938.⁴ I call attention to the importance of understanding the early days of *A. gambiae*'s presence in Brazil, along with the disconnect between the initial activities to combat this vector. This approach prioritizes details of a chronological delimitation which has not yet been widely considered by the historiography.

In *The making of a tropical disease: a short history of malaria*, Packard (2007) dedicates some pages to resuming his and Gadelha's argument with regard to *A. gambiae*, consequently providing a competent historical overview of malaria. Meanwhile, the early conditions at the time that the African mosquito arrived are neither emphasized nor mentioned in the data documented by Shannon.⁵ Packard makes a major contribution by starting the conversation about the "human ecology" of malaria in the region, examining factors related to the circulation of workers during dry periods and the problem of the production of space in the agriculture of the "sertão" (Packard, 2007, p.91-96), an element that deserves exploration at another time.

I intend to explore new elements related to the history of the biomedical sciences, such as data from medical entomology and historical restraints related to expanding means of transport on the continent and new routes. Analysis of the first months after the mosquito's arrival in Natal shows that Fred Soper's activities and authority as a central figure was not sufficiently established, considering the challenges posed by political turbulence between local and regional levels. In this regard, it addressed the period prior to the establishment of his authority as the "arch-eradicationist" (to use the term coined by Nancy Stepan, 2011, p.11).

Soper only became well-known after 1940, following the success of the SMNE and the anti-*gambiae* program. For this reason, addressing the period when *A. gambiae* first arrived permits historical investigation into an unclear trajectory involving the entomological research conducted by Raymond Shannon and Brazilian researchers such as César Pinto. During this phase, when eradicationist triumphalism had not yet clouded the initial perplexities and instabilities provoked by the mosquito, we can see some fundamental background to *A. gambiae*'s spread across Brazil starting in 1930.⁶

First contact: a "species new to science?"

Cases of malaria in Natal began to skyrocket in April 1930. According to a report by Rio Grande do Norte's governor Juvenal Lamartine de Faria (1939, p.70-71), the situation had "a new and alarming aspect, even for the most longstanding clinics of our land," which he dubbed an "endo-epidemic of malaria". Even though it was common for malaria cases to increase during the rainy season, generally from March to July, Lamartine de Faria found increased numbers of patients and more severe symptoms during the first half of 1930. In an attempt to minimize the severity of the situation, an emergency service was created; it featured two officers, a doctor and a nurse, and was augmented by three nurses from the Institute for Childhood Protection and Care. It was still necessary to establish a temporary care center, a "Malaria Care and Prophylaxis Center," which was opened on May 26, 1930,

at the headquarters of the Brazilian Scouting Association, which was “kindly provided by its members,” according to Faria (1930, p.70).

The emergency in Natal was not only unusual because of the strength of this apparent outbreak of malaria. The unprecedented and “alarming feature” had an extraordinary and alien element of uncertainty which traveled the new transcontinental routes where Natal was a waypoint. In March 1928, two years before the African mosquito was identified in this city, regular mail delivery was established between Dakar and Natal, using fast boats known as *avisos* that made the transatlantic crossing in less than three days.

Some hypotheses about the conditions that led to the arrival of the mosquito began to be raised in 1930. In his annual report to the federal government on health conditions in the state of Rio Grande do Norte, governor Juvenal Lamartine de Faria indicated the cause of recent health problems among the population of Natal in 1930 from a scientific bulletin. In Faria’s report, the central concern was the increase in malaria cases. He focused on the mosquito that had recently arrived from Dakar in his narrative on the reasons behind the growing number of cases, in a very detailed text which explores technical aspects of medical entomology. Faria utilized data from contemporary scientific journals and addressed the vulnerabilities of Natal’s location in relation to the importation of disease vectors from the African continent. To support this text, he quoted an excerpt from the August 1930 issue of the journal *O Saneamento*, and a translation of an article published in *Science* in April of that year which addressed the unprecedented arrival of *A. gambiae* in Brazil. In his report, Lamartine de Faria presented current scientific data on the situation in Natal:

Foci of ‘Anophelina Gambiae’ were found in Natal, Rio Grande do Norte, Brazil, on March 23, 1930, by Dr. Raymond Shannon, engaged in entomological research related to studies by the Rockefeller Foundation, in northern Brazil. The telegram that related this discovery refers to it as the first *Mysomyia* found in the New World. Dr. Shannon believes that the species is probably a recent import, although the large number of larvae and nymphs found indicate that it is well-established in the area surrounding Natal (Faria, 1930, p.71).

Faria’s report also seems to indicate that the effects of the mosquito’s arrival were present even before Shannon identified it. From scientific notes on the arrival and establishment of the mosquito on the banks of the Potengi River,⁷ the governor of Rio Grande do Norte was able to express the violence of the malaria cases seen in the first half of the year, which he described in his October 1930 report (Faria, 1930, p.71). Additionally, the governor’s report cited entomological data indicating that the African mosquito seemed to have good reasons to adapt to the new region:

Dr. L. O. Howard, a United States Department of Agriculture entomologist, made the following comments: ‘The telegram of Shannon’s discovery is extremely interesting. *Anopheles gambiae* is found in many regions of Africa, and is a well-known bearer of malaria in the region as a whole, found in Zululand, Zanzibar, all of Portuguese East Africa, Southern Rhodesia, Nairobi, Gold Coast, and Mauritius. It is a frequent visitor to households and an easy bearer of malaria. In fact, it is the species which appears on the emblem of London’s Royal Society of Tropical Medicine. The name *Mysomyia*, which was cited in the telegram, is an anopheline species found by Blanchard in 1902.

It is currently considered a subgenre. The species was previously known only in Africa and India. The city of Natal, Brazil, is a seaport, and therefore an appropriate location for incursions of this nature. Since Dr. Shannon found it breeding there, it has likely already become a permanent guest. We thus have learned of another bearer of malaria in the Americas' (Faria, 1930, p.71).

Publication of the data on the mosquito's arrival in Natal and a preliminary study do not conceal Shannon's uncertainty upon first encountering this invader. When he found the larvae of the still-unrecognized African mosquito on March 23, 1930, Shannon (1942, p.2) conjectured that he was dealing with a species "new to science" because of the unique nature of the foci of this mosquito in the region. He only realized it was the deadly species when he conducted tests in the SCFA Yellow Fever Laboratory in Bahia, finally identifying *A. gambiae* and communicating this finding in a scientific note to *Science* magazine. He also published a note in *Brasil Médico* on May 30, 1930, concluding that the mosquito species found was already "well acclimated to the outskirts of Natal" (Shannon, 1930, p.516). Despite its recent arrival, *A. gambiae* did not take long to spread, and before local authorities could do anything, a severe epidemic of malaria struck the area surrounding Natal, as Shannon reported (1932).

Subsequent studies carried out in the late 1930s (based on Shannon's early investigations as well as other work by Brazilian researchers) clarified some aspects of *A. gambiae*'s arrival. Notable among these is the work by César Pinto,⁸ published in 1939 and entitled *Disseminação da malária pela aviação: biologia do Anopheles gambiae e outros anofelineos do Brasil* (Dissemination of malaria by aviation: the biology of *Anopheles gambiae* and other Brazilian anophelines). This study sought to shed light on important aspects of this topic, recognizing fundamental contributions by Adolpho Lutz;⁹ Pinto (1939, p.299) states that "at this time *Anopheles gambiae* had still not entered Natal, because it certainly would have been found by Dr. Lutz, who was conducting entomological research in this city and its surrounding area," and more probably was brought in later by seaplanes or by the *aviso* boats.

Conjecture about how the African mosquito entered the country was the object of study for years, along with attempts to understand and predict how it would move and adapt. César Pinto's studies during 1938 (eight years after the identification of this foreign invader) list the factors indicating that the swift *aviso* boats brought *A. gambiae*, since it is most likely that the adults made the crossing, because the water tanks in these boats were sealed (Soper, Wilson, 2011, p.103; Pinto, 1939, p.299). The arrival of *A. gambiae* also led to security measures and more careful inspection of aircraft (Pinto, 1939, p.300); this in turn lent visibility to unpublished studies on the transport of mosquitoes in aircraft, such as the article "Mosquitoes transported by airplanes: staining method used in determining their importation" (Griffitts, Griffitts, 1931) and the book *Epidemiology in relation to air travel* (Massey, 1933).

The new public health concerns began to be legally formalized from an international perspective in 1933, with the signing of the International Sanitary Convention for Aerial Navigation at the Hague; this document regulated sanitary control of aviation services and established a series of standards and conventions which took effect in 1935. This document described and regulated the definition of an aircraft for sanitary control purposes, as well as the minimum criteria for operating an "authorized aerodrome," which was expected

to meet the requirements in Article 5 pertaining to structure and hygiene conditions (International..., 12 abr. 1933, p.30).

The Brazilian scientific community which was interested in medical entomology did not take long to confirm the danger of this foreign mosquito. Even though the state of Rio Grande do Norte faced the sanitary problems related to a region where malaria was endemic, the invading mosquito was seen as an unexpected element that made the fragility of public health in the area even more evident. Although malaria was already part of the region's endemic landscape, *A. gambiae* is seen in clear contrast, granting malaria new proportions not only for Rio Grande do Norte but for all of Brazil.

The arrival and specificity of the "endemo-epidemic malaria" caused by *A. gambiae* was also the subject of discussions at the Society of Medicine and Surgery in September 1931. Roughly a month before he took charge of the Rio Grande do Norte Board of Health, a statement by the physician Genserico de Souza Pinto was reprinted in the *Correio da Manhã* newspaper. In this communication entitled "Condições sanitárias do Rio Grande do Norte" (Health conditions in Rio Grande do Norte), Souza Pinto commented on the malaria cases recorded between April and July, pointing out the devastating effects of this new form of malaria. He stated that the endemic malaria in the region never drew the attention of the "health powers" because its effects were "not very intense" in comparison with the malaria caused by this African mosquito (As condições..., 16 set. 1931, p.3).

Even though the objectives of the SCFA did not include plans to research or combat this new mosquito, this entity provided travel for researchers to investigate this unexpected epidemic in early 1930 in Natal. During this period, Nelson C. Davis (director of the SCFA's yellow fever laboratory in Bahia) assisted Shannon in his research during the first weeks after the discovery of *A. gambiae*. Everything indicates that there were local rumors that the new epidemic could be yellow fever, and confirmation of the cases by the SCFA using the samples collected from this region was essential. Davis rushed to Natal and ruled out the possibility of yellow fever, since *Aedes aegypti* was not present in the region, and confirmed the presence of malaria from blood samples (Shannon, 1942).

In order to illustrate the precariousness of the situation, the new head of the SCFA, Fred Soper Lowe, reported that on April 28, 1930 (just over a month after the discovery of *A. gambiae* in Natal) he visited forty houses in the capital of Rio Grande do Norte and found that "some entire families were sick, with none able to procure and prepare food" (Soper, 1966, p.471). For him, "this was malaria in a new dimension, a dimension which required 'food as well as quinine'" (Soper, 1966, p.471). According to the SCFA reports, there was an "explosive outbreak" already underway when Shannon detected the presence of *A. gambiae* (Soper, Wilson, 2011, p.128). Shannon and Soper's reports reaffirmed the statements in governor Lamartine de Faria's October 1930 report with regard to the initial impact and the exceptional nature of malaria cases caused by *A. gambiae*.

In order to understand how the mosquito from Dakar behaved in the affected region, it was necessary to learn the habits of the species through studies conducted in Africa. There is a general concern with the domestic nature of this vector, as well as its ability to fly, which can be found in the initial studies, especially in the work of Shannon (1932) and Pinto (1939), but also that of other scientists of the same period.¹⁰

Political disintegration and the silent spread

Considering the novelty of *A. gambiae* in Natal in 1930, it is important to call attention to one element which has not yet been thoroughly explored: Soper's first attempt to carry out a definitive solution against this mosquito. This attempt was frustrated, which reveals the scientific and political complexity of the Rockefeller Foundation's work, in the case of *A. gambiae*. Initially, Soper's approach was based essentially on Shannon's initial studies, and took a pragmatic approach to contain the spread of the mosquito. To deal with the problem in the capital city, he suggested using salt water to flood areas where water had accumulated along the Potengi River, where the first foci of *A. gambiae* were found. Near where the Potengi emptied into the sea, the solution would be to "flooding the tidal flat where *gambiae* were breeding by opening the dike to let in salt water" (Soper, 1966, p.471). This technique would have stopped the newly-arrived mosquito from proliferating before it had completely adapted to the region, using local resources and little manpower, but flooding of the area was not authorized.

Even though *A. gambiae* would initially have been vulnerable to a certain extent, within distribution that "tends to be extremely localized" (Shannon, 1932, p.653), the flooding plan had to be abandoned. According to Soper, this setback was the result of local restrictions as well as problems in terms of priorities and resources which had already been used by the SCFA. He was therefore told by Frederick Russell, the director of the IHD, to "leave the problem of *Gambiae* to the Brazilians" (Soper, 1966, p.471). In a 1949 lecture by Borges Vieira (a professor at the São Paulo School of Hygiene and Public Health) entitled "Cooperação internacional e o progresso da higiene no Brasil" (International Cooperation and the progress of hygiene in Brazil) reexamined the political obstacles that frustrated initial plans to combat *A. gambiae* in 1930. Vieira points out that even though Shannon recommended opening the dikes and flooding the original breeding areas used by *A. gambiae* a few months after the mosquito's presence was confirmed in Brazil, the measures could not be carried out at the right time "because of nefarious bureaucracy," where local authorities could not "act without orders from Rio" (Vieira, 2010, p.19); this reaffirmed the political disconnect faced by initial actions against the invading mosquito.

It is important to individually define other factors which combined to slow efforts against *A. gambiae*. First is the relaxation of public outcry, as lethal cases of malaria dropped after the mosquito was expelled from Natal through an initial emergency operation. This emergency action combined with the droughts of 1932-1933 to result in less mosquito activity and consequent relaxation on the part of the authorities (Soper, 1966, p.472). Far from the capital of Rio Grande do Norte and with low activity during the dry season, the mosquito lost visibility, despite continuing to proliferate. As noted by Benchimol (2001, p.168), the relatively dry periods prior to 1937 "diverted the attention of the authorities to other issues, including yellow fever, because it was feared that the resurgent emigration of northeasterners could bring the disease back to Rio de Janeiro." Rio Grande do Norte's problem with *A. gambiae*, an issue initially considered localized and regional, did not have enough political force to compete with priorities related to health in Rio de Janeiro. This became clear in Fred Soper's own assessment: "The beautiful capital of Brazil and control

of that disease [yellow fever] took priority over all other health problems” (Soper, Wilson, 2011, p.133).

Soper explained to the IHD director in a letter that Shannon’s report was “optimistic and brings up the question of our responsibility regarding possible extinction of the species in Brazil,” while at the same time he was aware of the transition period and political issues that were still underway in Brazil in that era, and that “the present state of disorganization in the National Health Service makes it extremely difficult for anything to be done through official channels” (Soper, 7 jan. 1931, p.1).

Despite the initial setbacks and the impossibility of flooding the area where the African mosquito initially bred, the employees of the Rockefeller Foundation Cooperative Yellow Fever Service received instructions from Shannon, even though a specific plan had not yet been officially approved. In July 1930, emergency applications of Paris green¹¹ were carried out in some foci bordering the Potengi River. With the start of the dry season (around the month of August), the malaria problem slowed until December of that same year, confirming Shannon’s hypotheses about how the reproduction of *A. gambiae* was heavily dependent on rainfall patterns.

It is important to remember that Shannon’s original mapping was done in Natal around December 1930, and since the dry season runs from August until March or April, the implications of this period were considered in his study. Meanwhile, the rains of 1931 seem to have catalyzed the movement of *A. gambiae*, as larvae of this mosquito were found in São Bento, roughly 180 km from Natal, and also in interior areas of Rio Grande do Norte included within this same approximate radius, showing that the species can propagate to a surprising extent during a period of prolonged rainfall (Shannon, 1932, p.644). The expansion of the mosquito’s breeding areas resulting from a lack of control measures and the rains in early 1931 caused an unprecedented epidemic that drew the attention of the federal government, which requested help from the Yellow Fever Service, the only organized service in the country capable of dealing with an emergency of this nature.

Without systematic efforts to eradicate the breeding sites in 1930, a second epidemic was expected by the experts at the SCFA. Considering the expansion of the area where the mosquito reproduced (approximately 6km²), the number of cases was proportionally greater. The second epidemic at the beginning of 1931 was more severe and felt after it undermined essential sectors in the city, with some areas of trade completely paralyzed. Even some of the activities by SCFA staff living in Natal were affected (Soper, Wilson, 2011, p.129).

In the following text, Soper expresses his view of some of the details of the challenge faced by the SCFA at that time, pointing out the federal government’s lack of preparation to deal with the problem of *A. gambiae* while it was expanding, and the occurrence of new cases in 1931:

The presidential election was followed by successful revolution with interruption of the normal relationship existing between the states and the Federal Government. The appeal for aid from Rio Grande do Norte to meet the epidemic of 1931 found the new Federal Government unprepared; the National Director of Health requested the Yellow Fever Service to assume responsibility for the gambiae problem in Brazil. On further

insistence of the Director, however, I agreed to an emergency malaria prevention program in Natal for a six-month period; this would enable the Government to prepare its own anti-gambiue program (Soper, 1966, p.471).

Although there were limits to the role played by the Rockefeller Foundation over the expanse of Brazil, with *A. gambiae* startling the activities by the SCFA and extrapolating the entire planning capacity of the International Health Division, by the end of 1930 the Vargas government had undeniably moved closer to and cooperated with the Foundation, a development which has already been explored in the historiography on the fight against yellow fever in Brazil during the first half of the twentieth century. As Jaime Benchimol suggests, there was a process of converging forces since “the 1930 Revolution ... created a political framework more conducive to verticalized control of mosquitoes and human populations” (Benchimol, 2001, p.125). This process, however, was not without various periods of instability and setbacks. In the early 1930s in Natal, Soper was still on shaky ground, vacillating and acting cautiously, unlike the “arch-eradicatorist” described by Stepan (2011), with an already well-known leadership profile during the 1940s.

In Natal in the early 1930s, although the directorship of the SCFA faced some initial setbacks (with the inability to flood the breeding areas with salt water and difficulty coordinating their own interests within the political disconnect of that time), relatively efficient control measures were carried out through an emergency cooperation agreement to face *A. gambiae* during these initial moments. The credibility and infrastructure of the organization in these emergency activities led Soper to assume responsibility for dealing with this outbreak, even with limited resources.

The action was planned according to the resources, timeline, and staff which were available. Despite the surprise caused by the emergency situation, the efforts against the invasive mosquito were now supported by Shannon’s field research and mapping, which clarified the location of *A. gambiae*’s main foci. Therefore, even though the invaded area expanded, the mosquito was still relatively restricted to the area surrounding Natal in early 1931 and subject to low rainfall, in more or less regular and predictable patterns.

The final agreement on the cooperative approach to fight *A. gambiae* was organized in a specific and palliative manner. The SCFA was the only health service with a federal reach. As a result, emergency control measures to halt the epidemic outbreak caused by *A. gambiae* in the capital of Rio Grande do Norte had to be negotiated with the Ministry of Education and Health (MES). But the resources and the personnel of the Rockefeller Foundation’s IHD were limited at that time, because of work to fight yellow fever. As the director of the SCFA, Soper noted that the state government of Rio Grande do Norte asked the federal government for help in the beginning of 1931, but the SCFA could not take on this task to combat *A. gambiae* since the resources of the yellow fever program were already fully committed. An emergency campaign was finally conducted, and *A. gambiae* was driven out of Natal in April 1932 (Soper, Wilson, 2011, p.133).

According to Soper’s report (1966, p.471), during this emergency procedure, “in accord with current practice, paris green was mixed 1 to 2 percent with a suitable diluent” before application. Malaria declined, and the number of *A. gambiae* found in homes also dropped

dramatically: “Only 11 were found in 8,393 homes researched” (Soper, 1966, p.471). This reduction occurred between July and mid-October of 1931. It was at this time that the federal government moved in a contrary direction, appointing Genserico de Souza Pinto as State Director of Health, using federal funds to combat the new outbreak of malaria in Rio Grande do Norte. As of October 14, 1931, the state service assumed full responsibility for the program, which consisted of systematic use of Paris green. This program ended in mid-April of 1932, with the end of the special budget for palliative measures against the invading mosquito.

Efforts to combat this mosquito with Paris green during 1931 and 1932 eliminated *A. gambiae* from Natal, and no other breeding sites were found in that urban area. Yet even with resources available, Soper became convinced that eradication of this species was no longer possible, considering its new expansion area into the interior of the state. It is important to note that elimination of *A. gambiae* in Natal also had the effect of silencing “public demand for relief from malaria,” as Fred Soper noted (1966, p.472). This relaxation resulted in the silent spread of this mosquito in subsequent years, and a major epidemic in 1938 in the interior of the states of Rio Grande do Norte and Ceará.

The SCFA reports on the expulsion of *A. gambiae* from the capital of Rio Grande do Norte indicate that in general terms, although 1932 was a dry year in the region, without control measures the rains in Natal would be enough to guarantee that the mosquito would breed within the city limits. Therefore, “there seems to be no reason to not attribute the disappearance of *gambiae* to the campaign carried out between 1931 and early 1932” (Soper, Wilson, 2011, p.129-130), as concluded in the report on this emergency action. Considering the spread of *A. gambiae* into the interior of Rio Grande do Norte, the report emphasizes the authorities’ role in decreasing malaria cases, stating that without the pressure of public opinion or the impact of deaths in the capital, the infiltration of the African mosquito would not have captured sufficient attention.

Other elements indirectly related to the political visibility of the mosquito and malaria cases can be considered. The spread of *A. gambiae* after 1932, for example, seems to have been delayed by drought and few opportunities to travel. To a certain extent, we can state that this spread could have been faster, which according to Shannon’s analysis would have shortened the period of “silent spread.” According to Shannon (1942), the long quiet period spanning the elimination of the mosquito from Natal in 1932 and the great epidemic of 1938 in the interior of Rio Grande do Norte and Ceará can mostly be explained by the years of drought and lack of swifter means of transport that could have hastened the mosquito’s spread. In other words, areas with higher population density and more breeding sites resulting from heavy rains would have made the mosquito more visible to public health authorities through increased numbers of cases.

Final considerations

The historical study of the determinants and effects of *A. gambiae*’s arrival in Brazil during the initial years underscore characters and events which have gone relatively unrecognized in narratives that portray this mosquito as the target of a structured

extermination program, for example historical studies on the Northeastern Malaria Service. Although the focus of this article was not the details of this program or its importance to reflections on the concepts of eradication (Stepan, 2011), or an overview of the history of malaria taking into account human ecology (Packard, 2007), or even a questioning of assumptions related to the actions taken by Fred Soper or the promotion of an anti-*gambiae* program (Packard, Gadelha, 1994), it was important to present elements that influenced subsequent events, such as the spread of the insect which demanded institutional responses, which is depicted in the established historiography on this topic.

The study of these early years did not attempt to fill a gap, but rather to present in more detail how the arrival of the African mosquito mobilized scientists interested in medical entomology, along with their concerns and assumptions about its spread during a period of political instability. In the early 1930s, the efforts of public authorities in partnership with the Rockefeller Foundation were not committed to the fight against malaria, but rather to fighting yellow fever in more politically significant areas such as Rio de Janeiro.

As we have shown, it is reasonable to state that the lack of effort sufficient to deal with *A. gambiae* in a peripheral region of Brazil at a time of political disconnect between the Rio Grande do Norte and federal governments combined to produce a silent spread which had disastrous consequences. It is important to consider that the silent movement of this mosquito into the interior region of Rio Grande do Norte and Ceará also seems to have occurred (according to entomological studies) because of their specific habits which had not been seen before, as studies conducted in sub-Saharan Africa indicated (Evans, 1938). During the dry periods between 1932 and 1936, *A. gambiae* spread from isolated spots along the banks of the rivers, then gained ground as the rains increased, consequently leading to the major epidemic of 1938 in the states of Rio Grande do Norte and Ceará. According to the report by the Northeast Malaria Service, the behavior of *A. gambiae* generally followed the pattern in its region of origin, with a preference for “spawning in areas where water collects and is exposed to the sun.” (Relatório..., 1939-1942, p.7).

Amid the heterogeneous constraints, it is important to emphasize not only the formal content of the historical documents that help us understand the political visibility or invisibility of *A. gambiae*, but also to comprehend the trajectory of this mosquito from the documents written by researchers who dealt with it in the field. This is not to advocate the advantages of the scientific point of view of medical entomology during the period over the more general political records, but rather to show how initially, studies by researchers like Shannon and Pinto (based on previous research conducted by Alwen Evans) help us to understand, even if indirectly and partially, the assumptions that formed the foundation of the narratives, trajectories, and decisions related to the African mosquito in Brazil.

The natural history of *A. gambiae* and its anthropophilic habits should not be disregarded, since its coexistence and adaptations to the various ways in which human cultures occupy spaces are woven into and comprise its coexistence and adaptation, an important aspect that deserves attention and more detailed historical studies without fear of entering into temporalities which are uncomfortable for historians *tout court*, as Randall Packard (2007) has aptly shown.

The documentary production by scientists, Brazilians as well as and foreigners, who helped closely map the movement and specificities of *A. gambiae*, seems as quiet and invisible in the historiography as the mosquito was during its “silent” period. For this reason it is fundamental to reaffirm the importance of these documents in understanding the scientific assumptions which are associated with or entered into conflict with institutional activities. In general way, Soper’s political expression and representativeness as a historic character seems to overshadow the work of scientists who worked closely with and monitored the surprising trajectory of *A. gambiae* when it first was found.

Even after historical analysis, *A. gambiae* still seems mysterious and surrounded by speculation in terms of the path it took as well as whether it was able to adapt or not, or even whether it became a permanent resident in the states of Rio Grande do Norte and Ceará (or beyond).

Instead of reducing this object to a given context, with no room for the imponderable, it may be important to observe the elements that placed this mosquito at the center of narratives that demarcate its unpredictability at a moment of uncertainty prior to the institutionalization of anti-*gambiae* efforts promoted by the SMNE.

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NOTES

¹ Before entering the International Health Division in December of 1927, Shannon taught entomology at George Washington University, where he also did some graduate study. In 1926-1928, he was involved in studies in Argentina and Patagonia, first working for the Argentine government and later for the Rockefeller Foundation’s International Health Division. In 1912, at 18 years of age, he began to work for the government as a student assistant in the office of Frederick Knab; he was reported to be a “born naturalist, bright, avid, eager, and appreciative, and everyone was glad to aid him” (McAtee, Wade, 1951, p.211).

² In this and other citations of texts from Portuguese, a free translation has been provided.

³ Fred Lowe Soper (1893-1977) began his work at the Rockefeller Foundation in January of 1920, after brief training in parasitology at the Johns Hopkins University. Initially Soper worked in northeastern Brazil, conducting studies and organizing the Rockefeller Foundation’s campaigns against hookworm disease in the states of Pernambuco and Alagoas. In 1921, he was transferred to Rio Grande do Sul to monitor the campaigns against hookworm which were underway in that state. In 1922–1923, he returned to the US for a year of studies in order to obtain his master’s degree in public health from the Johns Hopkins School of Hygiene and Public Health. In 1927, Soper returned to Rio de Janeiro as lead administrator of the regional office, and later organized campaigns against yellow fever and malaria as head of the Cooperative Yellow Fever Service in 1930 and then as the head of the Northeastern Yellow Fever Service in 1939 (The Fred..., s.d.). Between Brazil and Paraguay, Soper lived in South America for roughly twenty years, from 1920 to 1942. Marcos Cueto (2007, p.113) reports that he was known as the “commander” in Brazil because of his discipline and military ethos in his formulation of health campaigns.

⁴ The Northeastern Malaria Service (SMNE), which was created in 1939, replaced the Anti-Malaria Service (Serviço de Obras Contra Malária, SOCM), established in August 1938. The main difference between the two is that the SMNE was exclusively committed to exterminating the mosquito and gave full autonomy

to the Rockefeller Foundation's International Health Division, as the SOCM had no formal agreement with the Brazilian government or the Foundation and was essentially a national service. The thesis by Gláubia Cristiane Arruda Silva (2012) is an excellent resource for understanding the function of this service, which has not been thoroughly explored by the historiography. The SOCM was created as an emergency response, and faced difficulties prioritizing its activities in the states of Rio Grande do Norte and Ceará, with different approaches in these two states. In Ceará, resources were directed towards palliative care for those affected by malaria, and in Rio Grande do Norte research on *A. gambiae* was prioritized; this resulted in the 1939 study by César Pinto entitled *Disseminação da malária pela aviação; biologia do Anopheles gambiae e outros anofelinos do Brasil* (The spread of malaria via aviation: the biology of *Anopheles gambiae* and other Brazilian anophelines).

⁵ Interestingly, Packard reports *A. gambiae* as arriving in 1931 (Packard, 2007, p.91-138), differing from the records left by Shannon, the scientist who discovered this mosquito in Natal in 1930.

⁶ The process addressing the spread and displacement of *A. gambiae* to its eradication is analyzed in my doctoral dissertation, *Anopheles gambiae: do invasor silencioso ao "feroz mosquito africano" no Brasil (1930-1940)* (*Anopheles gambiae: from silent invader to the "ferocious African mosquito" in Brazil*) (Anaya, 2016). This article is based on the first chapter of my dissertation.

⁷ The statement by Packard and Gadelha (1994, p.201) that *A. gambiae*'s original procreation area was the "Apody River" does not line up with the documentary evidence. Shannon's (1932, p.646) report defines this location as the "Potengy River." The river currently known as the Apodi (and mentioned by Packard and Gadelha) is found in the municipality of Areia Branca, in the western region of Rio Grande do Norte's northern coast (approximately 300km from the capital, Natal). The Potengi River, which Shannon cites as the original location where *A. gambiae* was found, can be confirmed by the fact that this river flows into the port of Natal and also harbored seaplanes and ships travelling Dakar-Natal route in 1930.

⁸ In an article published in the newspaper *A Manhã* in 1949, César Ferreira Pinto (1896-1964) is presented for his activities to combat *A. gambiae* in his entomology work for the Anti-Malaria Service. He joined the staff of the Oswaldo Cruz Institute in 1920 and worked "intensively in entomology along with Arthur Neiva" until 1926. Later he assisted Lauro Travassos as chair of parasitology at the São Paulo School of Medicine for three years (César Pinto..., 1949, p.8). He also authored an important 1939 study entitled "Disseminação da malária pela aviação: biologia do *Anopheles gambiae* e outros anofelinos do Brasil" (Dissemination of malaria by aviation: the biology of *Anopheles gambiae* and other Brazilian anophelines).

⁹ After an invitation from Oswaldo Cruz himself on November 1, 1908, Adolpho Lutz (1855-1940) became head the service at the Oswaldo Cruz Institute at age 53, and remained at this institution until his death. Lutz is recognized in fields including bacteriology, parasitology, and epidemiology; he became known for his studies in medical entomology, and is considered one of the founders of this field (Benchimol, Sá, 2006). Lutz also was César Pinto's professor of entomology at Manguinhos.

¹⁰ Ilana Löwy (2006, p.301) states in her historical treatment of this topic, "Vírus, mosquitos e modernidade: a febre amarela no Brasil, entre ciência e política" (Viruses, mosquitoes, and modernity: yellow fever in Brazil, between science and politics), that unlike *Aedes aegypti*, *Anopheles gambiae* "does not reproduce near human dwellings." In a review of records from the period conducted for this article, the mosquito Shannon found in 1930 was classified as optimally suited to reproduce in shallow puddles exposed to the sun, but after the rains was able to reproduce in natural depressions (like holes in trees and crab burrows) as well as artificial containers such as cans and barrels (Shannon, 1932, p.638); it was also "as strongly domestic as *stegomyia* [*Aedes aegypti*]." The most important difference between the two species, in terms of control, was the eggs' ability to resist dehydration, which is much greater in the case of *A. aegypti* (Shannon, 1942, p.5). The domestic nature of *A. gambiae* is described in detail by the British researcher Alwen M. Evans (1938, p.317). Later, starting in 1939 as the mosquito spread to Ceará, Evandro Chagas conducted experiments using insecticide within houses using spray pumps, already considering the domestic habits of mosquitoes (Chagas, 31 dez. 1938). After the mosquito was exterminated from the affected regions, studies by Leônidas Deane, Ottis Causey and Maria Deane (1943, p.180) emphatically asserted that "one of the greatest manifestations of its domesticity is the number of species, both males and females found in human dwellings."

¹¹ Paris green (copper acetoarsenite) was a compound used in the nineteenth century as a pigment, but was later abandoned for this use because of its toxicity. It was mixed with kerosene and applied to areas where mosquitoes bred to kill the larvae. It was also known as emerald green, imperial green, or moss green. It is green, odorless, and sinks and mixes slowly with water. It is poisonous if inhaled or ingested (Pimentel et al., 2006, p.1143).

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