The social production of the zika virus and disease and the vector. A sociopolitical and technoscientific history

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Abstract: Since at least the last four decades, emerging infectious diseases have confronted the theoretical, methodological bases of the Public Health. This article discusses these diseases based on the genesis of the zika virus and disease and the vector. The framework developed for this research is supported by epistemology and history of science combined with the theory of reflexive modernization formulated by Ulrich Beck. The empirical material analysed were scientific articles that produced the "discovery" of zika virus and disease and the vector, as well as scientific material of the sociocultural context in which these articles were produced. These materials were analyzed using the latourian methodological approach of scientific facts construction. The results show that zika virus and disease and the vector are not only natural facts, but they are social and human production, procedeed in Entebbe, Uganda, Africa, in the second quarter of the 20th century, approximately. It was through social processes that the zika virus emerged and became a pathogenic agent. It shows also that, under the assumptions of the reflexivity of modernity, the health field needs to rethink epistemological perspectives regarding infectious diseases, considering them radically as a product of the relations between society and nature, and, thus, permeated by constitutive uncertainties.

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Introduction

This article discusses emerging infectious diseases, more specifically zika, one of the diseases in this group. The assumption, based on the literature on epistemology and history of science, is that the genesis of the zika virus and disease and the vector associated with transmission are not only natural facts in themselves, but result from a social production.

Based on this assumption, the theoretical framework of reflexive modernization formulated by Ulrich Beck is incorporated, and emerging infectious diseases are discussed as a product of social practices, that is, their genesis and transformations resulting not only from natural factors, but also from techno-scientific developments, with unpredictable side effects.

Methodologically, the scientific articles on the "discovery" of the zika virus and disease and the vector were analyzed, as well as other scientific works on the sociocultural context in which these articles were produced. The approach proposed by Latour and Woolgar (1997) on the construction of scientific facts was used, in their macro and microsocial dimensions of constitution and consolidation. In other words, in order to understand the genesis of the zika virus and the zika disease and vector, we sought to analyze the connections between humans and non-humans that shape the elaboration of scientific statements about them.

The articles were identified in the Web of Science database, using the descriptors "zika" and/or "zika virus", between the years 1952 and 2014; from the first publication until the year before the emergence of the Brazilian epidemic outbreak. This article specifically presents the results of the analysis of articles published between 1952 and 1980.[1] The material analyzed regarding the sociocultural context was determined based on the fact that the identification of the zika virus occurred during studies on wild yellow fever, carried out in Africa around the 1930s and 1940s, at the Yellow Fever Research Institute (YFRI) in Uganda. It was therefore considered pertinent to incorporate the research work on yellow fever at the YFRI during this period.[2]

Based on the analysis of these materials, we sought to construct the social genesis of the zika virus and disease and the vector, articulating humans and non-humans, and to discuss emerging infectious diseases in the context of the framework of reflexive modernization.

The installation of technoscience in Uganda and the search for unknown viruses: a non-chance encounter with the zika virus

The experiments that first identified the zika virus were conducted in 1947 at the YFRI in Entebbe, Uganda. The identification was considered a "by-product of yellow fever research" (Dick *et al*., 1953, p. 14), an incident "in the course of studies designed to discover the vector responsible for the non-human [sylvan] cycle of yellow fever in Uganda" (Dick *et al*., 1952b, p. 531).

According to Cummiskey (2017), analyzing the history of the founding of the YRFI, studies of "previously unknown viruses" (p. 46) developed in parallel with studies of sylvan yellow fever and were, for some periods, the focus of scientists.

The author also states that:

> [...] yellow fever was never a clinically recognized problem in Uganda, [and] the demonstration that the Institute could identify and possibly offer some control suggestions for other diseases that caused recognizable morbidity was valuable to the colonial state (Cummiskey, 2017, p. 47).

Dick *et al*. (1952a, 1953) described the identification of ten different viruses between 1937 and 1947, such as the Rift Valley fever virus, the Mengo encephalomyelitis virus, the Bunyamwera virus, the Semliki Forest virus, the zika virus, among others. In other words, the zika virus was yet another virus among those identified through experiments carried out by YFRI scientists. The experiment that identified the zika virus dates back to 1947, but the data were published in 1952 by the East African Virus Research Institute (EAVRI), which was renamed YFRI in 1950 (Cummiskey, 2017).

Research into unknown viruses was part of the context of tropical medicine and used field and laboratory experiments. Theoretical-empirical approaches to tropical medicine emerged at the end of the 19th century, in a combination of "warm climate medicine" (geoclimatic determinism) and "pasteurian sciences" (science of microbes), aiming not only at the occupation of the so-called New World, since so-called "tropical" diseases were considered an obstacle to colonization and international trade, but also at the advancement of experimental and field medical sciences (Löwy, 2006).

With the improvement of the sciences of microbes, the development of experimental and laboratory techniques, and the description of diseases transmitted by vectors in warm regions, the tropics became, for scientists in the Old World, a unique place for scientific practice, for testing forms of prevention and treatment, and "for hunting microbes" (Löwy, 2006, p. 38). For the Old World, the tropics contained characteristics of an unhealthy and inhospitable environment; of a threatening nature, infested with diseases, to be controlled by scientific knowledge (Caponi, 2002). And, at the same time, a fertile and available environment for scientific progress, its experiments, manipulations and observations. Within these concepts, European medical-scientific institutions of tropical medicine were spread to Asia, Africa and South America (Löwy, 2006).

One of these centers was the YFRI, installed in Entebbe, Uganda, Africa, intended, at its foundation, for research on wild yellow fever. According to Tilley (2011), in the region of Uganda, the installation of these institutions developed mainly under English guidelines, in the conjunction of interests between the Royal Society, the London School of Tropical Medicine and British colonial administrative authorities. For the author, the problems of the European colonial authorities were:

> [...] how to pacify populations and deal with resistance, slavery and labor issues; how to incorporate populations and land into new [capitalist] modes of production, how to develop state infrastructures, how to contain epidemics, control diseases and improve health. (Tilley, 2011, p.16).

In short, the issue was to modernize (westernize) the African population and its territory.

Aiming to deal with such problems, a change in British colonial political and economic guidelines was implemented in Tropical Africa between 1929 and 1930, and a new format of colonial medical-scientific program began to be developed within the scope of a comprehensive development and modernization project. The idea of this project is expressed in the phrase taken from the opening speech of the Pan-African Congress of Agriculture and Veterinary Medicine and the International Geological Congress, given in 1929: "'What can Africa provide to science?'...'What can science provide to Africa?'" (Hofmeyr, 1929 *apud* Tilley, 2011, p. 2-3).

This project was instituted through the *African Research Survey*, a study carried out between 1929 and 1939 that aimed to establish new standards for colonial policies through the production of scientific knowledge. In general terms, its main objective was the systematic and broad use of the African continent on several research fronts, as an open-air laboratory with no restrictions to drive techno-scientific progress (Tilley, 2011).

Medical-scientific research began to focus on direct interventions on humans, non-humans and their environments; in short, the production of knowledge about African populations and their living conditions, their environment and their bodies. They focused on field research, using the environment as a “natural laboratory”, “(...) the only possible laboratory for the epidemiological monitoring of communicable diseases” (Frost *apud* Löwy, 2006, p. 170).

In order to implement this project, colonial administrative practices and intervention methods in African territories began to be implemented with greater dynamism and systematicity. Many European scientists and technicians settled in Tropical Africa to structure a set of specialized services in the most diverse areas – infrastructure, research, agriculture, medicine – to provide support for the installation and development of this modernization project.

Analyzing the project's planning documents, Bonneuil (2000) showed that the layout and organization of the places to be built combined a city project, in the European model, with experimental units. Spaces and populations were rearranged; areas were to remain uninhabited, others were to be populated, and others were to be evacuated; populations were to be displaced, others were to be grouped together; dry areas were to be irrigated for the implementation of monocultures. Dams, highways, houses, wells, and bridges were also to be built; lands were to be divided and surveyed; river courses were to be altered, all in accordance with the:

> […] technocratic settlement and resettlement schemes, based on geometrization, simplification, standardization and discipline […] to guarantee not only the social order […], but the experimental order necessary for the production of specialized knowledge (Bonneuil, 2000, p. 271).

In this scenario, YFRI, its laboratories and research structures, focused on the environment, which should be transformed into an object and place of research. Scientists should produce the environment for research, and experimental science would even serve as an instrument for the development of the African continent, making it a “living laboratory”[3] (Tilley, 2011, p. 5).

Cummiskey (2017) reported that the YFRI installation “was not simply natural and of static quality. The Institute actively constructed the places where it researched, to maximize its capacity to produce knowledge that would be valuable outside Uganda” (p. 10). The more universal the space, the more universalizable could be the knowledge produced. Uganda, its environments, its humans and non-humans were thus transformed into objects of research, in order to "observe African bodies and extract biological specimens from the African population" (Cummiskey, 2017, p. 43).

In addition to doctors, bacteriologists, entomologists and epidemiologists considered experts in yellow fever, mice, monkeys and a park of equipment were also sent to build a cutting-edge laboratory infrastructure at the time (Cummiskey, 2017).

During the research, people from native communities in the region were recruited to work at YFRI as messengers, drivers, clerks, attendants and caretakers of the experimental colonies of mice and monkeys, named "laboratory assistants", "temperature scouts" – Africans who measured the temperature of the experimental animals – and "mosquito-boys" – mosquito hunters for the experiments (Cummiskey, 2017, p. 83).

Cummiskey (2017) reported that, given the failure of the search for the wild yellow fever virus, the Bwamba region, in Uganda, was chosen for a "large-scale ecological experiment" (p. 64). This was a region of dense forest, inhabited by several African communities and sporadically visited by Europeans.

The experiment consisted of distributing experimental Rhesus monkeys caged on platforms installed in the treetops of various locations in Bwamba, with the purpose of using these animals as sentinels, that is, "indicative sensors" of virus circulation. Thus, the experimental monkeys could be constantly observed, and if they developed a fever or died, it would indicate to the scientists that a virus was circulating in that region. In this way, the scientists believed they could identify a disease outbreak in real time, when it manifested in an experimental monkey, and not only in retrospect, as happened with the application of immunological tests to identify antibodies (Cummiskey, 2017).

The Rhesus monkeys used were native to South and Southeast Asia, bred and domesticated since the late 1920s for use as experimental models to predict yellow fever infection. Scientists believed that these monkeys developed fevers and pathological symptoms similar to those of humans when infected by viruses; unlike other animals, such as other species of monkeys and guinea pigs.

As mentioned, in parallel with the research on yellow fever, research was carried out to search for unknown viruses. During Bwamba's experiments, one of the Rhesus monkeys, named 766, fell ill. Its serum was removed and injected intracerebral into experimental mice that also fell ill, which indicated to scientists that Rhesus monkey 766 was infected with a virus, which was named zika in reference to the zika forest where the monkey was located. Thus, Dick *et al.* (1952a) stated that a "filterable transmissible agent" had been identified (p. 510).

It can be inferred that the "discovery" of the zika virus is a historical-scientific-experimental process that occurred in the context of the modernization of Tropical Africa, which would occur through the production and use of techno-scientific knowledge, among others, that related to tropical diseases and their agents located in "wild" nature. Therefore, it was a non-occasional encounter with the zika virus, unlike what is stated in the articles as the "occasional discovery during research on yellow fever". The experiments were designed and applied so that scientists could identify unknown viruses. It is in this sense that it can be said that there was a production of the zika virus through social practices, which are also scientific, technological and political, inscribed in a certain time and space.

Producing a zika virus infection in humans. The socio-scientific genealogy of the infection.

Dick *et al.* (1952a; 1952b), respectively the first and second articles published on the zika virus, mentioned that there could be zika virus infection in humans due to positive serological experiments. "(...) it seems likely that humans have come into contact with the virus [zika], based on the demonstration of specific antibodies in high titers" (...) (Dick *et al.*, 1952b, p. 532).

This doubt about human infection by the zika virus became the guiding principle for experimental studies published after the identification of the zika virus, until zika disease was "found" (actually produced) in humans.

MacNamara (1954) reported a case of zika virus infection in a 10-year-old girl. The previous suspicion was that the yellow fever virus infected her, but this was rejected after the experiments. In these experiments, the girl's serum was first removed and injected intracerebrally into an experimental mouse that became ill. Then, "the mouse brain virus [the virus suspected of infecting the girl] [...] was subjected to neutralization tests using sera from Rhesus monkeys [considered] immune to various viruses" (p.141); bunyamwera virus, bwamba virus, mengo virus, ntaya virus, west nile virus, zika virus, among others. These tests consisted of injecting a mouse with the mixture of 'mouse brain virus', together with the solution obtained from the experiments with Rhesus monkeys. If the mouse did not become ill, it indicated to the scientists that the girl's serum contained the virus that was neutralized by the antibodies in the solution. This happened, according to the author, for the zika virus.[4]

Eager to "explore fully the results of zika infection" (Bearcroft, 1956, p. 442), the injection of the zika virus into a human volunteer was reported. The injected material was obtained by infecting a mouse with the serum of the 10-year-old girl from the experiment described by Macnamara (1954). The volunteer presented symptoms of low-grade fever, headache, malaise, nausea and dizziness, which ended a week later.

Another case of zika virus in humans was recorded by Simpson (1964), author of the article and a scientist at EAVRI who became infected with the zika virus, presenting symptoms of low-grade fever and rash. It was not clear whether he had become infected during field work, through a laboratory accident, or intentionally, by infecting himself. Similarly, Filipe (Filipe *et al.,* 1973) reported his accidental infection with the zika virus during laboratory work. The scientist presented fever, back pain and sweating for about a week. These were therefore the first cases of zika disease recorded in the literature. From the publications that followed, the zika virus became the causative agent of a disease in humans, zika disease.

It has been found that human infection by the zika virus, more specifically, the relationship between a clinical symptom picture in humans and infection by the zika virus, arises from cases obtained and/or induced experimentally. In other words, the identification of the cases occurred through a set of experimental procedures, in which techniques and knowledge obtained from previous practices were used, specifically, those that led to the production of the zika virus, for example, the techniques for producing zika virus solutions and antibodies against the zika virus, both obtained from experiments with Rhesus monkeys.

Thus, the cases were produced by injections of animal serum into humans, injections of human serum into animals and by mixing these serums with other solutions produced from experiments similar to those for the production of the zika virus. zika disease thus arises from a set of experimental scientific practices of manipulation of humans and non-humans.

Producing a vector for zika disease. Multiple interspecies arrangements.

Dick *et al.* (1952a; 1952b; 1953) identified the mosquito species Aedes africanus as the transmitter of the zika virus, because it was the most frequently captured for experiments and also because the zika virus had been identified in it during experiments with mice and Rhesus monkeys.

To identify the virus in mosquitoes, they were first captured in large quantities and then frozen, crushed, centrifuged and filtered, obtaining the solution to be injected into the experimental animals. However, doubts remained:

> [...] although the zika virus was isolated from A. africanus, it is quite possible that A. africanus is not a vector for this virus [...] because the monkey from which the zika virus was isolated was caged at the time of virus isolation in a type of cage that A. africanus does not enter (Dick *et al*., 1953, p. 20).

In order to identify which species would be the vector of zika infection, numerous experiments were carried out. Bearcroft (1956) reported the injection of the zika virus into a human volunteer, with the solution obtained from the intracerebral injection of a mouse with the serum of the girl from MacNamara's experiments (1954). Afterwards, the volunteer's arm was exposed to bites from mosquitoes of the species *Aedes aegypti*, and those potentially infected were placed in contact with mice, to see if the mosquitoes could infect them, which was not verified, since there were no signs of illness in the mice.

According to Boorman (1956), it was necessary to infect experimental *A. aegypti* mosquitoes with the zika virus – through insects cultivated in laboratories –, since there was not a sufficient supply of wild *A. africanus* mosquitoes for the experiments. The author reported procedures for this new technique of experimental mosquito infection, which consisted of using a membrane made from mouse skin to feed *A. aegypti* mosquitoes with blood containing the zika virus.

Weinbren (1958) and Haddow *et al.* (1964) reported experiments with A. africanus mosquitoes collected in the Lunyo and zika forests, respectively, for the analysis of the presence of the zika virus. In both collections, antibodies against the zika virus were recorded, using solutions with zika virus produced in experiments with Rhesus monkeys and experimental mice.

Lee (1972) reported similar experimental procedures, using mosquitoes of different species and different viral types. The zika virus was identified in the species *Aedes luteocephalus*.

Renaudet *et al.* reported, in seroepidemiological investigations carried out in Senegal, that the species *A. luteocephalus* and *A. (D) furcifer taylori* group were the vectors of zika virus infection in humans in Senegal. In another seroepidemiological investigation, it was mentioned that *A. africanus* seemed to be the main transmitter of the zika virus to humans in a community in Nigeria, but that the species *A. luteocephalus* and *A. aegypti* could have some role in the transmission (Fagbami, 1979).

There is thus a plurality of possibilities in the relationships between humans, the zika virus and the vectors, which are experienced depending on scientific practices, together with the different species of mosquitoes collected and handled. Several species of mosquito were considered as potential vectors of zika virus transmission, although the *Aedes* genus prevailed in the experiments. These relationships suggest that there are unlimited arrangements that make up the interrelations between human and non-human beings, and that articulate socio-scientific practices and the elements of nature.

The social production of the natural: a pathogenic virus, a disease and a vector

What is found, mainly, in the introductions of scientific articles on zika, in health manuals and in quick searches on this topic is that the zika virus was isolated from a sentinel Rhesus monkey in the zika Forest, Uganda, in 1947, causes zika disease and is transmitted by mosquitoes of the *Aedes* genus (Wikan, 2016). According to the statements, it is assumed that the virus inhabited the environment and, suddenly, began to infect humans and cause them a disease and that science identified, almost 'suddenly' that virus, the corresponding disease and the transmission vector. From this perspective, it was up to science to separate, in nature, that which could threaten humans.

However, it was found from the articles analyzed that behind these statements there are social practices – political, scientific, economic – that took place in Entebbe, Uganda, dating back to the second quarter of the 20th century, and that such practices constituted the genesis of the zika virus and disease and the vector. From certain economic-political and theoretical-epistemological perspectives, forged in the colony-metropolis relationship, a certain form of colonization of Tropical Africa by the Old World was established, supported by the conception that the African territory and its populations were deficient in health and available for knowledge production.

A form of knowledge production based on laboratory and field experiments predominated, using the environment and human and non-human beings. This type of research was valid in the production of knowledge to unveil nature and its diseases, which are called tropical because they relate to the environment of the tropics—its climate, relief, and beings.

The selection of these scientific objects was made within colonial relations, unfolding in socio-scientific practices, such as the unrestricted collection of human and non-human specimens for these experiments, the use of African populations as labor and/or guinea pigs in research, the use of the forest for experimentation, etc. Through these practices, a virus became a pathogenic agent and was given the name zika; infection by this virus became a disease, zika, with mosquitoes of the *Aedes* genus as its vector. There was a socially produced nature.

The social production of infectious diseases in the uncertainties of the society-nature relationship

Based on the social production of the zika virus and disease and the vector, the phenomenon of emerging infectious diseases is discussed, with zika being one of them. This term was coined in the 1990s, marked by the HIV epidemic, designating a new moment of infectious diseases with the emergence of previously unknown symptomatic and pathophysiological conditions, the resurgence of old diseases considered under control, the resurgence and/or increase in the incidence of other diseases and/or the emergence of diseases caused by infectious agents of other species only (Luna, 2002; Snowden, 2008).

This new era is associated with factors such as increased population mobility through travel and migration, urbanization and modernization, manipulation of microorganisms, for example, to create biological weapons, expansion of health service coverage and the incorporation of new technologies for diagnosing and treating diseases (Luna, 2002). In short, factors linked to the transformations of social practices resulting from technological and scientific advances.

This link is exemplified by the emergence of avian and swine flu described by Wallace (2020). Crossing phylogeographic data on influenza with aspects of global economic geography, the author explains the role of increased production and global distribution of industrial livestock for human consumption in the production of new pathogens and diseases. The expansion of mechanized poultry and swine mono-livestock farming to various regions of the Global South[5], due to low labor and land costs, little regulation and large subsidies, created sociogenetic conditions, in the author's terms, for the emergence of recombinant viruses capable of producing zoonotic jumps between species and new diseases.

Another example can be found in Snowden (2008), in the relationship between biomedical technological and scientific advances and the emergence of diseases:

> By prolonging life, medicine is creating an increasing number of elderly people with compromised immune systems. [...] In addition, these people are often concentrated in environments where body-to-body transmission of microbes is amplified, such as hospitals, nursing homes, and prisons. The proliferation of invasive procedures has also increased the opportunities for such diseases [emerging infectious diseases] (Snowden, 2008, p. 16).

These examples make explicit the anthropogenic character and, one could say, with Beck (1997, 2011), the adverse effects of techno-scientific advances and modernization on the emergence of infectious diseases. According to Beck (1997, 2011), the current stage of the modernization process is reflexive, in which what is on the agenda is the confrontation with the risks generated in the previous stage of modernization, called by the author the first modernity. In this stage, techno-scientific development was credited with greater security and control over nature, or even greater protection of individuals and populations against the vulnerability in which they found themselves in pre-modern times (Beck, 2011, Ianni, 2018). Beck (1997, 2011) notes that in the course of modernization, together with its successes, there was a proliferation of risks produced in and by techno-scientific[6] development (Beck, 2011, Ianni, 2018). The reflexivity of the current phase of the modernization process, according to Beck (1997), means self-confrontation and unpredictable side effects.

In the field of health[7], Ianni (2018) identifies in Illich (1975) and Berlinguer (1978), classic authors in the field of health, this articulation between transformations of social practices (biomedical) and the emergence of diseases. For Illich (1975), while on the one hand biomedical advances proved effective against certain diseases, on the other they generated iatrogenesis. Berlinguer (1978) described changes in the nosological scenario in which there was a shift from the predominance of physiogenic diseases – resulting from physical-chemical, dietary and biological factors – to anthropogenic diseases, "diseases created, stimulated and reinforced by human intervention" (p. 105).

Thus, it is considered that emerging infectious diseases should be understood within the transformations of social practices, in the context of reflexive modernization. This implies, more specifically, taking into account the unpredictable adverse effects of the transformations in social practices resulting from technological and scientific advances, which are clearly linked to the transformations in the interrelationships between beings. So to speak, it implies understanding infectious diseases in the articulation between society and nature.

The health field, aware of this articulation, has historically sought explanatory models and key concepts that mediate between the natural and social dimensions of the illness of populations, such as the model of the natural history of disease or the concept of social determination of the health-disease process. However, as Ianni (2018) notes, these concepts kept the natural and social dimensions of illness separate, each being treated by its specific set of disciplines, the natural/biological being the responsibility of the natural sciences; and the social being the responsibility of the social sciences, disregarding the socially constructed natural (Ianni, 2018). Transplants; prostheses; antimicrobial, oncological, immunotherapeutic drugs, among others; viruses, bacteria, genetically modified insects and animals, etc..., social practices and products that shape and transform the bodies of humans and non-humans, that transform the natural, the social and their interrelations (Ianni, 2018).

In this sense, one can identify in the genesis of the zika virus and disease and the vector one of the aspects of what Ianni (2018) points out, a nature that was socially produced by social and scientific practices in a certain time and space/environment. The zika virus became pathogenic to humans under certain technoscientific, social, political, economic and also biological conditions. The latter are another aspect that should be highlighted. The social and scientific practices undertaken in Entebbe, as a consequence of colonial policies, produced transformations in the interrelations between beings and between these and their environment. For example, many humans and non-humans[8] were brought to Entebbe; mice, monkeys and, along with them, microorganisms, "entities endowed with size, weight and mass" (Crosby, 2011, p. 205). In addition, local humans and non-humans were recruited for experimental work and to support the experiments; the forest, with its countless beings, was used as an experimental laboratory. Along with the introduction of scientific research in Entebbe, and through it, a new mode of social production and reproduction of nature was instituted, giving rise to new relationships between humans, non-humans and their environments, new interspecies relationships. What new relationships? How did the microorganisms that inhabited the experimental monkeys interact with those that inhabited the other beings in that environment? Or, can laboratory experiments interfere with the virulence and pathogenicity of viruses outside the laboratory? Do the processes of manipulating beings, described in the experiments, produce permanent forms of interspecies relationships?

These questions are at the heart of the transformations that humans have been imposing on "nature", and in the stage of reflexive modernization, "a new stage of society in which progress can turn into self-destruction (...)" (Ianni, 2018, p. 254), they seem to confront the dynamics of infectious diseases. However, it is important to consider that these are complex questions that cannot be answered with unequivocal answers, since there are dimensions of chance in natural processes that cannot be grasped by technoscience.

It is worth revisiting a basic biological premise: "[…] the immune system of individuals is adjusted to the part of the world to which they belong […]" (Crosby, 2011, p.44). Thus, exposing individuals to microscopic beings that are not familiar to them can cause epidemics. Diseases from the Old World such as smallpox, measles, yellow fever, dengue fever and many others decimated huge populations in the New World. The opposite also occurred, and, according to the author, this was one of the reasons for the successful expansion of humans from the Old World to the New World, through biological hybridization. Non-humans (animals, plants and microorganisms) that traveled and settled in the New World, together with humans, provided, on numerous occasions, adaptive advantages to them (Crosby, 2011).

Beings are constituted through interrelations. Microorganisms and their hosts, human and non-human, transform each other, co-evolve through different biological mechanisms, and may (or may not) generate other diseases (Forattini, 2001).

Modern biological thought is based on the Darwinian conception of the evolution of species that separates natural selection – the long-term selection resulting from the dispute between beings for resources to keep them alive, without intention or agent – and artificial selection – carried out by humans, in the manipulation of beings with a certain intention, but without full knowledge of the product of this manipulation (Pimenta, 2019). Social practices in reflexive modernity contradict the Darwinian separation. "[...] the evolution of species, their survival and diversification, must be rethought, now as not only "biological" processes, but naturally cultural ones." (Ianni, 2018, p. 253). Natural and artificial overlap on different scales of time and space in an integrated and complex dynamic of co-evolutionary dependencies between beings in their environments, generating uncertain and unpredictable products (results and/or beings). It is not possible to know in advance exactly what will be produced, for example, with the use of genetically modified mosquitoes to control Aedes. How will this being created in a laboratory interact with other species? What type of microorganisms might it be susceptible to? The processes analyzed in a compartmentalized way by science find processes that are not compartmentalized by the life of beings in the environment; natural and artificial selection occur in mutual constitution.

It is necessary to assume, therefore, that there is a permanent uncertainty that governs the processes concerning the human manipulation of nature and that provides opportunities and, one might say, even guarantees, unexpected results.

The process of social production of the zika virus and disease and the vector raises an alert about laboratory practices and procedures, their products and side effects. What is done in the laboratory, the mixtures of human beings with non-humans, together with various solutions created in the laboratory, cannot imitate life in the environment. The interrelations that can occur are unquantifiable in their entirety, since their scope in time, space and bodies cannot be measured. Paraphrasing Lewontin (1991), we have become so accustomed to understanding scientific experiments as mimesis of what would happen in nature that we forget that what happens in the laboratory is a mimesis, not the being in the world.

Therefore, confronting infectious diseases in the context of modernization requires new epistemological perspectives, among them understanding "natural things" from within "social things" and considering the production of uncertainties concerning the society-nature relationship. As Wallace (2020) states, analyzing the emergence of avian and swine flu, "the dynamics of pathogens generally arise from a multitude of causes, which interact on various time scales and in different biocultural domains" (p. 29). The time of the evolutionary and adaptive processes of beings varies enormously and depends on the environment in which they occur.

It is not possible to understand the relationships between viruses and humans exclusively in terms of morphological, molecular and laboratory characteristics. Political, economic, social and techno-scientific processes must be included in the analyses. The reflexivity of modernity imposes this challenge on the health field: to consider infectious diseases, radically, as what they have always been, a product of the relationships between society and nature.[9]

References

BECK, U. A reinvenção da política: rumo a uma teoria da modernização reflexiva. *In:* Beck, U.; GIDDENS, A.; LASH, S. *Modernização Reflexiva: política, tradição e estética na ordem social moderna*. São Paulo: Editora da UNESP, 1977. p. 11-71.

BECK, U. *Sociedade de risco*: rumo a uma outra modernidade. São Paulo: Editora 34; 2011.

Bearcroft, W. G. Zika virus infection experimentally induced in a human volunteer. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, v. 50, n. 5, p. 442-8, 1956.

BERLINGUER, G. *Medicina e política*. São Paulo: CEBES Hucitec, 1978.

BONNEUIL, C. Development as experiment: Science and State Building in Late Colonial and Post Colonial Africa, 1930-1970. In: Roy Macleod (editor). *Nature and Empire: Science and the Colonial Enterprise*. Editora: University of Chicago Press Journals, 2000, p. 258-281.

BOORMAN, J. P. T.; PORTERFIELD, J. S. A simple technique for infection of mosquitoes with viruses transmission of zika virus. *Transactions of The Royal Society of Tropical Medicine and Hygiene*, v. 50, n. 3, p. 238-242, 1956.

CAPONI, S. Trópicos, microbios y vectores. *História, Ciência e Saúde-Manguinhos*. Rio de Janeiro, v. 9, n. 11, p. 111-138, 2002. Available at: https://www.scielo.br/j/hcsm/a/ZSChh5NS5QYLkRVHw77rYHt/?format=pdf&lang=es

CROSBY, A. W. *Imperialismo ecológico:* a expansão biológica da Europa 900-1900. São Paulo: Companhia das Letras, 2011.

CUMMINSKEY, J. R. *Placing Global Science in Africa: International Networks, Local Places, and Virus Research in Uganda, 1936-2000*. 2017. Tesis (Doutorado em História da Medicina) - School of Medicine, Johns Hopkins University, Baltimore, 2017.

DICK, G. W. A.; KITCHEN, S. F.; HADDOW, A. J. Zika virus I. Isolations and serological specificity. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, v. 46, n. 5, p. 509-520, 1952a.

DICK, G. W. A.; KITCHEN, S. F.; HADDOW, A. J. Zika virus. II. Pathogenicity and physical properties. *Transactions of the Royal Society of Tropical Medicine and Hygiene,* v. 46, n. 5, p. 521-534, 1952b.

DICK, G. W. A. Epidemiological notes on some viruses isolated in Uganda; Yellow fever, Rift Valley fever, Bwamba fever, West Nile, Mengo, Semliki forest, Bunyamwera, Ntaya, Uganda S and Zika viruses. *Ordinary meeting of the royal society of tropical medicine and hygiene*, p. 13-48, 1953.

FAGBAMI, A. H. zika virus infections in Nigeria: virological and seroepidemiological investigations in Oyo State. *The Journal of Hygiene*, v. 83, n. 2, p. 213-219, 1979.

FILIPE, A. R. *et al*. Laboratory infection with zika virus after vaccination against yellow fever. *Arch für die gesamte virusforsch*, v. 43, n. 4 p. 315-319, 1973.

FORATTINI, O. P. O pensamento epidemiológico evolutivo sobre as infecções. *Revista Saúde Pública*, v. 36, n.3, p.257-62, 2001.

HADDOW, A. J. *et al*. Twelve isolations of zika virus from *Aedes* (stegomyia) africanus (theobald) taken in and above a Uganda forest. *Bulletin of the World Health Organization*, v. 31, n. 1, p. 57-69,1964.

IANNI, A. M. Z. *Mudanças sociais contemporâneas e saúde*: estudo sobre a teoria social e saúde pública no Brasil. São Paulo: Hucitec, 2018.

ILLICH, I. *A expropriação da saúde*. Nêmesis da Medicina. 3.ed. Editora: Nova Fronteira, 1975.

LATOUR, B.; WOOLGAR, S. *A vida de laboratório.* A produção de fatos científicos. Rio de Janeiro: Relume Dumará, 1997.

LEE, V. H.; MOORE, D. L. Vectors of the 1969 yellow fever epidemic on the Jos Plateau, Nigeria. *Bulletin of the World Health Organization*, v. 46, p. 5, p. 669-73, 1972.

LEWONTIN, R. C. *Biology as Ideology*: The doctrine of DNA. Harper Perennial, 1993.

LÖWY, I. *Vírus, mosquitos e modernidade*: a febre amarela no Brasil entre ciência e política [online]. Rio de Janeiro: Editora Fiocruz, 2006. Available at: https://static.scielo.org/scielobooks/7h7yn/pdf/lowy-9788575412398.pdf

LUNA, E. J. A. A emergência das doenças emergentes e as doenças infecciosas emergentes e reemergentes no Brasil. *Revista Brasileira de Epidemiologia*, v. 5, n. 3, p. 229-243, 2002. Available at: https://www.scielo.br/j/rbepid/a/m9MYsBMfVB4zTkdJ3tBx9SG/?format=pdf&lang=pt

MACNAMARA, F. zika virus: A report on three cases of human infection during an epidemic of jaundice in Nigeria. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, v. 48, n. 2, p. 139-145, 1954.

PIMENTA, P. P. *Darwin e a seleção natural*: uma história filosófica. São Paulo: Edições 70 e Discurso Editorial, 2019.

RENAUDET, J. *et al.* Enquête sérologique pour les arbovirus dans la population humaine du sénégal. *Bulletin de la Societé de Pathologie Exotique et des ses Filiales*, v. 71, n.2, p. 131-140, 1978.

SIMPSON, D. I. H. zika virus infection in man. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, v. 58, n. 4, 1964.

SNOWDEN, F. M. Emerging and reemerging diseases: a historical perspective. *Immunological Reviews*, v. 225, n. 1, p. 9-26, 2008. Available at: https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1600-065X.2008.00677.x

TILLEY, H. *Africa as a living laboratory*. Empire, development and the problem of scientific knowledge, 1870-1950. The University of Chicago Press, 2011.

WALLACE, R. *Pandemia e Agronegócio*. Doenças infecciosas, capitalismo e ciência. São Paulo: Editora Elefante, 2020.

WEINBREN, M. P.; WILLIAMS, M. C. zika virus: Further isolations in the zika area, and some studies on the strains isolated. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, v. 52, n. 3, p. 263-268, 1958.

WIKAN, N.; SMITH, D. R. zika virus: history of a newly emerging arbovirus. *Lancet Infectious Diseases,* v. 16, n. 7, p. 119-126, 2016. Available at: https://www.thelancet.com/action/showPdf?pii=S1473-3099%2816%2930010-X

Notes

[1] In the Web of Science database, 68 articles published between 1952 and 2014 were found using the descriptors 'zika' and 'zika virus'. Of these, 53 articles were selected that had the virus and zika disease as their central theme. The articles were periodized according to a temporal logic related to the themes: 1st period, from 1952 to 1980, the articles predominantly dealt with experimental studies with zika virus; 2nd period, from 1980 to 2007, studies of populations infected by the zika virus and/or zika patients; and 3rd period, from 2007 to 2014, records of cases and epidemics of zika disease in various regions of the world. This text addresses the analyses related to the 1st period.

[2] From this selection the following materials were obtained: Bonneuil (2000); Cummiskey (2017) and Tilley (2011).

[3] The idea of Africa as a living laboratory is mentioned in the 1938 African Survey document: "Africa presents itself as a living laboratory, in which the reward of study may prove to be not merely the satisfaction of an intellectual impulse, but an effective addition of well-being to the lives of the people" (Tilley, 2011, p.5).

[4] The experiments carried out, in general, consist of identifying the presence of the zika virus indirectly, through the laboratory identification of antigens and/or antibodies in serum samples from humans or non- humans.

[5] Term that refers to both the third world and the group of developing countries.

[6] Beck (2011, 1997) does not use the term technoscience, but considering the reflexivity of modernity in Beck, it can be understood as a result of the transformations of modern industrial society.

[7] The health field refers to a set of public and private institutions, policies and practices aimed at health, both at the level of care and research, in its various disciplines and branches.

[8] Tilley (2011) uses the term "scientific diaspora" to designate the large number of scientists and other professionals who migrated to Tropical Africa during the period of the African Survey.

[9] L. G. Moura: conception, execution of the research and, writing of the manuscript. A. M. Z. Ianni: research guidance and manuscript review.

Resumo

A produção social do vírus e da doença zika. Uma história sociopolítica e tecnocientífica

Desde pelo menos as últimas quatro décadas, as doenças infecciosas emergentes confrontam as bases teórico-metodológicas da Saúde Pública. Este artigo discute essas doenças a partir da gênese do vírus e da doença zika e do vetor. Parte-se dos pressupostos da epistemologia e história da ciência, conjuntamente com o referencial teórico da modernização reflexiva formulado por Ulrich Beck. O material analisado foram artigos científicos que produziram a "descoberta" do vírus e da doença zika e do vetor, bem como outros trabalhos científicos sobre o contexto sociocultural de produção desses artigos. Esses materiais foram analisados através do enfoque metodológico latouriano de construção dos fatos científicos. Os resultados evidenciam que o vírus e a doença zika e o vetor não são apenas fatos em si naturais, mas decorrem de uma produção social, humana, circunstanciada em Entebbe, Uganda, África, e datada, aproximadamente, do segundo quartel do século XX. Por meio de processos sociais que o vírus zika emergiu e se tornou um agente patogênico. Evidencia-se ainda que, sob pressupostos da reflexividade da modernidade, ao campo da saúde se impõe repensar as perspectivas epistemológicas frente às doenças infecciosas, considerando-as, radicalmente, como produto das relações entre sociedade e natureza, e, assim, permeadas por incertezas constitutivas.

➤ **Palavras-chave:** Doenças Infecciosas Emergentes. Zika. Saúde Pública. Natureza e Sociedade.