Vectors of Health:
Epidemics, Ecologies, and the Reinvention of Mosquito Science in Brazil

by

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Abstract:

The *Aedes aegypti* mosquito can be a disease vector, transmitting pathogenic viruses that are harmful to human health, such as Zika, dengue, chikungunya, and yellow fever. Since the early 20th century, this insect has been the focus of scientific research and public health campaigns, framed as a conveyor of death and targeted as a winged enemy to be destroyed. This species continues to be a serious concern; in Brazil, the *A. aegypti* is a persistent presence in urban landscapes, with disease outbreaks an almost expected public health issue.

This dissertation ethnographically investigates three groups proposing novel solutions to manage this multispecies interaction. All three projects aimed to instrumentalize the *A. aegypti*, harnessing the insect in the very efforts to address the viruses it can transmit. The proponents of these projects argued that their strategies worked *with* these insects. In Rio de Janeiro, a group infected the *A. aegypti* with a bacterium called *Wolbachia*, a microbe that can inhibit viral transmission. In Recife, a group sterilized male mosquitoes through irradiation, releasing these insects to mate with wild ones on the island of Fernando de Noronha and prevent future *A. aegypti* generations. The third group, in Foz do Iguaçu, made use of the mosquitoes' need for blood to mature eggs and preference for biting humans in order to entrap these insects; captured mosquitoes were then transformed into sentinels, mapping the insect's presence, distribution, and status as a vector.

Here, I show that in these bio-technoscientific projects the goal was not simply to transform the *A. aegypti* from a vector of pathogenic viruses into a *vector of health* that could embody the solution to mosquito-borne diseases. I also argue that my interlocutors themselves aimed to become *vectors of health* who inverted the usual direction of knowledge production, globally, nationally, and administratively. In this case, these mosquito projects were expected to give the science produced from their particular positionality (Global South; Northeast of Brazil; and a public health center) deserved recognition, even amid austerity measures and budget cuts that threaten research and health policies. In addition, I demonstrate that these projects are situated within Brazil's long history of instrumentalizing mosquitoes to make scientific and political claims.

Overall, my research shows that national ideologies of belonging are intertwined with modes of knowledge and power that shape relations between humans, and between humans, mosquitoes, and microbes. What, I ask, are the different geopolitics of knowledge production and health practices that drive efforts to address mosquito-borne diseases? What kinds of multispecies arrangements emerge in these racialized, political ecologies? How are the histories and imaginaries of Brazilian science reinscribed or transformed through these initiatives?

Based on two years of multi-sited ethnographic research as well as qualitative interviews, document analysis, and archival research, this dissertation shows that mosquitoes are not only historical, social actors that can reconfigure politics and the production of knowledge, but that the *A. aegypti* species in particular has come to embody both the legacies and possibilities of Brazilian science. And by thinking with, and alongside, my interlocutors, historical actors, and even the *A. aegypti* species itself, I reveal the politics and possibilities of pursuing scientific research and public health interventions in Brazil.

Thesis Supervisor: Stefan Helmreich
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Às mulheres Reis,
Por serem meu chão e meu horizonte.
Und an Philipp,
Der immer an meiner Seite steht.

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ACKNOWLEDGMENTS

This dissertation was written during a deadly pandemic. Even worse, during most of my writing the presidents of both my countries—Brazil and the United States—were actively disrupting efforts to mitigate the coronavirus' transmission, worsening an epidemiological situation that has disproportionately affected Indigenous, Black, and other marginalized communities. I state this not simply to situate my Ph.D. in a historical moment; I do it because finishing this dissertation required me to continue working, numbed in the face of unprecedented death and devastation. Thus, I would like to open these acknowledgments by humbly paying my respects to those who have lost their lives and to those who have lost their loved ones: the hundreds of thousands who have left this world, not because of a virus, but because of negligent and incompetent governments.

It might already be commonplace to say that academic work is a collective endeavor but that is certainly the case here. First and foremost, my sincere gratitude for my "interlocutors." Some have become close friends, while others I have only talked to for half an hour; but I am forever indebted to all for sharing their time, their stories, and their knowledge. As this dissertation discusses, conducting research requires financial support. My extensive fieldwork research in Brazil was funded by an International Dissertation Research Fellowship from the Social Science Research Council; a Doctoral Dissertation Research Improvement Grant (BCS-1823376) from the National Science Foundation—Cultural Anthropology Program; and a Dissertation Fieldwork Grant (Gr. 9677) from the Wenner-Gren Foundation. At MIT, I am grateful for the financial support of the Martin Family Society of Fellows for Sustainability; the Center for International Studies (CIS); and the International Science and Technology Initiatives (MISTI). In addition, Mr. Raj Tahil's donation to the HASTS program funded my writing during the summer of 2020.

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- Introduction -

VECTORS OF HEALTH

Epidemics, Ecologies, and the Reinvention of Mosquito Science in Brazil

"These funding cuts will hamper the training of tomorrow's researchers. Those who might have to fight a future Zika or dengue, won't even exist."[1] So spoke an exasperated scientist at a June 2016 public hearing on the future of scientific funding in Brazil. The meeting unfolded in a small plenary hall; six tables, equipped with microphones and electronic hook-ups, were arrayed in tightly spaced rows, in classroom style. At the front, the podium and speakers' table were flanked by a large television, which showed close ups of the panelists and politicians. People stood elbow-to-elbow, overflowing the back and sides of the room. The dropped ceiling, lack of windows, and old, dark grayish-green carpet created a claustrophobic feeling. There was also a perceptible tension in the air.

Brazil's first woman president, Dilma Rousseff (from the Worker's Party, PT), was on trial for allegedly covering-up budget deficits and faced possible impeachment.[2] Rousseff's powers had been suspended for the duration of the trial, with Vice-President Michel Temer (from the Brazilian Democratic Movement Party, PMDB) acting as Interim President. A key priority of Temer's interim government was cutting national spending. In addition to further reducing the science and education budget, he had merged

[1] My fieldwork in Brazil was conducted entirely in Portuguese; translations of quotes are all my own.

[2] Rousseff was formally impeached on April 17, 2016, accused of what is referred to as "fiscal pedaling" (a fiscal manipulation that disguises a deficit in the public accounts), although popular perception was that she was on trial for the corruption scandal at the state-run oil company Petrobras. On May 12, the Senate voted to suspend her powers for the trial's duration—which ended on August 31, 2016, with the Senate removing Rousseff from office by a 61-20 vote. Several left-leaning scholars, politicians, and activists have described the Rouseff impeachment as a *golpe*, a "parliamentary coup" with judicial and media support and strong undertones of sexism against Brazil's first woman president (I. J. de R. Machado 2016; Jinkings, Doria, and Cleto 2016; Rubim and Argolo 2018). The legality and the legitimacy of the process were and remain a heated, divisive topic. The word *golpe* in Portuguese can mean not only a coup d'état but also a con or a blow. Just the impeachment's extremely controversial and polarized nature can already be considered a hit to the stability of the democratic institutions and to the trust in the rule of law in the country.

the Ministry of Science, Technology, and Innovation with the Ministry of Communications (Nader and Davidovich 2016; M. H. de S. Santos and Silva 2019). This was what had brought us all to this crowded room in Brasília—a public hearing to discuss these changes, organized by the Chamber of Deputies' Commission for Science and Technology, Communication and Informatics.[3] Many of those attending the hearing that day held signs with calls for the merged ministries to be reinstituted and their funding to be restored, as well as signs calling Temer and those in his new cabinet *golpistas*, usurpers of power who had illegitimately claimed the presidency.

Two scientists—both of them affiliated with universities from Brazil's Southeast region—had come to speak in this public hearing, representing leading national scientific societies. Farthest to the left, at the large table facing the audience, sat Helena Nader, president of the Brazilian Society for the Advancement of Science (SBPC). A biomedical scientist at the University of São Paulo (USP), Nader is the third woman to be SBPC's president and, like every other SBPC president before her, a White person.[4] At the opposite side of the table sat Luiz Davidovich, president of the Brazilian Academy of Sciences (ABC). A physicist at the Federal University of Rio de Janeiro (UFRJ), Davidovich is a White man, like all but one of ABC presidents before him.[5]

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[3] The public hearing request (REQ 153/2016 CCTCI) was submitted by Deputies Sibá Machado (PT), Luciana Santos (Communist Party of Brazil, PCdoB), and Margarida Salomão (PT). In total, Temer reduced the number of ministries from 31 to 22. In his newly appointed cabinet all ministers were White men; the last time this had happened was in 1979 (Koren 2016).

[4] In this dissertation, I capitalize identity-based descriptors, in their racial or ethnic sense. There is growing consensus on capitalizing Black and Indigenous, recognizing them as identities and not as adjectives—a small, but important step on reckoning with the ways in which language upholds racist structures. After all, in 1899 the sociologist W.E.B Du Bois was already making a case that, when referring to Black people, the word "Negro" should be capitalized, since "eight million [U.S.] Americans are entitled to a capital letter" (Du Bois 1899, 1; see also Tharps 2014). But in relation to White, discussions on capitalization have been thornier. Some are concerned that it might empower white supremacists, who have long been capitalizing White. However, others point out that not capitalizing it runs the risk of affirming White people as non-racialized and Whiteness as the standard and norm—the exact opposite of what this dissertation aims to do (for more on this debate, see Appiah 2020; Craven 2020). Following the recommendation of groups such as the National Association of Black Journalists (NABJ), I capitalize White and Whiteness. However, to address some of the valid concerns that come with this decision, I will not do so for white supremacy or whitening.

[5] All ABC presidents have been men. The only nonwhite president has been Sandrano Moreira (1872-1933), a Black psychiatrist credited with establishing psychoanalysis in Brazil. He joined the Academy in 1917, presiding over it

Sitting between Nader and Davidovich was the public hearing's Chair, the Deputy Alexandre Leite (Democrats, DEM), and the Minister Gilberto Kassab (Social Democrat Party, PSD), recently sworn in to lead the newly-named Ministry of Science, Technology, and Innovations and Communications (MCTIC). Both were White men. In fact, most people in the room that day were White/light-skinned, and the vast majority were men, especially those seated in the area reserved for deputies. This was the case even on the walls around us, which held a row of portraits of suited White men, smiling blandly. The room's demographic is particularly noteworthy, considering that nonwhite people comprise the majority of the Brazilian population.[6]

Kassab was first to address the audience. The Minister began with flattering remarks about both the deputies and scientists, highlighting the importance of dialogue between politicians across the political spectrum and civil society. With a calm voice and conciliatory tone, Kassab argued that merging the two ministries did not downgrade the value of Science, Technology, and Innovation. It was simply an institutional reorganization, needed to overcome the "economic crisis." [7] He concluded by praising

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from 1926-1929 (for more on Moreira's importance for psychiatry in Brazil, see Oda and Dalgalarrondo 2000; for an analysis of his theories, especially as it relates to immigration, see Venancio and Facchinetti 2005).

[6] According to a 2019 survey, 46.8% of Brazilians self-define as "*pardo*"; 42.7% as White; 9.4% as *preto* (Black); 1.1% as Indigenous or "*amarelo*" (Yellow) (IBGE 2020; see also IPEA 2003). Used to describe a nonwhite person of mixed ancestry, the term *pardo* has a particularly complicated history, being part of the political and ideological apparatus of whitening in Brazil, being now included in the category *negro* (which includes *pretos* and *pardos*) (Hasenbalg 1979; Munanga 1999; L. A. Campos 2013). More recently, however, scholars, in particular Indigenous thinkers, have highlighted how abandoning the term—placing all nonwhite people within the larger category *negro*/Black—might unintentionally contribute to the erasure of the role of Indigenous peoples (past and present) in the racial formation of the country, who have had a particularly (but not exclusively) strong presence in the Northeast and North of Brazil (J. P. de Oliveira 1997; Jamille Nunes 2019).

[7] I use the notion of an "economic crisis" because this is how it was framed at the time. However, as economic anthropologist Janet Roitman (2013) has described in her extensive examination of the notion of "crisis," the term is both an "object of knowledge" and a "narrative construction" mobilized by actors to create a state of exception in which normalcy does not prevail and interventions are justified (3). Crises are "an observation that produces meaning" (82), as Roitman puts it, and this meaning also becomes quickly charged. This "economic crisis" in Brazil was used to regulate narratives and course of action, allowing certain questions to be asked, proposals to be considered, while others foreclosed.

Brazilian science, and by making broad, unspecific commitments to support research and education during his tenure.

Nader spoke next, stating that, while she agreed that there was a need to reduce public spending ("*enxugar a máquina*"), she disagreed that this Ministry was the best place to do so, asserting that research and innovation were essential to taking the country out of the economic crisis it now faced. Nader also questioned whether an interim government had the right to make such significant structural changes without discussing them with the scientific community beforehand. Both Nader and Davidovich, who spoke next, quoted statistics, rankings, surveys, and budget information to reveal how science was undervalued and underfunded in Brazil, even as, they claimed, Brazilian scientists managed to produce innovative, ground-breaking, and socially relevant research.

Three more people were invited to speak (one representing funding agencies, another state level public officers, and the third institutions of higher education),[8] offering different perspectives for why the merging of the two ministries and the budget cuts should be fiercely rejected. Then the floor was opened up to statements and questions by the deputies. Politicians from both left and right took the microphone, making passionate speeches about the noteworthiness of Brazilian science and the importance of supporting scientists to secure the nation's future. As deputies from across the political spectrum spoke highly of Brazilian science, Davidovich and Nader's facial expressions implied that they were hopeful the ministry would be reinstituted and their funding restored. But they quickly realized they had been caught in the cross-fire, with both sides using Brazilian science and scientists to promote contrasting political agendas.

Those on the left would always start by reminding the audience that this was a government of *golpistas*, who had usurped power from the democratically elected president to implement undemocratic

[8] Those who addressed the audience were the Executive Secretary of the National Council of State Research Support Foundations (CONFAP), Luiz Carlos Campos Nunes; the Secretary of Science and Technology and Higher Education of the State of Ceará, Inácio Arruda, also addressed the audience; and the Executive Secretary of the National Association of Directors of Federal Institutions of Higher Education (ANDIFES)—the three of them White men.

austerity measures that had never been sanctioned by Brazilian voters. They would then go on to describe their commitment to science and education, recalling how previous governments (left-leaning PT held the presidency since 2003) had increased the number of education and research institutes and provided generous funding for fellowships and research projects. Those on the right would also commend Brazilian scientists, who according to them had accomplished incredible feats with little support. They would also name the previous governments' reckless and corrupt spending as the cause for the very economic crisis that now forced budgets to be cut, putting the future of Brazil's science and education at risk.

As the discussion became more and more general, with sweeping accusations from both sides, I could see that Nader and Davidovich were becoming increasingly anguished. Both scientists tried to bring the conversation back to the concrete issues at hand. In particular, they raised concerns about how, since most funding for higher education in Brazil is public, slashing the number of undergraduate, graduate, and postdoc fellowships was going to hamper scientific research for years and, perhaps, decades to come. The future of Brazilian science was at risk. These concerning prognoses were being made not just at the public hearing, but also in street protests and in multiple letters, petitions, and opinion pieces, in which scientists voiced warnings about the prospects of scientific production in the country.

During the public hearing, speakers had brought up Zika, dengue, and the other pathogenic viruses transmitted by the *Aedes aegypti* mosquito a few times to showcase the relevance of Brazilian science, as the opening reference, said by Davidovich, illustrates. The *A. aegypti*—the subject of this dissertation—has long been entangled with Brazil's history, in the legacies of colonialism, slavery, and dispossession: it probably arrived in the ships that crossed the Atlantic bringing enslaved people and removing expropriated natural resources (for mosquitoes and colonial histories, see Espinosa 2009; McNeill 2010; Ebron 2020). But it was only at the beginning of the 20th century, once it was established that the *A. aegypti* could convey pathogens, that the mosquito became a focus of scientific research and public health, framed as a conveyor of death and targeted as a winged enemy to be destroyed. Despite this, the mosquito continues to be a serious concern in Brazil and beyond. This dissertation, based on two years of ethnographic research,

examines efforts to tackle the *A. aegypti* and the pathogenic viruses it can transmit as a window to investigate the politics of knowledge production in Brazil. This dissertation shows that mosquitoes are not only historical, social actors that can reconfigure politics and the production of knowledge (Mitchell 2002), but that the *A. aegypti* species in particular, has come to embody both the legacies and possibilities of Brazilian science.

At the time of this public hearing, Brazil was embroiled in the Zika virus epidemic. Linked to an increase in fetal malformation cases and to babies born with health issues, most notably microcephaly, the virus took the country and the scientific community by surprise in late 2015 (Kelly et al. 2020; Löwy 2019; Reis-Castro, Fleischer, and Segata 2020).[9] Although the Zika virus can also be sexually transmitted, the *A. aegypti* was at the center of national campaigns and policies to address the epidemic, and even the armed forces were mobilized for war-like campaigns to kill the insect (João Nunes and Pimenta 2016; Ventura 2016; A. C. R. da Silva, Matos, and Quadros 2017).[10] But long before this epidemic, the mosquito had already been a familiar figure to Brazilian scientists and public health workers as a disease *vector*, which transmits pathogens from one organism to another.

Previously, scientific enterprises and public health campaigns in Brazil attempted to eradicate the *A. aegypti* by destroying breeding spots and spraying chemical insecticides (Stepan 2011; Magalhães 2016). Starting in the 1900s, the mosquito was targeted as the culprit for the recurrent yellow fever epidemics besetting the country (Löwy 1997; 2001; Benchimol 1994; 2001). It was not until 1958, after decades of military-like campaigns, that Brazil was certified by the Pan American Sanitary Organization (now Pan American Health Organization, PAHO) to be free of *A. aegypti* (PAHO and WHO 1960; Löwy 2017).

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[9] Although the cases of microcephaly was what marked the epidemic, continued research demonstrated that children showed a spectrum of clinical symptoms, nowadays known as Congenital Zika Virus Syndrome (van der Linden et al. 2016; Miranda-Filho et al. 2016). The virus was also linked to cases of Guillain Barré, although these received much less attention in Brazilian media (Brasil et al. 2016; Nóbrega et al. 2018).

[10] On the racial and gendered politics at play in this disregard for the sexual transmission of Zika, see Reis-Castro and Nogueira (2020).

However, by 1968, there were already reports of the insect's presence in Brazil in so much as the *A. aegypti*, whose eggs can be dormant for months, might never have been completely eliminated or it might have been reintroduced from another country (Fraiha 1968; O. Franco 1969).

Yet, during the 1970s and early '80s, reports of the mosquito's return were regarded as local and marginal issues, receiving limited attention, especially with the advent of the yellow fever vaccine.[11] But with the outbreak of another virus—dengue—the *A. aegypti*'s ubiquitous presence in the country was impossible to ignore. Known in English as the "breakbone fever," dengue can cause body aches, eye pain, headaches, extreme fevers, occasional nausea/vomiting and rash, and, in its most severe form, internal hemorrhage. The first outbreak of this disease was registered in 1981 in Boa Vista, capital of the northern state of Roraima (Osanai et al. 1983). But it was the 1986 epidemic in Rio de Janeiro—capital of the southeastern eponymous state—that spurred a national response (Vianna and Piola 1986, 49).[12] From Rio, dengue quickly spread, making visible the mosquito's widespread presence throughout Brazil. Soon after, a new national campaign was set in place with the goal of once again eradicating the mosquito (Brasil 1996).

Nevertheless, this new eradication goal was unsuccessful. Earlier efforts had adopted large quantities of highly poisonous chemical insecticides, in particular DDT, which were under increasing scrutiny by environmental activists (e.g., Carson 1962; for more on the history of DDT, see E. P. Russell 1999; Kinkela 2011; Oreskes and Conway 2010; in Brazil, DDT was forbidden in 1986 for agricultural use but only phased-out of vector control programs in 1997, Torres et al. 2009). In addition, in the 1980s and '90s the national anti-mosquito campaigns had to cover a significantly more extensive area because the

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[11] In 1967, after a new reintroduction of the *A. aegypti* in the northern state of Pará, the Superintendence of Public Health Campaigns (SUCAM) was created to address mosquito-borne diseases, but it was significantly underfunded (G. Lopes and Lara 2021, 77–78).

[12] Brazil's geopolitical landscape should not be brushed off here: the diminutive attention given to Roraima's epidemic also displays how politics within the country (that is, what/who matters the most) tends to be Southeast-centered (see Chapter 3).

country had undergone intense urbanization since the 1960s. Land speculation and mechanization of agriculture activities had restricted small producers' access to land and reduced labor demand, spurring an unprecedented rural exodus (Martine 1990; M. Santos 1993). The sprawling cities created the ideal conditions for *A. aegypti* to flourish, since, as the anthropologist of health and science Jean Segata (2016, 374) has remarked, this species is a "city dweller par excellence." The mosquito lays her eggs in stagnant, preferably clean, water, ranging from places as large as swimming pools to as little as bottle caps filled with rainwater. As a highly anthropophilic insect,[13] the *A. aegypti* insists on living close to humans, becoming an unwanted "domestic but not domesticated" organism—to borrow an expression from environmental anthropologist and multispecies ethnographer Radhika Govindrajan (2018, 132).

Cognizant of this situation, the Ministry of Health changed the guidelines in 2002: instead of striving to eradicate the mosquito—which it ruled to be "technically unfeasible"—the new plan was to settle for its *control*, achieved through the actions of the *agentes de combate à endemias* (agents/workers countering endemic diseases) (Brasil 2002a, 3). Based on a decentralized Brazilian public health structure, these workers were tasked with visiting homes, looking for breeding spots and dispersing insecticide when needed, in specific geographic areas—known as *territórios* (see also da Silva Maia and Hinchliffe 2021). These *agentes* work alongside another group of public health workers, the *agentes comunitários de saúde* (community health agents/workers). The latter are mostly people living in the communities in which they work, entrusted with managing the relationship between their fellow residents and the healthcare system. These workers were also considered part of the dengue response, trained to identify clinical symptoms (Brasil 2009b). However, this dissertation follows the work of the *agentes de combate à endemias*, who also target the *A. aegypti*.

[13] Research in genetics and sensorial behavior argues that the *A. aegypti* preference for human blood could be traced back to a genetic evolutionary adaptation which makes it more sensitive to human odors (McBride et al. 2014).

Despite the continuous efforts of these workers, *A. aegypti* continued to proliferate in cities, with outbreaks becoming a recurrent urban public health issue throughout the country. From 2015 onwards, *agentes* were meant to address not only dengue, but also two other pathogenic viruses that had arrived in the country: Zika and chikungunya, the latter characterized by joint pain and inflammation (arthritis) that can persist for years after infection (Chang et al. 2018).[14] Within this framework of control, the goal was not to eliminate these mosquito-borne diseases from the urban landscapes but to manage them by keeping the *A. aegypti* population at bay, so cases do not rise to epidemic levels.[15]

There is a broad consensus among the scientific community that the current tactics that attempt to control the *A. aegypti* are not working. To shed light on new efforts to mitigate these mosquito-borne diseases, this dissertation ethnographically investigates three technoscientific projects in Brazil that currently strive to identify new approaches. It follows efforts to address the pathogenic viruses transmitted by the *A. aegypti* that are relevant beyond Brazil, considering that the planetary distribution of mosquito-borne diseases is expected to spread, driven by the impact of climate change and deforestation/urbanization. Projections show that, with shorter and warmer winters, the *A. aegypti* will likely soon thrive in large parts of Europe and the United States (Liu-Helmersson et al. 2019; Iwamura, Guzman-Holst, and Murray 2020). In this case, current ecological conditions in Brazil are deemed by both Brazilian and foreign scientists to offer an oracular view of the potential epidemiological situation in other places—a view that may foretell a new mosquito epoch and generate knowledge to grapple with future mosquito-borne epidemics worldwide.

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[14] The first imported case was reported in 2010 and the first case of autochthonous transmission, in 2014 at Oiapoque, in the north of Brazil's Northern state Amapá. Then, by 2015, the virus had spread throughout the country (Brasil 2014c; L. P. de G. Cavalcanti et al. 2017).

[15] The focus on vector control as the only solution to address these diseases has reified the idea that mosquitoes do not simply transmit but are the very *cause* of mosquito-borne diseases (Reis-Castro and Nogueira 2020, 33). In conversations with anthropologist and geographer Túllio Dias da Silva Maia, he has suggested referring to them as *mosquito-related diseases*, in an effort to consider these insects as "more-than-vectors" (da Silva Maia 2018; 2020).

However, while Brazilian scientists consider their work relevant to counter future outbreaks, their current work conditions are grim, due to the government's increasing devaluation of education and scientific research, and a consequent lack of financial support (Angelo 2017; Moreira 2018; Monteiro 2020). Circling back to the opening scene of the 2016 public hearing, it is notable that Helena Nader and Luiz Davidovich referenced diseases transmitted by the *A. aegypti* to illustrate how Brazilian scientists worked against all odds but still produced innovative and meaningful research, achieving successful health outcomes. Nader, for example, mentioned the conditions of Zika's discovery, saying, "I would like to make clear the pride I have in Brazilian science: it was this science—which is young, poorly funded, peripheric—that managed to give the world an answer regarding Zika." She spoke emphatically, looking around the room to face the deputies. "It was Brazil, with doctors that we have trained, a doctor from Campina Grande working at a primary health unit, who made the association between microcephaly and the Zika virus."[16] Nader then took a deep breath, adding, now slightly louder, "So it is this science—which is still below what Brazil needs—that is providing the answers that we sorely need." Despite efforts from Davidovich, Nader, and several others in that crowded room, the public hearing concluded without any concrete commitments or changes. When Rousseff's impeachment trial ended two and a half months later, she was removed and Temer took over as President. He continued to push for a wide-range of austerity measures, further reducing funds for science and education. Since then, things have gotten even worse: extreme right politician Jair Bolsonaro took office in January 2019, further diminishing funding for science and education, which has now reached a record low, with several federal universities at risk of closing (the 2021 budget is 37% smaller compared to 2010's, corrected for inflation, Vassallo 2021; E. Oliveira 2021).

This dissertation project was undertaken during this period: a time of political turmoil and diminishing funds. Findings discussed in this manuscript are based on research conducted between 2015-

[16] In her study about the beginning of the Zika epidemic, anthropologist and bioethicist Debora Diniz (2016a) describes this discovery, arguing that it was first dismissed by Brazilian scientists themselves exactly because it had been made by a researcher working at a primary health clinic in the northeast of the country, away from what are usually considered the main centers of scientific research and innovation (see Chapter 3).

2019, including ethnographic fieldwork, qualitative interviews, document analysis, and archival research. For my ethnographic research, I investigated three novel technoscientific strategies harnessing the *A. aegypti* in the very efforts to address the viruses that this insect transmits. I show how in these technoscientific projects the goal was not simply to transform the *A. aegypti* from a vector of pathogenic viruses into a *vector of health* that could embody the solution to mosquito-borne diseases. I also argue that my interlocutors themselves aimed to become *vectors of health* who inverted the usual direction of knowledge production, globally, nationally, and administratively: from North-South to South-North; from Southeast-Northeast to Northeast-Southeast; and from a public policy direction to science. In addition, I demonstrate that these projects are situated within Brazil's long history of instrumentalizing mosquitoes to make scientific and political claims.

Overall, my research shows that national ideologies of belonging are intertwined with modes of knowledge and power that shape relations between humans, and between humans, mosquitoes, and microbes. What, I ask, are the different geopolitics of knowledge production and health practices that drive efforts to address mosquito-borne diseases? What kinds of multispecies arrangements emerge in these racialized, political ecologies? How are the histories and imaginaries of Brazilian science reinscribed or transformed through these initiatives? By thinking with, and alongside, my interlocutors, historical actors, and even the *A. aegypti* species itself, I reveal the politics and possibilities of pursuing scientific research and public health interventions in Brazil.

Contributions and Thematic Departures

My research project contributes to a series of scholarly debates and to broader societal discussions, which I—for the purpose of clarity—identify under three distinct themes: Brazil, race, and Whiteness; health and environment in the "Anthropocene"; and science and the politics of knowledge production. There are multiple connections bringing together these themes, but I consider them separately in the following three

subsections by reviewing the literatures that have informed my thinking and that I have used to build this dissertation.

Brazil, Race, and Whiteness

I did not explicitly set out to investigate race relations in Brazil. But the overwhelming presence of White/light-skinned scientists and public officials during the hearing also repeated itself throughout my fieldwork. While the technicians, students, and *agentes* with whom I interacted during my research were a very diverse group of people, those in higher, permanent positions were almost always exclusively White. The particular political history of "Whiteness" in Brazil has been the focus of a vast number of studies, analyzing the country's racial thinking and racial arrangements, especially as it relates to ideas of *miscegenação* (miscegenation) and *embranquecimento* (whitening). Starting in the late 18th century, Latin American countries, guided by theories of scientific racism, strategized ways to racially "improve" their national population, as they strove to leave behind their colonial past (Stepan 1991). In Brazil, this became explicitly the case once slavery was legally abolished in 1888 and with the proclamation of the Republic a year later. In the young Republic, politicians and scholars—including early anthropologists—voiced concerns over the fact that Brazil was a majority Black country (Schwarcz 1999b). Because of this demographic distribution, racial separation was considered to be unfeasible, with "whitening" emerging as a proposed solution (Skidmore 1974).

Policies to facilitate and financially subsidize the immigration of White Europeans were envisioned as a path to increase the country's Whiteness. For those proposing these policies, Blackness was associated with slavery and Brazil's colonial past, regarded as a hindrance to civilization. However, contrary to the United States, where concerns over racial purity and segregation were inscribed into law, in Brazil the idea of race-mixing was promoted—although always based on the assumption of white superiority (Skidmore 1974; S. A. dos Santos 2002; Telles 2004; however, during the end of the 19th century and first decades of

the 20th century, some Brazilian intellectuals also voiced concerns over the possible "degenerative" effects of "miscegenation," see Corrêa 1998; R. V. Santos 2010). Starting in the 1930s, some anthropologists and sociologists began promoting the idea that Brazil—the last country in the Americas to abolish slavery—exemplified a sort of "racial democracy" (Freyre 1933).[17] In this framing, Brazil was defined by its "miscegenation," a mix-raced nation in which there was a plethora of racial classifications, instead of a clear boundary between racial identities.

Several scholars, however, have identified how "the myth of racial democracy" has historically been used to deny the existence of racism and to delegitimize calls for reckoning with the country's racial inequalities (Gonzalez 1984; Twine 1998; Bernardino 2002; Carneiro 2011). Journalist and writer Abdias Nascimento (1978) has argued that the notion of racial democracy should be understood as consubstantial with the racist ideology of whitening. In this case, miscegenation should be regarded not as part of a sort of "post racial" ideology, but as a deliberate effort to erase nonwhite aspects, and in particular Blackness, from Brazilian identity—yet another expression of the long-standing and ongoing genocide against Black people in Brazil (see also Munanga 1999; Anjos 2006).

Other scholars have also examined how, while in theory, there was a national ideology of miscegenation, in practice, racism/anti-Blackness was still present in personal interactions and, particularly, in the country's social, political, and economic structures (S. Almeida 2019). Examining race relations in Brazil and the U.S., historian Micol Seigel (2003, 68) remarks that, "Brazil may never have legislated racism, as comparers are so avid to note, but it often worked no less hard to enforce it" (68). For historian Peter M. Beattie (2015, 4; 235), while Brazilian authorities did not "expend significant resources to defend the evolving lower boundaries of 'whiteness,'" Black/nonwhite Brazilians that experienced upward social

[17] These ideas were present in the 1933 book *The Masters and the Slaves*, by sociologist and anthropologist Gilberto Freyre's, but the term itself was first used by anthropologist and social psychologist Arthur Ramos (1941). For a review of the term, see Brochier (2014); for more on Ramos' work, see A. Oliveira (2021); for an analysis of Freyre's "racial populism and ethnic nationalism," see Dávilla (2019).

mobility faced recurrent "jocular and biting references to color [that] could surface to contain or obstruct that mobility." To put it differently, concerns over racial purity and racial policing were especially strong in elite spaces (see also Bento 2002).

Elite spaces in Brazil—including here academia—are predominantly White. For example, in 2017, only 16% of university professors were Black (*pretos* and *pardos*) (Moreno 2018).[18] Although this percentage is still far from mirroring the country's demographic, it represents an increase from 2010, when the number was only 11.5%. Such an increase illustrates a larger shift caused, in part, by the institutionalization of affirmative actions in the two last decades. These policies have guaranteed access to higher education—and in some cases to faculty positions—for Black and Indigenous peoples as well as for other historically marginalized groups (such as people from a low income background, disabled people and, in a few universities, *travestis/*trans people), transforming, even if timidly, Brazilian science and education (there is a vast literature discussing the effects of affirmative actions both at a structural and individual level, for example Passos 2015; Gomes 2016; Conceição 2016; Passos, Rodrigues, and Cruz 2016; A. M. Nascimento and Cruz 2017; Duarte 2017). While several anthropologists have ethnographically investigated how Brazil's racial inequalities and the legacies of racial conceptions driven by notions of white superiority play out across human interactions (Roth-Gordon 2016; Jarrín 2017; Denyer Willis 2018), my work reveals how these racial dynamics also extend to more-than-human assemblages.

Health and the Environment in the "Anthropocene"

Female mosquitoes need blood to mature their eggs. An *A. aegypti* that bites someone with a virus (dengue, chikungunya, Zika or yellow fever) can become infected with the pathogen, and later, as it bites another

[18] It should be noted that there is no information for 29.39% of respondents chose to not declare their race/color. The other numbers are: 53.6% are White, 1.01% are "Yellow," and 0.12% Indigenous.

person, relay the infection forward, as the mosquito's infected saliva enters and infects the human body.[19] Therefore, a bite from an infected *A. aegypti* can be a haptic reminder of how the production of diseases is always relational in our porous and permeable human bodies (see Nash 2007). Anthropologists and environmental humanities scholars have long emphasized the importance of investigating the multiple ways health and the environment affect each other (Baer 1996; Sze 2007; Agard-Jones 2014; Lamoreaux 2016; Niewöhner and Lock 2018). Such a concern has become even more relevant with the intensification of environmental degradation, climate change, and the many ensuing disasters happening across the world, including severe droughts, uncontrolled fires, devastating floods, toxic landscapes (Cassady 2007; Singer 2009; Cartwright 2019; Mbembe 2020; Liboiron 2021).

Geologists have coined the term "Anthropocene" to define the vast changes and impacts of human activity as a distinct geological epoch (Crutzen and Stoermer 2000; Crutzen 2002). For some social scientists and humanities scholars, the term calls attention to a more-than-human interconnectedness, and can be a tool for political intervention and for imagining new forms of scholarship and governance that address the harmful effects of human actions (Rose 2009; Ogden et al. 2013; Moore 2015; Gibson and Venkateswar 2015). Others, however, have highlighted how the term Anthropocene might obscure how these impacts are the result of specific human ways of living (colonialism, capitalism, and industrialization), with the inequality in both the causes and effects of these anthropogenic actions being covered over by the latent human exceptionalism and Eurocentrism/Whiteness in the concept (N. F. Sayre 2012; Fortun 2014; Haraway 2015; Davis and Todd 2017; Whyte 2017; 2018; Yussoff 2018).

My research brings these two debates together by revealing how Brazilian scientists argue that their particular geographic position and the historical and ongoing epidemics in the country offer them a vantage

[19] However, the susceptibility of mosquitoes to dengue virus varies—that is, not all mosquitoes biting a viremic person become infected and then infectious. There are also some cases of vertical transmission, infected *A. aegypti* female or male transferring the virus to their offspring (Ferreira-De-Lima and Lima-Camara 2018).

point to confront impending epidemics in the "Anthropocene." After all, in the case of mosquitoes, debates about anthropogenic actions unfold as climate change and urbanization expand the geographical range of insects like the *A. aegypti,* producing a new mosquito epoch that challenges current epidemiological geographies. To put it differently, I investigate the confluence between debates on the anthropogenic effects on the livable world and shifting global geopolitical and epistemological frames.

Ethnographic and historical accounts of mosquito control have addressed the politics of health inequalities (Packard 2009; Kelly and Beisel 2011; P. J. Brown 2017) and of the entangled multispecies relations (Mitchell 2002; Kelly and Lezaun 2014; Segata 2017). Medical and environmental anthropologist Alex Nading (2014), for example, recounts Nicaraguan history through the urban ecological and social entanglements of dengue fever, which "undermines simple spatial, social, and species barriers." While most scholars have focused on highlighting how local and global concerns are interconnected, this manuscript adds to this literature by tracing how mosquitoes can also be understood as materializing racialized, national politics.

Nevertheless, it should be noted that focusing on the *A. aegypti* to address the pathogens it can transmit entails particular understandings of the linkages and ethics between bodies and their environmental and social conditions—what medical anthropologist Margaret (Lock 1993; 2013) has defined as "local biologies" and anthropologist of science Michael M. J. Fischer (2013) calls "bioecologies" (see also Nash 2007). Therefore, this mosquito-focus exemplifies how the definition of an "intelligible field" for intervention anticipates the kinds of solutions proposed (Ferguson 1994; also Greenhalgh 2008). These interventions are shaped by environmental discourses, movements, and institutions (Brosius 1999) and by historical continuities (Li 2007), while forming new forms of governance (West 2006; Fagundes 2019) and multispecies arrangements (Cronon 1996; Ogden 2011; Sautchuk 2019).

The dominant methods adopted to control the *A. aegypti* population (eliminating breeding spots and spraying insecticide) have produced limited and temporary results. Cognizant of this situation, the three

projects I accompanied propose harnessing the insect's own biological preferences and habits. In other words, instead of simply fighting off, they aim to manipulate mosquitoes—manipulate their bodies and their populations—to use the insects as "flying public health tools" to tackle the very pathogenic viruses they can transmit (Beisel and Boëte 2013).

Science and the Politics of Knowledge Production

As the advocates of these three different strategies propose solutions for epidemics in Brazil and beyond, one might expect these projects to draw upon general, even universal, claims about the sciences of pest and disease control. However, this manuscript shows how proponents imagine their technoscientific solutions and their sites of intervention to be particularly Brazilian. Scientists from Brazil and abroad describe the country as the "gold standard" to evaluate whether new mosquito strategies can successfully control diseases. The "tropical" weather, the intricate, expanding urban landscapes, the recurrent mosquito-borne disease outbreaks, and the proliferating *A. aegypti* population are considered ingredients that can test these technological solutions. Advocates of all three projects present their work as particularly *Brazilian* solutions to a *Brazilian* problem: they propose to control mosquito-borne diseases while also developing a technological solution that can bring domestic and global recognition and resources. Therefore, while early ethnographers of scientific practices focused on laboratory settings (Latour and Woolgar 1979; Knorr-Cetina 1983; Traweek 1988), my research joins scholars concerned with examining how scientists' and policymakers' practices can define not only their work but also the world around them (Martin 1987; Gusterson 1996; Kelty 2008; Montoya 2011; Fullwiley 2011; Benjamin 2013).

A concern with the politics of scientific world-making has been a particularly relevant theme within social studies of science in Latin America (Vessuri 1987; Kreimer et al. 2014; Medina, Marques, and Holmes 2014; Fonseca et al. 2016; Rohden and Monteiro 2019). Ethnographers have described how Brazilian scientists often perceive themselves as members of a cosmopolitan science and, concomitantly,

of a specific national/Southern science. For example, environmental anthropologist and STS scholar Myanna Lahsen (2004) analyzes how Brazilian climate scientists advocate for transcending nationalistic concerns under the premise of ecological interdependence, while also recognizing that the responsibility and effects of climate change are unevenly distributed and that there are colonial continuities within current politics of knowledge making and knowledge interpretation. Most anthropologists and STS scholars have so far focused on climate change, energy policies, agricultural sciences, and environmental debates to examine the dilemmas of Brazilian scientists as they—cognizant of their positionality within global scientific production—aspire to international recognition while simultaneously seeking to produce a science tuned to the country's needs, limitations, and priorities (Velho 1990; Newberry 2015; Labruto 2018; Rojas 2016; Monteiro and Rajão 2017; Rajão and Duarte 2018).

My work builds upon and adds to this literature by investigating the multiple hierarchies and inequalities, in particular racial and regional, involved in producing knowledge in Brazil. Whereas much scholarship in Latin American studies analyzing the "geopolitics of knowledge" identifies the domination of Western epistemology and Eurocentrism (Dussel 1998; Mignolo 1999; 2002; Quijano 2000) and the deeply unequal financial, political, and institutional conditions of scientific production in the continent, in comparison to Europe or North America (Varsavsky 1969; Cueto 1989; Bastos 1994; Rajão, Duque, and De 2014; Blanco and Page 2020), less attention has been paid to how these global dynamics interact with Whiteness in the continent. In fact, while several of the Latin American scholars who critique asymmetrical global power relations are White, few of them reflect on how their own Whiteness is entangled in the dynamics and production of inequities that they analyze.

Ethnographic and historical accounts have also highlighted how in postcolonial and Global South locations, scientific research has often been deployed to promote nation-building projects and new geopolitical positionings (Abraham 1998; Hayden 2003; Soto Laveaga 2009; Benjamin 2009; Mavhunga 2017; Pollock 2014; Mason 2016). These endeavors, however, might be marked by internal disputes and fractal hierarchies. For example, scholars of India have pointed out the ways in which caste formation

permeates educational and scientific spaces, reinforcing economic stratification both within India and in its diaspora (Radhakrishnan 2011; Khandekar 2013; Subramanian 2019; Thomas 2020). To examine the dynamics and legacies of hierarchizations within science-making from Brazil—a place where miscegenation was once an official policy and where the myth of a "racial democracy" still persists—offers yet another perspective for these debates. Therefore, this manuscript contributes not only to burgeoning studies of science in the Global South, but also to the fractal hierarchies and nested inequalities within knowledge production beyond European and North American contexts.

Fieldwork: Methods and Data

During extended periods between November 2017 to August 2019, I conducted multi-sited participant-observation with different groups in Brazil harnessing mosquitoes to control diseases (on multi-sited ethnography, see Marcus and Fischer 1986; Marcus 1995; Hannerz 2003). I had already conducted previous and preliminary research. This dissertation builds on my Master's studies research project, for which I conducted one month of fieldwork in a molecular biology research group at the Max-Planck Institute for Evolutionary Biology in Germany, investigating laboratory practices in the science of transgenic mosquitoes. As a continuation of my Master's research, from April to May 2013 I conducted fieldwork in a biofactory rearing and releasing transgenic *A. aegypti* in the Northeast of Brazil (Juazeiro, Bahia), asking how the implementation of this new biotechnology was contingent on the calculated, careful, and constant manipulation of multispecies relations (Reis-Castro, forthcoming).

In January 2015, I went to the city of Rio de Janeiro to visit the archival collection of the Casa de Oswaldo Cruz, Brazilian's largest collection focusing on biomedical sciences and public health—including here the archives of Oswaldo Cruz, the scientist who led the early 20th century campaigns to eliminate the *A. aegypti* in Rio, nicknamed by Brazilian media at the time as the "*general-mata-mosquito*" (General mosquito-killer) (O. Franco 1969, 83; see Chapter 1). Then, in January 2016 I conducted ethnographic

research accompanying doctors and community health workers at two public primary health centers in Belo Horizonte, capital of the southeastern state of Minas Gerais—which also happens to be my hometown. In a context of diminishing public resources, these health professionals were coping with a dengue epidemic and were preparing for a probable increase in cases of Zika, as the virus mushroomed across the country (in December 2015 there had been four confirmed cases in the city, see Belo Horizonte 2016). In June 2016 I conducted research in Brasília—the country's capital, located in the Center-West region. I interviewed government workers and politicians in Brasília, accompanied protests by public health practitioners opposed to the at-the-time interim government, and participated in public hearings and other public events discussing proposed austerity measures and scientific funding. I also attended the meetings of the "situation room" that had been set up to nationally coordinate responses to the Zika virus. Beyond Brazil, I visited the Rockefeller Archives in Sleepy Hollow, New York, in April 2016 and during the months of July and August 2017 I visited different groups in Australia also working with modified mosquitoes and researching vectorial capacity in Cairns, Townsville, and Clayton/Melbourne.

Then, in September 2017, I traveled to Brazil to conduct extensive fieldwork research. My first planned site was Brasília: during my preliminary visit, I had arranged to accompany the activities of public health officials at a department in the Ministry of Health. However, once Temer took office as president, several public officials working at the Ministries asked to be relocated—including those with whom I had made the arrangements. With rising political tensions and polarization, the new management took back the offer to conduct fieldwork with them. I spent one month in Brasília, where I interviewed workers at the Ministry of Health and at the Ministry of Science, Technology, and Innovations and Communications.

From November to July 2018, I was based in Rio, where I conducted ethnographic research with those working in the *Wolbachia* project, a group releasing microbe-infected mosquitoes across the city of Rio and the neighboring city of Niteroi. This group is based at a public health institute, the Oswaldo Cruz Foundation (Fiocruz), while also being part of a global health project named the *World Mosquito Program*

(WMP).[20] I had the opportunity to accompany the activities of several of the different teams within the project: the entomology team, who reared the infected-mosquitoes; the data team, collecting, analyzing, processing, and organizing all the data related to the project; the release team, who had to move through Rio to release these modified mosquitoes; the triage team, responsible for separating and identifying the mosquitoes captured by traps spread across the city; the communication team, a sort of public relations team, managing relations with reporters and other media sources and the project's social media accounts; and the engagement team, entrusted with the task of informing and explaining the *Wolbachia* project and why now mosquitoes were being released. The latter was the group with whom I spend most of my fieldwork time.

During my stay in Rio, I had a dual affiliation with Fiocruz: I was a visiting student at the History of Science and Health Graduate Program from the Casa de Oswaldo Cruz and I was a visiting researcher at the Social Sciences Zika Network. These institutional affiliations were crucial to grant me access to the *Wolbachia*-group. As part of the Social Sciences Zika Network's project on the "Present History of Zika," I also participated in a series of interviews with Fiocruz researchers (entomologists, virologists, collective health scholars, etc.) about the Zika virus epidemic. While in Rio, I also accompanied the activities of *agentes* who were releasing *Wolbachia* infected-mosquitoes in some parts of the city.

Then, from August 2018 until March 2019, I relocated to Recife, capital of the northeastern state of Pernambuco. While there, I was a visiting student in the Department of Collective Health at the Aggeu Magalhães Institute and conducted fieldwork with a research group from the Department of Entomology in the same institution. There, I followed day-to-day practices of different students and technicians, in particular those working on the irradiated *A. aegypti* project. These insects were reared at the research center and released in Fernando de Noronha, an island out in the Atlantic Sea that is a state-governed district of

[20] WMP's headquarters is in Australia, and I also accompanied some of their activities when I was there.

Pernambuco. The Aggeu Magalhães entomologist professor coordinating these releases helped me arrange a visit to the island, where I could accompany the activities of health officials and *agentes*.

Finally, from April to July 2019 I conducted fieldwork in Foz do Iguaçu, a mid-size city (with around 250,000 residents) in the Brazilian southern state of Paraná, located at the tri-border area between Brazil, Paraguay, and Argentina. In Foz, I joined public health officials in both internal and public meetings and followed *agentes* during their daily practices. I also participated in meetings that brought together public health officials and health professionals from the three neighboring countries to discuss health concerns in the region. In addition, I crossed the Friendship Bridge connecting Brazil and Paraguay to accompany the lab and field activities of Paraguayans health workers in Ciudad del Este for one day and to interview Paraguayan health officials.

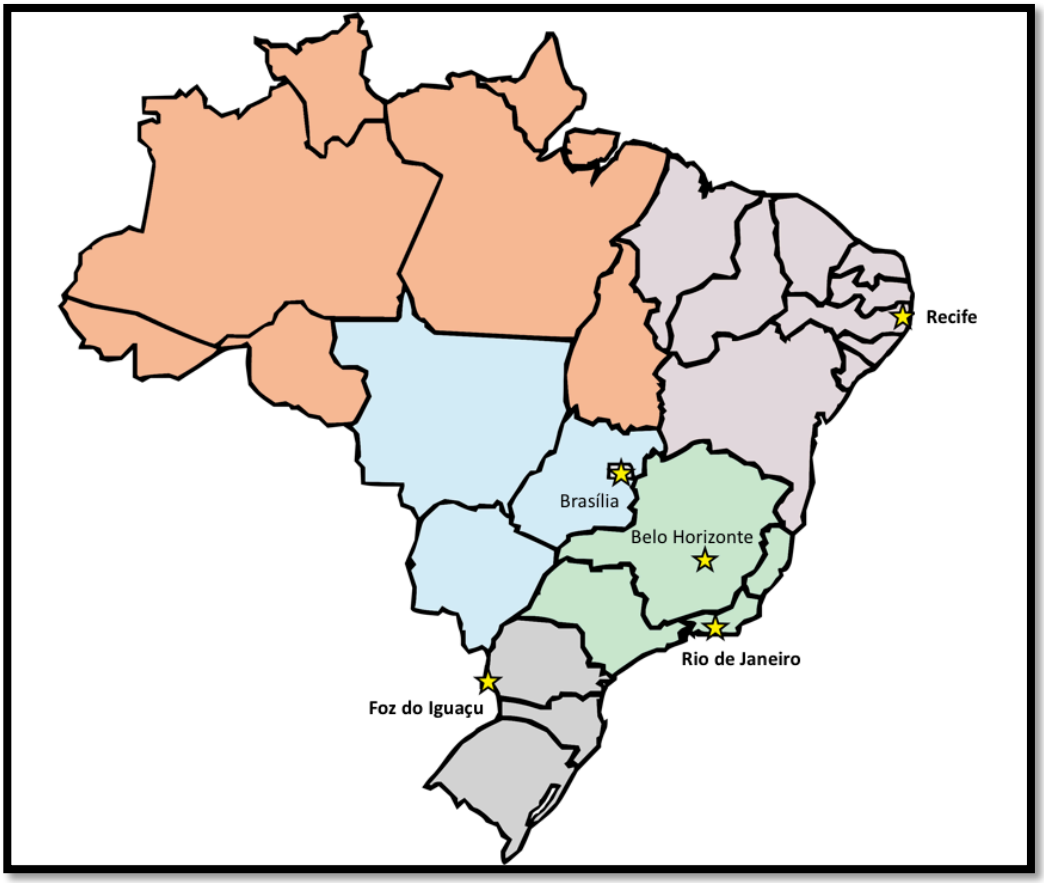

Figure 1: Map of Brazil (states and geopolitical regions)

Following the daily activities of researchers, technicians, and health workers implementing these three strategies in different parts of Brazil permitted me to attend to the particularities of each project and how harnessing *A. aegypti* to control pathogens both conforms to and rearranges policies centered on eliminating the mosquito. Since all three projects were in the early process of development, my analysis focused on the efforts to produce them, and the imaginaries and justificatory logics that surround their implementation (Edwards 1996; Fortun and Fortun 2005). I accompanied my interlocutors in activities where they explained and promoted these strategies to inquisitive, at times skeptical government officials, fellow researchers, and concerned citizens—offering me a particularly valuable opportunity to discern the justificatory logics and the opposing arguments that surround these projects. For each fieldsite, I also collected a range of documentation, including legal and regulatory documents, grant proposals, institutional agreements, social media publications, and newspaper articles. Several of these documents I had access to through the Brazilian Access to Information Law (LAI).

Because this dissertation aims to examine the fractal hierarchies, politics, and legacies present in the spaces that produce knowledge and health interventions, and because race is such a relevant aspect to understand unequal relations in Brazil, I often had to engage in the fraught and uncomfortable task of defining other people's racial/ethnic identities. It should be clearly stated that the very idea of racial differences is rooted in the violent past of scientific racism, with race having "no biological meaning outside the social significance we attach to biological explanation itself" (Viswesweran 1998, 77). I was particularly worried considering how racial ideologies and racial categorization have a complex, ambiguous, and shifting history in Brazil, with several scholars highlighting that education and higher status are often regarded as supposedly bringing people closer to Whiteness (Dávila 2003; Telles 2004; Otovo 2016; W. Anderson, Roque, and Santos 2019).

Concerns that racial categorization based on phenotypic appearance—a sort of "racial court"—would reproduce debunked and prejudiced race theories were also present in discussions about affirmative action in Brazil (Maio and Santos 2005). However, those supporting the implementation of such policies

argued that, only by discussing and recognizing how race has been a marker of difference in Brazil, could the country's long-standing racial injustices be addressed, especially considering that "the myth of racial democracy" has profoundly shaped national ideologies (Bernardino 2002; Anjos 2005; J. J. de Carvalho 2005; Segato 2005; S. A. dos Santos et al. 2008; Passos 2015). Similarly, cognizant of the risks involved in such an endeavor, I consider that defining other people's racial/ethnic identities was at times important in order to make visible the "structural racism" that permeate Brazilian politics, science, and public health (on "structural racism," see S. Almeida 2019).

And while the people working in the different groups with which I conducted fieldwork were very racially diverse, to the point that I do not even feel comfortable defining the racial identities of many of them, I could still clearly identify how those in higher hierarchical roles and in permanent positions were almost exclusively White. Therefore, these were not exactly "white spaces" in the sense described by sociologist Elijah Anderson (2015)—spaces with an overwhelming presence of White people. Instead, these were a sort of *white-ruled spaces*, with White people overwhelmingly represented in positions of power (see also Page and Thomas 1994; Brodkin, Morgen, and Hutchinson 2011).

A Note on Positionality

During fieldwork, the kind of access and interactions I had and, therefore, the kind of data I could collect, were closely tied to my different positionalities. I refer to positionalities as set of identifiers (race, gender, class, nationality, institutional affiliation, etc.) that are relational and moving positions rather than essential qualities, and that shifted depending on the context, place, and the viewpoint of my different interlocutors (Alcoff 1992; Creary 2004, 5–15; Robinson 2020). My reflections here draw on feminist standpoint theory and, within feminist STS, "situated knowledges," cognizant that, as environmental humanities and feminist STS scholar Maria Puig de la Bellacasa (2011) puts it, "knowledge is intrinsically politically and ethically

situated in its purposes and positionalities" (see Haraway 1991b; Harding 1991; for an interrogation of these situated positionalities in relation to fieldwork, see Berry et al. 2017).

Both in Rio and Recife, I was hosted by social scientists or humanities scholars within the same institution that supported the groups deploying new vector control strategies for harnessing the mosquito as a vector for health. These affiliations granted me a *crachá* (badge) that identified me as belonging to these institutions (even if temporarily) and that literally opened doors, making it easier to approach and secure permission to accompany the activities of these groups. In Foz do Iguaçu, the public health officials who welcomed me there understood my presence—as a graduate student—as within their goal to build bridges with academics.

I believe that being a White Brazilian also greatly eased my access and movement within these institutions. Lack of friction might be hard to perceive. However, while researching clinical trials in Brazil, the anthropologist of science and health Rosana Castro (2018; 2020) discusses how she—a Black woman—was frequently coded as a patient/trial participant, not as a researcher. Whiteness is often considered the norm in scientific and medical spaces in Brazil. Castro (forthcoming) also reports how, during fieldwork at a pharmaceutical research center, her presence was questioned and marked as different even as she wore a white coat, the foremost biomedical insignia. In comparison, I could navigate these spaces inconspicuously and not once were my scholarly credentials contested.

Being Brazilian and a graduate student affiliated with a U.S. institution granted me with both an insider and an outsider status. My interlocutors often talked to be as if they considered that I too belonged to Brazilian science and had an experiential understanding of the particularities of studying and researching in Brazil.[21] For example, when discussing the challenges of doing science in the country—from the lack of financial support to the extensive bureaucratic requirements of funding agencies—my interlocutors would

[21] I am an alumnus of a Brazilian public university, the Federal University of Minas Gerais (UFMG), where I earned my undergraduate degree.

often add commentaries such as, “You know how these things are in here” or “But you know this kind of practice is just too common.”

At the same time, however, my institutional affiliation with an U.S. university and, in particular, my fellowship and research grants paid in dollars clearly set me apart. For example, during fieldwork in Recife, a group of students and technicians were discussing when, or even whether, their project stipends would be paid that month. We were all drinking coffee during an afternoon break and, as they discussed these financial concerns, one of the grad students commented, “Luísa doesn’t have to worry about these things. Ah, one day I will also be paid in dollars, you’ll see!” And everyone laughed, with two others saying, “Oh, I want it, too!” I did not perceive his comment as hostile but as a public acknowledgment that, while we were both grad students, there was a clear demarcation of difference between us. The affordance granted by my punctually-paid-dollars—which during my research stay in Brazil significantly increased in value in comparison to the Brazilian reais—starkly contrasted with the diminishing research funds and the financial uncertainties faced by my interlocutors. Several of these interlocutors, chiefly students, expressed interest in also going abroad and, being able to help them, even if in incredibly small ways, became yet another way to establish connections while also marking me as different.

Ethnographer and public health scholar Melissa Creary (2004) also discusses a sort of insider and outsider status during her research on sickle-cell diseases in Brazil. In particular, she notes how, as a Black woman, she was coded as Brazilian—a Black Brazilian—which meant she was “treated as a devalued citizen, often ignored, at times denied entrance to certain establishments, and at other times assumed to be a prostitute” (7). This changed sharply once she spoke, and her foreignness became apparent. As Creary notes, “Speaking English, and certainly my U.S. citizenship elevated my status to ‘white’ in Brazil” (8). To put it differently, while her phenotypic racial classification was unambiguous, because of her U.S. citizenship, educational status and occupation (as a former U.S. government employee), her social status was perceived as equal to Whiteness. In my case, while my Portuguese accent was unambiguously Brazilian—even particularly regional, to the point most people could quickly identify where in Brazil I am

from—my connections to the United States bolstered my Whiteness, placing me into a sort of global Whiteness (Lyons, Parreñas, and Tamarkin 2017, 42). It connected me to resources, opportunities, and networks unavailable to my interlocutors, reproducing the global, racial, and institutional hierarchies in knowledge production that this dissertation set out to study.

Framework and Overview of Chapters

What does it mean to live alongside mosquitoes like the *A. aegypti*, which can act as vectors for viruses harmful to human health? What kind of transformations—regarding multispecies relations, practices of health, and modes and procedures of knowledge—occur when mosquitoes are conscripted in tackling the very pathogens these insects can transmit? It was in 1881 that the Cuban physician Carlos Finlay first theorized that the *A. aegypti* could be the vector for the pathogen causing yellow fever. This theory was later confirmed in 1990 by the U.S. Yellow Fever Commission headed by Walter Reed, who set up experiments in Havana (Espinosa 2009; discussions around mosquitoes' vectorial capacity were also happening, simultaneously, on the *Anopheles* and its role in transmitting malaria, see Worboys 1996; Roy 2013). Examining this historical moment, the philosopher and physician Georges Canguilhem (1989) writes that "the elucidation of yellow fever's mode of transmission altered the figure of Death," making possible a rhetoric that claimed that "Death has wings." To put it differently, mosquitoes—and the *A. aegypti* more specifically—came to be defined by their vectorial capacity, the very embodiment of human death and harm (cf. da Silva Maia 2018; 2020).

The three projects ethnographically examined in this manuscript all propose a bio-technoscientific solution to manage this multispecies interaction that can be so harmful to humans. While all my interlocutors held great ambitions for the potential relevance and geographical expansion of their projects, they were all cognizant that mosquito-borne diseases were just a small fraction of the plethora of issues in Brazil, which are all exacerbated by the country's vast inequalities and inequities. Yet, they considered that

addressing these diseases could at least produce a specific, located, and measurable difference (Good and Good 2012; Redfield 2018). That is to say, they were not aiming radically to transform the world but also refused to let things remain as they were, striving to create new kinds of mosquito futures (see Ballestero 2019, who examines a similar position among her interlocutors, as they worked to create new water futures).

All three projects aim to instrumentalize the *A. aegypti* by either modifying or manipulating the mosquito to instrumentalize its reproductive capacities and biological preferences, habits, and instincts. This reformulation can be understood as an example of the making of what medical sociologist Catherine Waldby (2000, 33) has defined as "biovalue," which is "generated wherever the generative and transformative productivity of living entities can be instrumentalized along lines which make them useful for human projects" (see also Waldby 2002). Several other STS scholars have also analyzed how nonhumans' reproductive and generative capacities are commodified and captured by regimes of accumulation (Franklin and Lock 2003; Sunder Rajan 2006; 2012; Helmreich 2007; 2009; M. Cooper 2008; M. Cooper and Waldby 2014).

Each project harnessed the mosquito in a different manner. One group has infected the *A. aegypti* with a bacterium called *Wolbachia*, a microbe that is passed from a female mosquito to her progeny and that can inhibit viral transmission. Here, infected-mosquitoes are released to mate with the so-called wild *A. aegypti,* spreading the bacterium. By transforming future generations of mosquitoes from vectors into non-vectors, *Wolbachia*-infected mosquitoes are expected to engender a sort of *transformative* reproductive labor. In the second project I studied, males sterilized through irradiation are released to mate with the wild *A. aegypti* and prevent future mosquito generations. In this case, they are expected to engender a sort of *contraceptive* reproductive labor. While the first two projects manipulate mosquito bodies, the third one manipulates the mosquitoes' needs as a population to map the insect's presence, distribution, and status as a vector. That is, the group makes use of the *A. aegypti*'s need for blood to mature eggs and preference for biting humans in order to entrap these insects, which will later be deployed as sentinels, engendering an *entrapping* reproductive labor.

In all three cases, my interlocutors explained their strategies by extending the "work" of countering viral transmissions to the mosquitoes themselves. In particular, they clearly positioned their approaches in opposition to unsuccessful efforts that depended on human action against the *A. aegypti.* Rather than a war on mosquitoes, the proponents of these projects argued that their strategies worked *with* these insects. Their approach can be understood as being part of a larger shift in ecological thinking, which moves away from a sort of command-and-control logic towards what environmental geographer Jamie Lorimer (2020) defines as a "probiotic turn"—probiotic here used in an expansive meaning to describe human interventions that "use life to manage life." In the cases examined in this manuscript, mosquitoes—historically framed as an enemy of humankind—are now being used to manage mosquitoes themselves. The *A. aegypti* becomes an unwitting insect "ally" to humans in the attenuation of epidemic disease.

Anthropologists have warned that, in describing nonhumans as performing labor, there is a risk of naturalizing and projecting a labor theory of value into all of the planet's energies, as if value is derived from nature's fecundity and (re)productivity (Yanagisako and Delaney 1995; Paxson 2013; 2018). Indeed, as they conscripted the "labor" of mosquitoes, the very aim of my interlocutors was to grant value to the *naturalness* of their projects (Helmreich 2007; 2009). To my knowledge, none of the groups had plans to commodify their strategies, but in all three cases, my interlocutors capitalized on these efforts to modify mosquito bodies or manipulate their biological instincts and needs to make both scientific and political claims.

Throughout my fieldwork, discussions about the lack of financial and institutional support and the overall uncertain and precarious conditions of science and health in Brazil were ubiquitous. However, demonstrating that they could face and overcome these adversities was also part of the narrative around these strategies' potential. Rosana Castro (2019; 2020) describes how Brazilian scientists reframe the country's inequalities and inequities as conditions that enable and propel scientific research in the country—what she defines as "opportune precariousness." Medical anthropologist Johanna Crane (2013, 168) describes similar circumstances in collaborations between Uganda and US-based universities, where "the

very poverty and inequality" that institutions in the United States (or in Europe) are aspiring to "remedy is also what makes their global health programs both possible and popular." Crane defines these as "valuable inequalities"; in the Brazilian case, then, they would be *national* valuable inequalities.

These precarious conditions, amplified by the fact that current vector controls have been unsuccessful, placed all three projects at the fine line between health intervention and experiment—governing more-than-human life through a regime that scholars have called "experimentality" (Petryna 2007; Nguyen 2009; Rottenburg 2009).[22] This positioning was crucial for the kinds of claims my interlocutors made: to produce epidemiological results that would improve the (future) lives of their fellow citizens; to produce science that could be used in (future) locations beset with mosquito-borne diseases; and that such findings would give the science produced from their particular positionality (Global South; Northeast of Brazil; and a public health institution) the deserved recognition, even amid austerity measures and budget cuts that threaten research and health policies.

Chapter 1, "Mosquitoes, Race, and Politics in Brazilian Science: Yellow Fever Campaigns and their Afterlives," add to discussions on the racialized politics of science by showing how different historical actors have mobilized the *A. aegypti* to make contrasting claims that promoted their standing, nationally or globally. First, I describe how controlling yellow fever was regarded as a path toward belonging to the "civilized world," to achieve a sort of global Whiteness—associated with modernity, progress, and healthiness. While in the early 20th century, providing healthy environments was seen as crucial to promoting Brazil to its potential, during the 1964-1985 military government the biomedical sciences were no longer regarded as a national priority. The idea that science was the path to progress was still present, but the focus was on the fields of knowledge that could advance the country's techno-military standing. Then, I analyze how the opposition to the authoritarian regime once again placed biomedical sciences at

[22] Thinking beyond the context of health, there are several other concepts that have been developed to consider the blurring of the boundaries between the field and the lab, including "real-life experiment" (Krohn and Weyer 1994) or "real-world experiment" (Kohler 2002)

the center of nation-building. When facing the 1986 dengue epidemic, controlling the *A. aegypti* was regarded as a flagship strategy for political transformation, remedying some of the dictatorship's wrongdoings and injustices. Finally, I analyze the framing of the Zika epidemic as an "opportunity," as it aimed to confront global hierarchies of knowledge production, although it also reinforced the racialized politics of Brazilian science.

In Chapter 2, "A (Future) Ecology of History: *Wolbachia*-infected Mosquitoes in Rio de Janeiro," I contribute to debates on global health by analyzing how the *Wolbachia* project hoped to transform the biopolitics of infection and the geopolitics of knowledge production. Here, my scientist interlocutors framed their strategy as belonging to and advancing a national/scientific public health agenda and, simultaneously, a global health priority. In addition, I explore how the *A. aegypti* in Rio—as it thrives in urban landscapes, carries multiple viruses, and is impossible to control, due to insecticide resistance—embodies not only past failures but also future threats, especially with regard to the mosquito's climate change-driven geographic expansion. By investigating efforts to "nationalize" this strategy (originally developed in Australia), I describe how the project was promoted as Brazilian, while Rio was framed as the ideal place to test the novel approach. Yet, in order to implement the *Wolbachia* project, researchers, technicians, and *agentes* had to navigate the unequal, racialized ecologies and histories of knowledge production and health interventions in Brazil.

Chapter 3, "The Geopolitics of Knowledge and More-than-Human Work: Irradiated Mosquitoes in the Northeast (Recife and Fernando de Noronha)" focuses on Brazilian science's regional politics. I expand environmental anthropology and multispecies ethnographies of science by analyzing how modified mosquitoes and the island of Fernando de Noronha itself were enrolled to support the development of Northeastern science—historically belittled in a national scientific arena dominated by those based in the Southeast and South of the country. Noronha created the necessary conditions for the project's implementation: the island's geographically distant, territorially isolated from the mainland, with a constant flow of people and objects arriving and leaving, as well as its dense, yet bounded, informal urbanization.

Exploring the parallels between the research done in Recife and life on the island, I describe the historical and structural conditions that compelled people to resort to creative practices to make the best out of a situation of material inadequacy. Finally, while the irradiated mosquitoes project aimed to confront the unequal conditions that have constrained knowledge production and health interventions in the country, I show that the very precarity and inequities it aimed to address were also what was instrumental for the project's success.

In Chapter 4, "Borderland Sentinels: Trapping and Testing Mosquitoes in the *Tríplice Fronteira* (Foz do Iguaçu)," I add to the analysis of policies and politics of health by identifying how my interlocutors mobilized different borderland positions (geopolitical; multispecies; and bureaucratic) to implement their strategy. Here, I analyze how borders themselves were conceptualized, characterized by a ubiquitous "in-betweenness" while, simultaneously, a constant yearning for separation and distance. In a borderland region profoundly shaped by ecological disturbances (construction of a mega-dam, deforestation and rapid urbanization, and monocultural soy production), addressing the increase in mosquito-borne diseases can be seen as yet another episode where collaboration is required even amidst distrust and rivalry. Therefore, I discuss how novel vector control strategies are positioned within a long history of Brazilian dominance in the region. In addition, I describe the practices and modes of knowledge required to transform captured mosquitoes into a proxy for infected humans, particularly in an area defined by mobility and border-crossing. Finally, I analyze my interlocutors' claim that pursuing scientific research from within the public health system, allowed them to create novel proposals that would still be feasible as a public policy.

Together, these four chapters examine the politics—biological, technical, scientific, economic, geographical, regional, geostrategic, racial, North-South, planetary—of mosquito and epidemic control in Brazil, both historically and today. This dissertation asks and answers: What is the relevance of these mosquito projects for ecological, political, and health concerns within Brazil and beyond? How are new *A. aegypti* bio-engineered, transformed, and utilized in the lab? How are they released and managed in the field? What *is* the field—a city, an island, a border? How does their release and manipulation reinforce or

reorganize existing human-insect-microbe landscapes—as well as human-human landscapes (of power, of race, of partisan politics)? What is the relevance of such work for the biomedical sciences in Brazil, both within the country and globally? And what can these projects tell us about epidemiological futures? I conclude this dissertation with a reflection on the politics of location in my own research and in anthropology more broadly.

- Chapter 1 -

MOSQUITOES, RACE, AND POLITICS IN BRAZILIAN SCIENCE

Yellow Fever Campaigns and their Afterlives

"A preserver of the African element and exterminator of the European element, the yellow plague, negrophile (*negreira*) and xenophobic, was attacking the nation's existence in its marrow, in the regenerative sap of the good Aryan blood," proclaimed the Brazilian Senator Rui Barbosa in May 28, 1917, "with which the immigratory flow comes to purify the veins of primitive miscegenation, and presented us, in the eyes of the civilized world, the looks of a slaughterhouse for the white race."[23] This speech was delivered at Rio de Janeiro's Municipal Theater to a crowd of distinguished guests. Barbosa had been asked to praise the accomplishments of the recently deceased Oswaldo Cruz, the physician and microbiologist credited with eliminating local populations of the *A. aegypti* mosquito, vector for the virus that causes yellow fever.

Before the public health campaigns led by Cruz, "the world [saw] Brazil as a yellow fever country," as Barbosa himself put it, with Rio de Janeiro—Brazil's capital at the time—beset by recurrent epidemics. The city's first great epidemic happened in the summer of 1849-1850, when about a third of the 266,000 inhabitants came down with yellow fever.[24] Although the official death toll was 4,160, the number of fatal cases may have reached 15,000 (O. Franco 1969, 35–37; Chalhoub 1996, 61; Benchimol 2001, 26). Some historians have traced this epidemic to the arrival of the slave ship *Navarre*, which came from New Orleans, stopping in Havana and Salvador before docking in Rio on December 3, 1849. Ten days after *Navarre*

[23] I use the version of Barbosa's speech published later (July 1917) in the *Revista do Brasil* (R. Barbosa 1917). This and all other quotes from writings in a language other than English are my translation unless it is mentioned otherwise.

[24] Retrospective historical analyses have shown that in 1685 yellow fever was already ravaging some states, including Pernambuco and Bahia (Benchimol 2021).

arrived in Rio, news of an epidemic in Salvador reached the capital. The consignee, fearing the illness that was raging on the ship, decided to sell it. Its crew then dispersed and, a few days later, "yellow jack" broke out in the inn where most of them were lodged, quickly spreading across Rio. The business of slavery had literally made the city sick.

Beyond moralistic claims that the epidemic was God's wrath against the vices and sins of Rio's inhabitants,[25] explanations for the spread of yellow fever fell into two camps: those who argued it was directly *contagious* and those who argued it was more dispersedly *infectious*. The first group held that the disease was transmitted through contact with a sick person or with an object contaminated by their secretions. The second group held that transmission would happen due to the prevalence of a dangerous miasma, a noxious form of "bad air," emanating from damp soil, rotted matter, and standing water. According to those following the miasma theory, the entirety of the "tropics"—with its heat, humidity and quick process of decay—was hazardous (Stepan 2001).[26] And Rio's geographic characteristics were seen as further exacerbating the threat of pestiferous gases. Situated on a marshy plain, where rainwater did not drain from the soil due to the low slope, the city was surrounded by sea—contributing to the humidity—and by hills—preventing the circulation of purifying winds.

But then came Oswaldo Cruz, who argued that yellow fever was caused neither by miasma nor contagion.[27] With financial support from his father-in-law (a wealthy Rio merchant), in 1896 Cruz had gone

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[25] The epidemic in Rio prompted a series of processions and a boom in sales of religious objects that promised cures and protections; in addition, because some physicians associated the disease with promiscuity, women were forbidden to be on the streets after 6 p.m., the Angelus time, which in Catholic Brazil is known as the "Hail-Mary" time (Chalhoub 1996, 62–64; Sedrez 2004, 96).

[26] These characteristics were also used to explain the "degenerative" effects of the tropics, weakening physical and mental forces (Stepan 1985; Arnold 1996; W. Anderson 2003; for analyses of efforts to question the "degeneration theory," see Peard 1999; Amador 2015).

[27] Even though Cruz's success greatly popularized microbiology in Brazil, the new scientific theories proposed by Louis Pasteur had been of interest in the country much earlier than that. In São Paulo, for example, Adolpho Lutz and Emilio Ribas were also arguing that the mosquito was the vector for the yellow fever pathogen. Even the Brazilian Emperor Dom Pedro II was interested in Pasteur's theory, exchanging letters with the French microbiologist and inviting him to come to Brazil and propose solutions for yellow fever (Benchimol 1990, 54).

to Paris to attend the Pasteur Institute's *Grand Cours*, where he honed his skills in the new discipline of microbiology (Löwy 2001, 86).[28] After two years in France, Cruz returned to Rio and, in 1899, was invited to lead the Manguinhos Serotherapy Institute, located on the outskirts of the capital, that produced vaccines and immune serum (mostly using horses) (Benchimol 1990). Then in 1902, the newly elected president, Rodrigo Alves, entrusted Cruz with the task of ridding the city of its pestilences.[29] In the case of yellow fever, Cruz's proposal was based on a novel disease causation theory: that the *A. aegypti* was the vector for the pathogen causing the disease and, therefore, the mosquito would need to be eliminated in order to halt transmission.

When Cruz launched his anti-mosquito campaigns in Rio, the "mosquito theory" was just that, a *theory*. Because Cruz focused only on eliminating the insect, some politicians—and some other physicians—accused him of recklessly abandoning older methods, such as disinfecting sick people's clothes and other possessions (Britto 1995, 94–96). Cruz, however, had the backing of President Alves, who was determined to finally stamp out yellow fever epidemics after decades of failed attempts.[30] The capital's recurrent epidemics were seen as a stain on the country's image, a threat to not only local "civilizing" ambitions but also to the well-being of "civilized" nations elsewhere. With the disease out of control, ships would avoid Rio's harbor, and Brazilian crews and goods abroad had to undergo quarantine.[31] Yellow fever was also seen as an impediment to the "whitening" aspirations of a Brazilian elite that had

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[28] In Paris, Cruz also worked for the city's municipal laboratory, tasked with bacteriological water analysis.

[29] Prior to that, Cruz briefly established a clinical analysis laboratory, the first of its kind in Rio de Janeiro. The first in the country had been inaugurated earlier in São Paulo, in 1892 (Benchimol 1990).

[30] Before becoming president, Alves had been the governor of São Paulo, where he followed with enthusiasm the efforts by Lutz and Ribas to replicate experiments proving the mosquito theory (M. de Almeida 2003).

[31] Brazilian authorities also imposed sanitary measures on ships arriving from Europe, in particular during the 1892-1893 cholera epidemic that beset the continent. There were even cases of ships forced to turn back and, in 1893, the Brazilian government interrupted some of its pro-immigration policies, banning ships from Italy and Spain (Rebelo, Maio, and Hochman 2011). Historian of health and science Fernanda Rebelo (2013) has described how Brazilian sanitary measures changed from late 19th century to early 20th century driven by the novel theories of disease ecology and microbiology. For a history of how early 20th century maritime networks were transformed by fumigation technologies and spurred visions of a disease-free global trade, see Engelmann and Lynteris (2020).

advanced policies to facilitate and financially subsidize European immigration.[32] In his speech, Barbosa mentioned a mortality rate of 92% within immigrant colonies, and, although these numbers are probably inflated, it is relevant that this is the rate in which the government believed (Chalhoub 1996; Sedrez 2004, 98).

A higher lethality among European arrivals can be explained not in terms of racial differences but by what environmental historian John McNeill (2010) calls "differential immunity"[33]: because yellow fever confers immunity to survivors, those who have had it as children are much less likely to fall ill or die of it later in life. Examining antebellum New Orleans, the historian Kathryn Olivarius (2019) shows how this differential immunity yielded a racialized "immunocapital" for those living in the city (see also Willoughby 2017). For White people who were "acclimatized"[34] (yellow fever survivors), the social acknowledgment of this lifelong immunity was translated into economic, political, and social power. For Black enslaved people, on the other hand, their "acclimatization" was transformed into an added asset for calculating their supposed value as a form of property. In addition, an alleged innate resistance to yellow fever was also used to justify the enslavement of Black people.[35]

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[32] For more on immigration and "whitening" as a state policy, see Skidmore (1974; 1990); Seyferth (1996; 2002); S. A. dos Santos (2002).

[33] McNeill argues that this discrepancy in disease susceptibility—killing some humans while others survived—to both yellow fever and malaria (transmitted by the mosquito *Anopheles quadrimaculatus*) can help explain the politics of empire and independence in the Caribbean. Or as he puts it, the two insects "underpinned the geopolitical order in the Americas until the 1770s, after which they undermined it, ushering in a new era of independent states" (5). By describing how "people and pathogens were co-regent over human affairs" (307), McNeill shows the importance of understanding how disease ecology has shaped history—although there have been criticisms that the proposal falls into the trap of environmental (mosquito) determinism (for more on this debate, see Brady et al. 2011). Analyzing Cuba's relations with both Spain and the U.S. from 1878-1939, historian Mariola Espinosa (2009) had earlier made a similar argument about the importance of yellow fever in shaping and explaining political outcomes in the island.

[34] For more on the notion of acclimatization, for both humans and nonhuman animals, see Osborne (2000); Caponi (2007); and Ritvo (2012).

[35] Some historians have argued that people of African descent have an innate resistance to yellow fever, even though this argument lacks any biological or medical basis. According to these historians, this resistance would supposedly explain why plantation owners preferred to exploit enslaved Black people over other forms of labor. For a reappraisal of this argument, showing how it relies on and reiterates racist claims by slave owners, see Watts (2001).

At the time of these first yellow fever epidemics in Brazil (late 19th century/early 20th century), there were also discussions about resistance or differential immunities across diverse communities—although historians do not agree on how such discussions should be interpreted (for a historiographical analysis, see García 2019). For example, during Rio's early epidemics, physicians noticed that the enslaved population could tolerate and survive the disease, with most of these physicians concluding it was because the majority of the city's Black residents had been born in Africa and, therefore, were "acclimatized." For some historians, the emphasis on yellow fever—a disease that was known to disproportionately affect the White immigrant population, while being indifferent to other diseases that affected the Black community more strongly—reveals how physicians were ideologically supporting a logic that privileged White lives (Bodstein 1986; Chalhoub 1993; 1996). Although granting that there were racist policies in place at the time, other historians argue that the main ideology guiding public health measures for yellow fever was more attuned to a medical "environmentalist" logic.[36] To put it differently, the focus was not on supposedly deterministic racial differences but instead on "improving" individuals by intervening and controlling in their milieu (Lima and Hochman 2000; Maio 2010).

Analyzing these different approaches to population "improvement," the historian of science Nancy Stepan Leys (1991) categorized them as "hard eugenics"—based on conceptions of Mendelian inheritance, combined with racist understandings of white superiority—and "soft eugenics"—based on more Lamarckian notions of heredity in which social and environmental conditions impacting the body and the mind were heritable. By discussing the two historiographical interpretations about which approach to population "improvement" was more prevalent in the yellow fever campaigns, I show that in both views one can identify the desire among medical and political elites to achieve a global Whiteness—associated

[36] The term "environmentalist" should be understood here not in its current usage but "to refer to the myriad ways in which factors in the environment or milieu, from climate, to latitude, to topography, to soil conditions, to changes in the seasons and to meteorological events, could affect the course and outcome of human illness" (Stepan 1991, 153–54).

with modernity, progress, and healthiness.[37] That is, addressing yellow fever offered the route to belong to what Barbosa had called, like so many before him, the "civilized world."[38]

As several historians of science and STS scholars have pointed out the yellow fever campaigns led by Cruz have assumed the place of the "foundational myth of Brazilian technoscience" (Cukierman 2007, 12; see also Stepan 1976; Britto 1995) and still today shape the imaginaries of science being pursued in the country. This chapter draws upon and extends these literatures by investigating Cruz campaigns alongside their afterlives, discussing the inequities and inequalities in Brazilian science, particularly those that place Whiteness at the top of discriminatory structures. By analyzing how historical actors have mobilized mosquitoes—and more specifically the *A. aegypti*—to make political claims that promoted their standing either nationally or globally, I examine how efforts to control these insects have been entangled with contrasting national ideologies. Here, I argue that centering mosquitoes on histories of Brazilian science can demonstrate both the shifting politics and racial legacies of knowledge production and health intervention in the country.

Mosquitoes as Passports to Global Whiteness

Historians have traced how, long before the institutionalization of tropical medicine in the 19th century, there was a "medicine of warm places," driven by European fears that heat and humidity weakened the body's physical and mental force (Arnold 1996; Stepan 2001; W. Anderson 2003). Here, I examine how Brazilian scientists sought to develop a science that would mitigate—and at times question—the supposed

[37] Cultural theorist Stuart Hall (1997) has examined how Whiteness has historically been upheld in opposition to nonwhiteness through racial discourses that associate it not only with civilization but also with cleanliness, control, and restrain—in opposition to dirt, barbaric, undisciplined, and violence associated to nonwhites, framing the latter as dangerous threats.

[38] The topic of health campaigns as being part of the colonial or imperial "civilizing" endeavor, across the world, is well-studied in the history of science, in particular when it comes to vector-borne diseases (Sutter 2007; Mavhunga 2011; Roy 2017; Cummiskey 2020).

ill effects warm places had on human bodies, especially White ones. Even further, based on the theories of microbiology, Brazilian scientists would later mobilize their allegedly inferior position in the "tropics" to produce a science that would both add and expand European and North American research. From a liability and limitation, "a science from the tropics" could be turned into an opportunity to address diseases afflicting the country, to produce scientific knowledge, and to assert international prestige. I show how medical and biological sciences became part of the Brazilian nation-building project, regarded as a coveted, racialized "touchstone of modernity" (I. da C. Marques 2007, 414).

Historian of medicine Julyan G. Peard (1999) describes, for example, how from the 1860s to 1880s a group of physicians in Salvador, capital of the state of Bahia, focused on addressing "issues from the tropics." Known as the *Tropicalista* Bahian School, these Brazilian and foreign-born physicians met regularly to discuss medical news from abroad and local clinical cases, in particular diseases afflicting those living in poverty, who, in a vastly unequal, slave-owning society, were mostly Black. For these physicians, "tropical illness" were also related to matters of social justice and development. By emphasizing the distinctiveness of practicing medicine in the tropics, these physicians proposed reforms to medical education in Brazil and "provided conceptual tools with which the national intelligentsia could resist derogatory labels of difference and inferiority produced by European scientific and medical discourse" (9). According to Peard, the *tropicalistas* contradicted "the long-standing image of nineteenth-century Latin American physicians faithfully (and passively) reproducing European science in their mainly tropical countries" (166). Adapting and innovating the tools of Western medicine, these physicians aimed at challenging the impossibility of "civilization" in the tropics.

Similarly, physicians in Rio were also invested in confronting the Euro-U.S. American theories attributing inevitable deterioration to those in the tropics, a concern aggravated by the yellow fever epidemics. In 1850, with the first great epidemic, the Imperial Ministry created the Central Public Health Community to centralize and coordinate responses, setting up, for the first time, an institutional system to scrutinize and discipline the urban space (O. Franco 1969; Benchimol 2001, 27–29). Then in 1851 the

Central Board of Public Hygiene was launched to implement broader medical policies and sanitation projects in the capital. The Board led interventions such as draining swamps, creating a sewage system to remove some of the putrid stagnant waters, and even demolishing hills to enhance wind circulation (E. C. Marques 1995; L. O. Ferreira 1999). In the view of some board members, the homes of those living in poverty and poor people themselves were considered to be a health threat because they would generate and harbor the poisonous miasma (Chalhoub 1996). This contention was used to justify demolishing the colonial neighborhood's *cortiços* (large multi-family houses) in the city center—forcibly displacing thousands of families.

The social historian Sidney Chalhoub (1993; 1996) has argued that, although the *higienista* approach was supposedly not racialized—interventions were aimed at improving the environment, not focused on racial characteristics or differences—yellow fever's primacy over other diseases, such as tuberculosis, suggests otherwise (Bodstein 1986 had also made a similar argument earlier). Not only was yellow fever more fatal to recent European arrivals but the news of the devastating epidemics also deterred a number of people from immigrating to the country. For example, at one point the Italian government officially discouraged its citizens from going to Brazil, mentioning the nation's dangerously unhealthy reputation (D. B. Cooper 1975). Chalhoub argues that the priority given to a disease more harmful to White immigrants and harmful to the whitening ambitions that drove immigration policies reveals how the *higienistas* were in fact driven by a racialized—and racist—thought.[39]

The historian and political scientist Marcos Chor Maio (2010) disputes this argument, claiming that Chalhoub shows no evidence of the sort of "social Darwinism" that he alleges to have compelled the *higienistas*—except for the retrospective examination linking Barbosa's speech to 19th century *higienismo*. Maio argues that yellow fever's primacy in comparison to tuberculosis could be understood alternatively

[39] Segata (2016) highlights how yellow fever was also framed as a "socialist disease" because it afflicted both the poor and the rich.

as caused by the latter's chronic nature, which made it less perceptible than the epidemics that struck the city. Maio also questions Chalhoub's claim that tuberculosis was a "disease of the Black," asserting that it afflicted different communities (69-70).[40] Furthermore, Maio points out that, while it was known that yellow fever impacted recent European arrivals with special severity, other groups were also considered vulnerable; for example, the historian mentions a speech discussing the disease's effects on "Brazilians coming from the countryside" (64-66). Therefore, Maio concludes that the *higienista* movement was driven by a non-racialized, environmentalist approach.

Although highlighting this historiographical debate is important to understand the nuances within the motivations and logics driving 19th century sanitary campaigns, both interpretations share a common aspect: controlling yellow fever as part of an aspiration to achieve a global Whiteness. Here, I discuss *Whiteness* not as being defined by a light skin pigmentation, specific phenotypic characteristics or European ancestry (although these also matter), but particularly as a relational construct, a subjective position of power derived from its proximity with a set of cultural, political, economic, normative structures (Ware and Back 2002). Analyzing Whiteness in contemporary Brazil, the social psychologist Lia Vainer Schucman (2012) clarifies this distinction by stating that *brancura* refers to a "White phenotype"—including light skin and straight hair—while *branquitude* to a position of privilege within a racialized hierarchical society (see also Sovik 2009, 50; Schucman and Cardoso 2014).

Examining the historiographical debate between Chalhoub and Maio with the contemporary analytics of *brancura* and *branquite*/Whiteness can provide another perspective into this discussion—even though it is an anachronistic usage of these terms, since Maio's point is precisely that the *higienistas* were

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[40] Maio emphasizes yet that, throughout the 19th century, the government still played a very limited role in addressing diseases and promoting health, calling attention to how it was civil society organizations that brought forward diseases like tuberculosis as a health concern (for more on the history of tuberculosis in Brazil, see Bertolli Filho 2001; D. R. do Nascimento 2002). The historian of health and science Luiz Otávio Ferreira (1999) traces the importance of medical journals to the development of a sanitary agenda centered on the main problems of Brazilian pathology. Journals became the path for the institutionalization of medical practice and knowledge as well as their social legitimation, enabling the sanitary agenda to be inscribed into public life.

not driven by a racialized framework. In the interpretation offered by Chalhoub, yellow fever control promoted a sort of corporeal Whiteness by attracting new immigrants and keeping them alive. That is to say, stopping the epidemics would enable the success of immigration policies aimed at White Europeans—while barring or hindering the immigration of Asians and Africans[41]—permitting both a demographic shift (expanding the number of Whites in relation to nonwhites) and a miscegenation (through interracial relations) that would "whiten" the current population.[42] The aim here was to increase the *brancura* both in the national body and in individual bodies. However, stamping out the disease to permit immigration was also considered a path to increase the country's *branquitude*: European immigrants were expected to not only replace slave labor but also support the modernization and industrialization of Brazil's economy, enhancing the country's global standing (Alberto 2012; this expectation was particularly strong in São Paulo, see Weinstein 2015, 35–36).

In the interpretation offered by Maio, addressing yellow fever and other diseases was crucial to the civilizational process that would place Brazil among the other "civilized" nations, elevating the country's *branquitude* within the global stage. One reason for that is that it would permit the development of commercial and diplomatic activities, since the epidemics tainted Brazilian goods and travelers as a health threat. Further, sanitation and hygiene policies were understood to be not only a marker of civilization but

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[41] In the 1870s there were proposals to bring Chinese laborers as a temporary alternative to slave labor, who were not considered to be immigrants, but contract workers that were neither expected nor encouraged to remain in the country. When the Republic was declared in 1889, the government's first immigration decree banned the entry of Asians and Africans except with congressional authorization (Loveman 2009, 449–50). These laws were later removed, in part because Brazil wanted to maintain its image as a "racial democracy," although entrance of those of African descent was still hindered by, for example, denying them visas (Alberto 2012). Furthermore, historian Jeffrey Lesser (1999) has examined how fears of social and labor activism and concerns over "Germanism" in the early 20th century prompted new immigration policies that encouraged the arrival of non-European groups, although anti-Blackness continued to drive these efforts. While Whiteness remained to be an aspiration, what it meant to be "White" shifted, with more immigrants coming from Syria, Lebanon, and Japan. In a 1935 speech before the House, Federal Deputy Acylino de Ledo stated, "The Japanese colonists… are even whiter than the Portuguese [ones],"underlining their contribution to the Whiteness of economic growth and domestic production (Lesser 1999, 115; also Hernández 2013).

[42] These interracial relations were expected to push for European "dominant" traits and eliminate the "recessive" ones from the country's nonwhites, pivoting "heterosexual reproduction as the engines of national development" (Larvie 2003, 294).

also a tool that would enable the country's progress, by ensuring the health of its population. Putting an end to the recurrent epidemics was the ultimate proof that civilization was possible in the tropics, that science could control and subdue nature (Kury 1994; De Oliveira Sobrinho 2013).

With the end of slavery in 1888 and the end of the Empire in 1889, public health and race became more prominent in discussions about national identity in the young Republic (Skidmore 1974; Schwarcz 1999b; Lima and Hochman 2000). Medical and biological sciences were considered pivotal for "improving" the nation and its people, with new developments in microbiology and disease ecology reenergizing the idea that epidemics could be stamped out (Benchimol 2000). Cruz's proposal that mosquitoes transmitted the pathogen causing yellow fever offered a new conceptual tool to challenge negative views about the tropics: it was the mosquito, alongside other vectors and harmful microbes, that hampered civilization in the tropics.[43] Eliminating these insects became a national flagship project—a passport to, finally, reach global Whiteness.

Cruz's effort to eliminate the *A. aegypti* took place in Rio from 1903 to 1907, when he led a draconian public health campaign: *mata-mosquito* (mosquito-killer) brigades forcibly entered homes, breaking receptacles collecting water (to eliminate eggs and larval mosquitoes) and fumigating chemicals such as sulfur and pyrethrum (to eliminate adult mosquitoes). The campaign reproduced the stark inequalities present in Rio, with the different socio-economic classes receiving strikingly unequal treatment. For example, families and physicians were required to report any yellow fever case, with lower-income patients quarantining in public hospitals, while the wealthier ones were allowed to isolate in their homes (Benchimol 2001). Even though Cruz's extremely unpopular methods provoked discontent among many

[43] The historian of science and medicine Ilana Löwy (2001, 14) remarks that vectorial transmission was simultaneously "unsettling and reassuring," since avoiding contact with sick people could be easier than avoiding the ubiquitous mosquitoes. At the same time, "experts hoped," Löwy noted, "that the mosquito would reveal itself to be the weak link in the chain and that its elimination would lead to the eradication of the pathology whose agents it disseminates" (see also Löwy 1997).

Rio residents, the campaigns yielded positive epidemiological results: the mosquito was locally eliminated, curbing the city's yellow fever outbreaks (Sevcenko 1993; Britto 1995).[44]

Cruz's achievement—alongside other successful anti-mosquito campaigns, such as those by General C. Gorgas in Havana and the Panama Canal zone, by Joseph H. White in New Orleans, and by Emílio Ribas and Adolpho Lutz in São Paulo—became proof that the mosquito theory was right, confirming the *A. aegypti* as the vector for yellow fever disease and fueling national and global efforts to eliminate the insect (Shaw et al. 2013; Magalhães 2016). Cruz also leveraged his epidemiological triumph to enhance his campaign's logistical and scientific base into an institute for experimental medicine, an institute along the lines of the Pasteur Institute but adapted to a Brazilian context (Benchimol 1990; Löwy 1990). At a time when the study of microbes, vectors, and disease ecology was emerging as a distinct branch within infectious disease research (Delaporte 1989; W. Anderson 2004), vector control campaigns were considered to be a niche in which Brazilian scientists could both improve local living conditions and produce knowledge that would promote the country's global scientific standing.

Historians have examined this as an inflection moment for scientific endeavors, with growing recognition of Brazilian science both domestically and abroad—even praised as a model on how to develop a scientific program in non-hegemonic/"Global south" countries (Stepan 1976; Schwartzman 1991; Kropf and Hochman 2011). This new phase is represented both materially and symbolically by the "Castle of Manguinhos," envisioned by Cruz to host the institute for experimental medicine—which would later be renamed in his honor as the Oswaldo Cruz Institute. Construction started in 1905, with functional laboratories and luxuriously decorated rooms, such as the entrance hall and the library reading room, containing the most modern facilities available, including a central telephone system, gas and electricity

[44] The anti-mosquito campaign happened alongside other sanitary policies such as mandatory vaccination (to control smallpox) and rat trapping (to control the bubonic plague).

facilities, and an elevator[45] (B. T. de Oliveira 2003; R. G.-R. Costa 2005). It is unclear how Cruz secured funding for such a monumental project, but some evidence shows that, once yellow fever started to decline in Rio, he began diverting campaign funds to construct the Institute's facilities (Britto 1995, 66; Cukierman 2007, 110–15).

Built to be a bastion of Brazilian science, most of the construction materials were imported: from France came roofing tiles, floor ceramics, and bricks; from Germany, light fixture, steel, tiles, and window frames; from the United States, locks and hinges; from England, iron and cement; from Italy, marble; and from Portugal, tile for the walls (R. G.-R. Costa 2005, 59).[46] By taking the best from other (Western/White) countries, Cruz and his colleagues asserted that they could transform, expand, and innovate the fields of experimental biology and medicine, producing a national science that would advance the country's international stature. That is, the Castle became the very embodiment of Brazilian science, guiding the nation as it left behind its colonial past and joined the civilized nations.[47]

Manguinhos and its scientists were central to the expansion of sanitary campaigns across the country, propelled by a distinctively nationalist ideology. As political scientist and historian of health Gilberto Hochman (2016) indicates, the image of a plague-ridden country—Brazil as a "huge hospital"[48]—was offered as a symptom to explain the nation's "underdevelopment" and justify the need for state intervention. During the early 20th century, it became a state concern to provide healthy environmental

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[45] When I visited the Castle, I had the opportunity to ride this elevator, the oldest one in Rio still in operation.

[46] Even most of the labor came from abroad: Cruz did the first drawings but the Castle was designed by Portuguese architect Luiz Moraes Júnior and the foreman was the Austrian Basílio Silvestre Aor, who led a crew of Portuguese, Italians, and Spaniard workers.

[47] Analyzing Cruz's scientific project as a desire to launch a new sort of country, historian of science Henrique Cukierman (2007) describes how the proposal was to cast off "smallpox and (certain) values, rats and colonial roots, mosquitoes and bureaucratic mentalities" (12). Education scholar Priscila Elisabete da Silva (2020) has also analyzed how this civilizing desire, driven by an aspiration for Whiteness, was also what guided the establishment of the University of São Paulo (USP).

[48] The declaration that "Brazil is a huge hospital" was made in 1916 by prominent physician Miguel Pereira, epitomizing the idea of a country defined by its illness and in need of treatment. For a historical analysis of Pereira's speech at the National Academy of Medicine, see Sá (2009).

conditions for citizens, including launching anti-mosquito and other vector control campaigns. Such efforts were driven by a desire for "national integration," with the expectations that the vast hinterlands "would finally be developed and the population drawn into a national unit" (Stepan 2001, 132; also Lima and Hochman 2000). Examining the expeditions to inland Brazil by scientists from the Manguinhos Institute, historian of science Henrique Cukierman (2014) describes these scientific excursions as part of a nation-building project, with researchers being "entrusted with the civilizing mission of guiding [Brazil] toward modernity" (28). But Cukierman also argues that these expeditions entailed a dual "colonization": of the residents of these inland regions (through an "internal colonialism"[49]) and of the scientists themselves (through their desire to emulate European science in Brazil).

In 1958, after decades of war-like campaigns, the *A. aegypti* was considered eradicated from Brazil (Magalhães 2016; Löwy 2017). Even though the mosquito has firmly returned, currently a ubiquitous presence in urban Brazil, the yellow fever campaigns are still considered a symbol of Brazilian science's potential. In his eulogy to Cruz, Rui Barbosa (1917, 315) noted, "Brazilian hygiene [sciences] have been transformed, converted into a real power and, in its domains, raised the country to an unknown height. Nowadays, no one exceeds in [providing] products, services, improvements, and conditions for civilization than our sanitary science, embodied by the Oswaldo Cruz Institute." After Cruz, biological and medical sciences became part of Brazilian statecraft, understood as capable of shaping the nation and its possibilities.

[49] Starting in the 1960s-70s, "internal colonialism" has been a prevalent concept to analyze the particular dynamics of a kind of colonial relation present within Latin America and, more specifically, within Brazil (González Casanova 1963; 2007; Cardoso de Oliveira 1966; 1993). Investigations of the history of anthropology in Brazil have pointed out that the discipline, guided more by concrete objectives than theoretical questions, was also part of the nation-building project and closely entangled with internal colonialism (Peirano 1999; Schwarcz 1999a; for a critical review of these claims, see Pereira 2020). For a discussion on the concept of "internal colonialism," its analytical possibilities and limitations, see Cesarino (2018).

Culture, Science, and Health in an Authoritarian Regime

In Brazil, the Day of Culture and Science is annually celebrated on November 5th.[50] It was established in May 15, 1970, when General Emílio Garrastazu Médice signed into law the bill Nº 5,579, previously passed by the National Congress, instituting the day as a tribute to "remarkable figures of letters and science, in Brazil and in the world," with commemorations focusing on "the Counselor Rui Barbosa, born on November 5, 1849" (Brasil 1970). In the 1965 bill proposing the creation of such a day in praise of Barbosa, Federal Representative for the state of Acre Jorge Kalume (1965) wrote that it would be a "very fair acknowledgment to the admirable Brazilian, who knew how to honor our traditions and how to elevate high up the name of our Brazil."[51] The establishment of the Day of Culture and Science can be understood as a starting point for investigating the politics of Brazilian science during the military dictatorship (1964-1985) and the re-democratization process that followed it.

In the bill, Kalume had written that Barbosa "made his intelligence the extraordinary foil with which he defended the ideals of freedom, taking to the most civilized countries in the world the value and the *sadios* principles of our people." Here, the word *sadios* could be translated as sound—as in "sound principles." But in its literal translation *sadios* means "healthy," a perhaps meaningful usage of the word since, as this chapter has discussed, health and its sciences had been a touchstone of Brazilian statecraft and civilizational claims. Following the 1964 coup d'état that imposed a civic-military authoritarian regime, Barbosa and his legacy were mobilized to support claims about a certain "Brazilianness" at a time of intense

[50] There is also the National Day of Science and the Scientific Researcher celebrated annually on July 8 (and established in 2001).

[51] It is relevant to highlight the *our* here, since the country was contentiously divided, under the rule of a government that had usurped power the year before (on April 1, 1964) over threats of an alleged "communist threat" (Motta 2002). Kalume was a politician from the National Renewal Alliance (ARENA), founded in 1965 when the dictatorial government abolished the multiparty system and imposed a two-party one: ARENA, supporting the military rule, and the Brazilian Democratic Movement (MDB), the government-sanctioned opposition.

political and cultural dispute. Or as Kalume, a politician from the party that gave political support to the military rule, put it, establishing the Day was part of "the relentless battle for culture."

When Barbosa was invited to deliver Cruz's eulogy at the Municipal Theater in 1917, he was among the country's most influential political figures.[52] What arguably established Barbosa's reputation was his participation at the Hague's Second International Peace Conference, in 1907. In this meeting, Barbosa stood up against the proposal of an international court of law in which only the great world powers would participate, advancing the principle of the legal equality of nations. Barbosa was acclaimed for standing as equal to powerful nations such as the United States, England, and Germany. Both scholars and practitioners of international relations regard the 1907 Conference, and Barbosa's role in it, as the symbolic moment marking Brazil's entrance onto the international scene (Visentini 2012; Amorim 2007; Menezes 2021).

At present, one of the most discussed legacies of Rui Barbosa was his order to burn official documents related to slavery. On May 13, 1888, slavery had been abolished in a law that did not include any form of reparation for the millions of Black Brazilians who had labored in bondage.[53] Slave owners were the last pillar of support for the constitutional monarchy and just one year later, on November 15, 1889, army officers led—with no opposition—a bloodless republican coup in Rio de Janeiro (C. Castro 1995). Then in December 14, 1890, Barbosa, at the time the Finance Minister, ordered the incineration of

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[52] Born in Salvador, Bahia, Barbosa made a political career as both a State and Federal Deputy, Senator, Finance Minister and ran for president twice, unsuccessfully (for more on his political career, especially within Bahian politics, see Sarmento 2011). During the institutional design of the young Republic, Barbosa is credited with having given the Supreme Court its primordial role. Also prominent as a writer and a scholar of the Portuguese language, he was a founding member of the Brazilian Academy of Letters, a literary society of which Barbosa was the president from 1908 to 1919 (Wiesebron and Nagle 2012).

[53] There had been two previous laws that had freed all children born from enslaved parents (in 1871) and all enslaved people once they reached the age of 60 (in 1885). The law abolishing slavery, *Lei Áurea,* or the Golden Law, was signed by the Princess Isabel, who was acting as regent since her father, the Emperor Pedro II, had traveled to Europe (C. M. M. de Azevedo 2003). While credit is often bestowed upon the princess, there had been a mounting pressure to abolish slavery, in particular from the abolitionist movement, as well as an increase on the number of revolts and escapes by enslaved people (Schwartz 1992; M. H. P. T. Machado 1994; L. C. Santos 2010; Pinto 2019).

all slavery-related documents held by Finance Ministry offices across the country. In the decree he writes, "the Brazilian nation, through the most sublime step of its historical evolution, eliminated slavery from the homeland soil – the harmful institution that for so many years paralyzed society's development, infecting its moral atmosphere" (Brasil 1890). The decree also stated that burning these documents would remove the lingering "social stain." Some historians interpret Barbosa's order as an effort to hamper the growing political pressure to pay indemnities to the former slave owners, by destroying what could be used as proof for these "compensation" claims.[54] Barbosa, after all, was vehemently against such demands.[55] For other scholars, however, Barbosa's main motivation was to erase the shadow of slavery from Brazilian history—a familiar rehash of a tendency in the country's history to avoid reckoning with its violent past.[56]

Barbosa's revival by those supporting the 1964 military coup and the subsequent undemocratic regime is ironic since, throughout his life, Barbosa voiced loud opposition to the militarization of the government.[57] But it was Barbosa's moral teachings that inspired them. Kalume's bill refers to Barbosa's *Oração aos Moços* (Prayer to the Young Men), a work also mentioned by other politicians and intellectuals

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[54] Just 11 days after slavery had been abolished, Deputy Coelho Rodrigues proposed a bill to compensate former slave owners for their "losses," with several other similar requests being made that year (Lacombe, Silva, and Barbosa 1988). In July 1888, several prominent abolitionists had signed a proposal to destroy the registry books (*livros de matrícula*) of slaves (Chazkel 2015, 69–70).

[55] Barbosa even proclaimed that, "More just, and more fitting with national sentiment, would be if one could find a way to indemnify the ex-slaves, without onerous effects on the Treasury" (apud Sant'Ana 1988, 24).

[56] Reports and commentaries at the time announced the burning of all official documents related to slavery, fostering the discourse that the memory of slavery had gone up in smokes. In his book *The Africans in Brazil* (written from 1890-1905, published posthumously in 1932), notorious eugenicist Nina Raimundo Rodrigues was among the first to lament the erasure of the country's past, helping to create the idea that all documentation had been destroyed (see Côrrea (1998) for more on how Rodrigues profoundly shaped both medical and anthropological sciences in Brazil). Nevertheless, Barbosa's decree was directed only at the documents held by the Finance Ministry and, even so, his order was apparently not obeyed everywhere. Since the 1980s historians have demonstrated that there is still a lot slavery-related documentation available in the country (for more on Barbosa's order and the "slavery archive" in Brazil, see Slenes 1983; 1985; Lacombe, Silva, and Barbosa 1988; Araújo 2013; Chazkel 2015).

[57] From 1894-5, Barbosa exiled in Europe because of his opposition to President Field Marshal Peixoto, who he considered to be a despotic ruler (Oliven 2012).

supporting the right-wing dictatorship.[58] This was a commencement speech for the 1920 graduates from the Largo de São Francisco Law School, in São Paulo, where Barbosa had also graduated 50 years earlier. Given in a tone of advice to the new generation, the speech emphasizes how a moral man should be guided by three passions: God, work, and the homeland.[59]

Those that orchestrated the military coup were driven by a conservative Christian, rightist moralism. For them, ruling Brazil also meant advancing these values as part of a civilizatory project (Cowan 2016; Gusmão and Honorato 2019). Among those particularly targeted by this civilizatory agenda were Indigenous peoples, who were killed, persecuted or forced into assimilation (Brasil 2014a; 2014b; Payayá 2010; Munduruku 2012; Ciccarone 2018). The civic-military authoritarian regime promoted the idea that Brazil was a "racial democracy," even calling unpatriotic or non-Brazilian those who dared to highlight the country's diversity and racial inequalities (A. do Nascimento 1976; Skidmore 1994; for more on the repression endured by the Black Movement, see Gonzalez 1982; P. Domingues 2007). Therefore, praising Barbosa and establishing a day to celebrate him should be understood within a larger context of building a nationally hegemonic (read: Christian, White Brazilian) culture.

While Kalume's original bill had proposed a "Day of Culture," focusing solely on Rui Barbosa, the project was later changed to "Day of Culture and Science." The justification for such an addition was that November 5th was also the birthday of 17th century Italian physician Bernardino Ramazzini (although it is in fact the anniversary of his death) (Freire 1966). Ramazzini was one of the precursors of the environmentalist medical sciences, which would later drive the work of the Brazilian *higienistas* (referred to as the neo-Hippocrates approach) (Locher and Fressoz 2012; Seth 2018). The Italian physician was also

[58] For example, see M. A. Lopes, Paupério, and Menezes (1975). I am grateful to social historian Caio Fernandes Barbosa, who studies conservative intellectuals and youth during the Brazilian dictatorship, for pointing this out to me (see C. F. Barbosa 2020).

[59] Barbosa was ill, and could not join the solemnity. Therefore, the speech was read by Prof. Reinaldo Porchat. It was later published as a book (see R. Barbosa 1947) .

one of the first to propose the use of the quinine-rich bark cinchona in the treatment of the mosquito-borne disease malaria (Riva et al. 2018).

The amendment for the "Day of Culture and Science" was written by Federal Deputy from Minas Gerais Geraldo Freire, also from the party supporting the dictatorship. It states that Ramazzini can stand alongside Barbosa because both men share an "identity of origin," since both were "*latinos*." In establishing this connection with the Italian physician over *latinidade,* the document is also making a claim about belonging to a certain lineage of European science, placing "Brazilianness" alongside a global Whiteness. However, Ramazzini does not appear anywhere else within the law's procedures and adding him might have been an ad hoc solution. Perhaps, then, a better explanation for the amendment is a recognition of the importance of science and scientists in shaping "national culture."[60]

The authoritarian regime had an ambivalent relation with Brazilian science.[61] On one hand, universities and research institutes across the country were considered to be spaces dominated by the menacing and feared "communists," leading to extensive surveillance and violent persecution (e.g., Clemente 2006). Among the targets of the military government was the Oswaldo Cruz Institute. The first to suffer the regime's harassment was Walter Oswaldo Cruz—renowned hematologist and Oswaldo Cruz's son—who in 1964 had his laboratory sealed and his international funding (from the Ford Foundation) halted. According to his colleagues, it was this relentless and capricious persecution that caused Walter Oswaldo Cruz's death in 1967, at the early age of 56 (Lent 1978, 42; R. Cordeiro 1978, 102). Then on April 1, 1970, what has been called "the Manguinhos Massacre" occurred. Based on a decree that had revoked all constitutional rights,[62] ten prominent researchers from the institute lost their political rights and were

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[60] For literary scholar Fernando Floriano Petry (2012, 92), the combination of *Culture and Science* into one celebratory day can also be seen as one more symptom of the transformation happening in the Brazilian educational system: from humanistic to more technical.

[61] As historian of science Olival Freire Júnior (2007) describes, this ambivalent relation has also led scientists to create a sort of "double and conflicting memory" about the dictatorial period.

[62] During the dictatorial regime, there were 17 decrees overruling the Constitution, known as the "institutional acts." The most infamous one was the fifth institutional act (AI-5) issued on December 13, 1968: constitutional guarantees

ousted from their positions, with several of them fleeing the country (Lent 1978). Besides the loss of some of its best scientists, the institute also had part of its research infrastructure and collections confiscated—completely disrupting the work being done there (J. Costa et al. 2008).

On the other hand, however, funding available for scientific research and education increased greatly during the authoritarian regime, with an "unprecedented effort to create an institutional structure and an explicit policy for science and technology" (Adler 1987, 151). As sociologist of science Simon Schwartzman (1991, 217) remarks, "What brought intellectuals and scientists on the left together with the military on the right was nationalism and the shared belief in the powers of science and technology."[63] Academic departments and graduate program were expanded, and several new ones created (C. F. Barbosa 2009). Driven by the military regime's nationalistic ambitions, the government-owned National Bank for Economic Development (BNDE) launched a program to financially support technological development (Schwartzman 1991, 215). While one can identify here a rehashing of the idea that science is the path to Brazil's progress, the focus was no longer on medical and biological sciences. During the dictatorship, it was disciplines such as physics, informatics, and engineering that were prioritized—under the logic that they could produce applied technologies to boost Brazil's techno-military standing.[64]

In fact, during the dictatorial regime health became a very low priority, with dwindling resources allocated to public health services and infrastructure. For example, from 1968 to 1972 only around 2% of

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of political and individual rights were revoked, which led politicians against the regime to lose their mandates and laid the legal groundwork for government-sponsored torture to be sanctioned.

[63] On the left, this quest for scientific and technological autonomy was shaped by wider debates happening in Latin America on "dependency theory," in which the continent's problems were considered to be directly linked to the existing global economic order: the underdevelopment of "third-world countries" as necessary for "first-world countries" to amass their wealth. In other words, in this framework Latin America's dependency stemmed from the long history of exploitation by Europe and the United States, aided by local elites (for a nuanced analysis on the intersection of political and technological projects from the left, see Medina 2011; for a reflection on how dependency theory also influenced STS scholars, see Dagnino 2009; P. B. C. Silva 2015).

[64] Some areas received particularly generous incentives, such as agricultural sciences; studies on atomic energy, computers, and steel production; and the aircraft and weapons industries (Schwartzman 1991, 232; on computers, see I. da C. Marques 1980; 2003).

the national budget was assigned to the Ministry of Health, while the Ministry of Transport received 12% and the Armed Forces, 18% (Paiva and Teixeira 2014, 18). In the 1970s, professionals and activists began to organize to demand improved access to health—part of what became known as the sanitary reform movement.[65] But the military rulers often censured efforts to make visible how healthcare in Brazil was insufficient, inefficient, and profoundly unequal (Paim 2008, 74). The struggle for health became tightly connected to calls for ending the authoritarian regime, with health professionals and activists playing an important role during the 1980s "re-democratization" period (Lima et al. 2005). In its opposition to the dictatorship, the sanitary reform movement once again put biomedical sciences at the center of a nation-building project: this time as a path to overcome the country's economic and racial inequalities. That is, guaranteeing health was a crucial step toward the new "civilizatory stage," as a more just and equitable society (Fleury 2009, 159).

And here the *A. aegypti* mosquito was, once again, at the center of the action. Starting in late 1960s, the mosquito had been identified in a few locations, but these received limited attention, regarded as circumscribed occurrences. That was until the 1986 dengue epidemic in Rio de Janeiro. The virus, also transmitted by *A. aegypti*, revealed the widespread presence of the insect in Rio and, as the disease later spread across the country, revealed the mosquito's ubiquitous presence across urban Brazil. Several experts blamed the outbreak on the military government's lack of transparency and accountability in reporting the mosquito's return (G. Lopes and Reis-Castro 2019).

In Rio, protests erupted among those most affected by the disease: lower-income residents of the *subúrbios*, neighborhoods that spread out in the northern and western parts of the city. During the military government, many Black-majority communities living in the hills of Rio's wealthier south side had been

[65] A historical marker for the movement was the creation in 1976 of the Brazilian Center for Health Studies (CEBES) and, three years later, the Brazilian Association of Collective Health (Abrasco). There is a vast literature about the sanitary reform, mostly written by health professionals and activists who were part of the movement (Fleury 1997; Lima and Santana 2006; for a historiographical review, see Paiva and Teixeira 2014).

relocated to public housing in the *subúrbios* (McCann 2014). These neighborhoods were then enlarged by arriving economic migrants, most of them coming from the northeast of the country. Even though the *subúrbios* had been created as part of calculated and state-run practices, they lacked proper infrastructure, such as sewage and water systems (Leeds 1977).[66] For those protesting, the dengue epidemic illustrated the government's historical disregard for their well-being, and especially for their health and sanitary conditions. The ideas embedded in the dengue protests would become part of a national debate about advocating for broader understanding of health, including improving living conditions and promoting preventive medicine.[67] Such ideas would be integral to the creation of the 1988 *Sistema Único de Saúde* (SUS), the national, public, universal health system (Pires-Alves, Paiva, and Lima 2018). In this case, controlling the *A. aegypti* was seen as a way to remedy some of the authoritarian regime's harms, becoming, once again, a flagship for political transformation in Brazil.

Zika as an "Opportunity"

Although the re-democratization process was also a call for a more equitable and just society, the return to a democratic government did not result in a departure from the historical class and racial inequalities that have long defined Brazil. And, even though the creation of the SUS guaranteed health as a right—under the principles of universality and equality—access to healthcare is one of the aspects which most drastically show the country's discrepancies. Lack of investment in certain areas of the SUS as well as state support for the private insurance industry has resulted in two very uneven worlds of forms, structures, and technologies of care afforded by private and public health (Paim et al. 2011; Menicucci 2014; Jerome 2015;

[66] For more on the racialization of the *subúrbios*, particularly in its opposition to the wealthy south side, see M. P. de Oliveira and Fernandes (2010); Roth-Gordon (2016); Denyer Willis (2017; 2018); Guimarães and Davies (2018).

[67] This broader understanding of health was aligned with the 1978 International Alma-Ata Conference's emphasis on primary health care, which would significantly reshape health institutions across the world (Cueto 2007; T. M. Brown, Cueto, and Fee 2006).

Löwy and Sanabria 2016).[68] Furthermore, as several scholars have pointed out, "institutional racism" and gender discrimination further bring to question the universality and equality of the healthcare provided by the SUS (Goes and Nascimento 2013; Werneck 2016; Caldwell 2017).

Here, I analyze how discussions about race and class in Brazilian science and healthcare became once again apparent in yet another pathogen transmitted by the *A. aegypti*: the Zika virus.[69] When, in 2002, the Ministry of Health shifted its guideline from eradication to control, there was an implied acceptance that the *A. aegypti* would be a persistent presence in urban landscapes and that some dengue cases would be an expected public health issue. But these terms changed with the arrival of the Zika virus. Initially, Zika's clinical symptoms—rash, fever, and joint and muscular pain—were classified as a milder, "dengue-like" disease (G. S. Campos, Bandeira, and Sardi 2015). The pathogen was incorporated into the infrastructure already in place to counter the diseases transmitted by the *A. aegypti*, without at first causing significant alterations to these responses (Reis-Castro and Nogueira 2020, 31–34). That was until November 2015, when the Ministry of Health declared a Public Health Emergency of National Importance (ESPIN) because of the (at the time *possible*) correlation between the virus and an increase in fetal malformation and children born with health issues (Brasil 2015).

The Zika epidemic not only renewed anti-mosquito public health campaigns, but also boosted global research focused on the *A. aegypti*, a field of study in which Brazil already had an extensive expertise. Several Brazilian scientists even came out to declare that Zika was "an opportunity." In June 2016, biomedical scholar at the Federal University of Rio de Janeiro Wanderley de Souza wrote an opinion piece in one of the most prominent national newspapers—*O Globo*—with that exact title: "Zika is an opportunity

[68] It is important to note, however, that all Brazilians use SUS in some respect, benefiting from the effects of zoonosis control strategies, health surveillance in restaurants, or having access to vaccines at no cost.

[69] The virus was collected and isolated for the first time at the Zika forest, in Uganda. That is how Zika, the virus, got its name—and reason for why it is capitalized when dengue and chikungunya are not (Reis-Castro 2019; Cummiskey 2020).

for Brazilian science." Souza was also then-President of the Funding Authority for Studies and Projects (FINEP), an organization under the Ministry of Science of Technology, dedicated to funding science and technology in the country. He starts the piece by reminding the reader of how addressing infectious and parasitic diseases have historically been "the success stories of Brazilian science." After a brief history of the *A. aegypti* and the virus it can transmit, in particular the unprecedented effects of the Zika virus, Souza enumerates some of the public funding made available for Zika-related research.

The biomedical scholar then concludes stating that, "What is already clear at this moment, and deserves to be publicized and celebrated, is the Brazilian scientific community's effective response, showing its capacity to face a complex problem that involves a multidisciplinary approach." For Souza, the clearest evidence of the prominence in the Brazilian science's response to the epidemic could "be measured by the significant number of scientific articles published by our researchers in journals of the highest international level. Among the 540 articles published on Zika in 2016, 15% had the participation of Brazilian researchers. For the first time, we can celebrate the publication of three articles in 'Science,' one in 'Nature,' four in 'Lancet' and three in 'Jama,' four of the most important scientific journals in the world, in a period of five months" (W. De Souza 2016).

In a context of diminishing funds for science and education, Brazilian scientists mobilized both their long history of work on vectorial diseases and their particular epidemiological and geographic position—as the epidemic's epicenter—to establish international collaborations and to produce findings that brought stature and status for scientific research in the country. Success here is measured by the number of articles published in British and U.S. American journals. Such a move can be understood as both confronting the geopolitics of scientific production (by placing Brazil, a "Global South" country as a recognized producer of science) while also reproducing these global dynamics (by reifying Anglophone spaces as the legitimate centers for scientific knowledge).

Within Brazil, the Zika virus epidemic reproduced and exacerbated the country's inequities, affecting more severely low-income, majority-Black communities (Triunfol 2016). Data by the Ministry of Health showed that 80% of babies with "microcephaly" (now termed as Congenital Zika Virus Syndrome) were born from Black mothers (Maisonnave 2016). Political scientist Layla Pedreira Carvalho (2017) has discussed Zika's disproportionate impact on Black communities as an example of environmental racism. Carvalho highlights how marginalized neighborhoods, with majority-Black residents, generally have access to the worst public services. For example, the author describes her visits to households in Pernambuco, where, due to the inconstancy of the water supply, residents kept several buckets filled with water. This need to maintain these water reservoirs, which are ideal breeding grounds for the *A. aegypti*, clearly indicate how social inequality results in a disproportionate exposure to mosquito bites.

Nevertheless, studies suggest that the relationship between socioeconomic conditions and the prevalence of *A. aegypti* might be more complex, bearing in mind that the mosquito prefers to lay her eggs in clean water (A. Castro, Khawja, and Johnston 2010; Mulligan et al. 2015). Plant pot saucers or little-used toilets and pools can easily become breeding grounds in wealthy neighborhoods. It can be equally difficult to delineate and quantify whether the prevalence of diseases such as Zika is higher in certain parts of the world and, in Brazil, in certain regions of the country, due to climatic conditions or due the effects of colonialism and exploitation to which these places were and still are subjected, and that led to lingering structural inequalities and environmental imbalances (Reis-Castro and Nogueira 2020, 45).

What can be argued, however, is that differentiated access to health, including here lack of sanitation, can cause detrimental effects on viral responses, as ecologies and bodies shape and constitute each other (Fischer 2013; Moran-Thomas 2019). That is to say, while the opportunity for someone to be bitten might reach across different groups, lived inequalities (social, racial, gender, and regional) influence how a disease manifests and develops in each individual (Reis-Castro and Nogueira 2020, 45). The disproportionate number of Black women mothering children with Congenital Zika Virus Syndrome might also be explained by Brazil's discriminatory reproductive health legislation and practices. Although

abortion is a criminal offense, middle and high income, mostly white Women can pay for illegal but safe pregnancy termination, whereas low income, mostly Black women must risk their health and freedom to do the procedure (Diniz 2016b; Medeiros Santos 2017; A. G. de Mello and Rondon 2020).

While Black women were the most affected by the epidemic, they are among those least represented within Brazilian science, alongside Indigenous peoples. For example, a 2018 study identified that Black women (*negras*) comprise only 3% of higher education faculty—2.6% *pardas* and 0.4% *pretas* (L. Ferreira 2018). These statistics not only showcase two sides of the same coin—Brazil's striking racial and gender inequities—but also culminate in a racial demographics in which Zika impacted mostly Black communities and was an "opportunity" for the majority-White researchers. Even further, the very inequitable structures that caused the epidemic to disproportionately affect these Black women/families was also what provided the conditions for these researchers to develop their studies.

In an interview with a (White) scientist that was studying the Zika virus and worked at a research center linked to the SUS, she mentioned how, "It's really those most in need who you can recruit to join a research study. Those who live in nice neighborhoods usually do not want to participate—they don't have the time nor the interest; they are also not using the healthcare system to have their prenatal care and to deliver their babies, so we don't really even have access to them." This "access," which enables research to be developed, is the byproduct of historical social, economic, and racial discriminatory structures (Biehl 2005; Giovanella et al. 2008). Therefore, during the Zika virus epidemic, once again biomedical scientists were attempting to invert a vectorial direction: to transform Brazil from a country historically plagued by mosquito-borne diseases into one that can provide a better understanding about these diseases. Here, however, while the "opportunity" provided by Zika challenged the global geopolitics of knowledge production, it also reinforced the national sociopolitics of Brazilian science and healthcare.

Vectors of Health

In 1999 the speech given by Rui Barbosa in honor of Oswaldo Cruz was republished. The archival centers of *Casa de Rui Barbosa* and *Casa de Oswaldo Cruz* decided to do it in celebration of the 150 years since Barbosa's birth and, in the following year (in 2000), the 100 years since the foundation of the Manguinhos Institute. Carlos Chagas Filho—son of Carlos Chagas,[70] the renowned physician and scientist who was Cruz's student, colleague, and friend—was invited to preface the new publication. Chagas Filho was himself a physician, biologist, and researcher, who in the 1980s organized scientists to demand a more robust national science and technology policy, including more financial support to free Brazil from "technological colonialism," as he put it (*apud* H. M. B. Domingues 2012, 639).[71]

Chagas Filho—described by the political scientist Mario Brockmann Machado, then-President of *Casa de Rui Barbosa*, as "a participant in this admirable school of science and Brazilianness" (1999, 8)—wrote, in his preface, "The elimination of yellow fever, starting in the ports of Rio de Janeiro and Santos, is the magic wand with which our lands were opened to immigration and the wealth and the quality of our people could be known all over the world" (11). More than 80 years after Barbosa offered his racist view of Brazilian improvement, the immigration (of White Europeans) and its dividends for Brazil's international image continued to be understood as the campaigns' crucial achievement. Even the introduction written by then-President of the *Casa de Oswaldo Cruz*, the sociologist and historian Nísia Trindade Lima—renowned for her scholarship on the *movimento higienista*—only mentions in passing the whitening logic behind the

[70] Carlos Chagas is credited with discovering the Chagas disease, caused by the *Trypanosoma cruzi* (named by Chagas in honor of his mentor, Cruz) and transmitted by the *Triatominae*, the kissing bugs. Chagas described the pathogen, vector, host, clinical manifestations, and epidemiology of this previously-unknown disease—an impressive medical feat. For more on the disease's discovery and the politics around Carlos Chagas' recognition, see Coutinho, Freire Jr., and Dias (1999); Kropf (2009).

[71] He also advocated for the importance of supporting history of science studies and the creation of places to guard and organize scientific memory.

celebration of yellow fever's elimination.[72] Lima notes that two points stand out in the speech: "the positive valuation of European immigration and the fear that the 'negrophile' and 'xenophobic' disease, which spared Blacks and Mestizos (*mestiços*) and victimized Whites, would become part of the image other nations had of Brazil."

Starting from the Cruz-lead yellow fever campaigns, this chapter examined the multiple ways mosquito ecologies have become part of national politics. In doing so, it has also described the different conceptions of health associated with controlling the *A. aegypti*. In the early 1990s, health was conceived as a motor for population improvement and for national progress, part of an environmentalist ("soft") eugenic agenda that questioned theories positing an inevitable deterioration for those in the tropics. During the 1980s' dengue protests, health was envisioned both as a space in which the effects of an authoritarian and unjust government were more acutely felt and as a particularly potent place to confront and reshape said regime. Finally, in the Zika epidemic, health was considered as a site for innovative knowledge production, resulting in prestigious publications that would advance Brazilian science's global stature. That is, while controlling the *A. aegypti* has historically been a path to transform modes of knowledge and power in Brazil, the vectorial directions of these transformations have been varied. By drawing attention to the republication of Barbosa's speech, however, I conclude this chapter by highlighting another aspect in the afterlives of Cruz's yellow fever campaigns: the lingering Whiteness in Brazilian science. The coming ethnographic chapters show how, although the explicit racist narrative from Barbosa might not be (as) present, scientific production still reflects Brazil's racial hierarchies, being part and parcel of the inequities and inequalities that characterize the country.

[72] Lima is nowadays the President of Fiocruz, the first woman and the first social scientist to ever hold this position.

- Chapter 2 -

A (FUTURE) ECOLOGY OF HISTORY

Wolbachia-infected Mosquitoes in Rio de Janeiro

Slowed down by Rio de Janeiro's heavy traffic, we arrived a few minutes late at the *clínica da família*, a primary care public health clinic located in the northernmost part of the city. I was there with Patrícia, Ricardo, Tiago, and Erick,[73] who were all part of a project developing a new way of addressing the recurrent Zika, dengue, and chikungunya outbreaks besetting Rio. The project proposed releasing a version of the disease vector—the *A. aegypti* mosquito—that would be artificially infected with *Wolbachia,* inhibiting viral transmission. This bacterium, proponents of this project argued, would transform the *A. aegypti* from a vector of harmful viruses into what they called a "*mosquito aliado,*" an ally mosquito, supporting human efforts to tackle the worrisome cases of mosquito-borne diseases.

We were visiting the clinic that day to run a mosquito release training session with the *agentes de combate à endemias*,[74] who were going to be incorporated into plans for releasing the bioengineered mosquitoes across the city of Rio. *Wolbachia*-infected mosquitoes have to mate with their non-modified conspecifics so that the bacterium, passed from the female mosquito to her progeny, can spread through the

[73] All names are pseudonyms, which were mostly chosen by my interlocutors themselves. Although anyone who knows the people working on this project will be able to identify those in leadership positions, I also use pseudonyms to at least deter people from quickly finding them through search engines. For the technicians and health workers, I mix certain personal characteristics to further protect their identity. Finally, I use the title Dr. as it was employed by the majority of my interlocutors (that is, some people had a Ph.D. but were not referred to by the title).

[74] Operating across the country, these workers are known by different names; in Rio, they are more often referred to as agentes de vigilância em saúde (health surveillance agent/worker). However, because these workers also appear in Chapters 3 and 4, I decided to standardize the nomenclature, using the name adopted by the Ministry of Health (Brasil 2010; 2011; see also J. G. Evangelista et al. 2019). The Wolbachia project also worked with the other group of public health professionals, the community health workers, organizing events to get their support on spreading the word about the microbe-infected mosquitoes. However, throughout this manuscript, unless otherwise noted, the term agentes refer to the agentes de controle à endemias.

A. aegypti population. This can happen because the particular *Wolbachia* strain used by the project (the *w*Mel strain) causes something called cytoplasmic incompatibility (CI): a sperm-egg incompatibility causing the eggs of uninfected females to die when they mate with infected males.[75] That is, while *Wolbachia* is passed from infected female mosquitoes to their progeny, whether or not their partners are infected, CI reduces the number of offspring that uninfected females produce. Therefore, at play here is a sort of *transformative reproductive labor* that works twofold: *Wolbachia* converted the *A. aegypti* into a non-vector by hindering viral transmission, and, through CI, increased the ratio of *A. aegypti* hosting the bacterium.

These training sessions with *agentes* were part of an effort to increase the *Wolbachia* strategy effectiveness and speed up result delivery. Project proponents had plans to expand their operations, and the successful control of Rio's persistent outbreaks would produce persuasive epidemiological data attesting to *Wolbachia*'s efficacy. Through the reinforcement provided by the *agentes*, the project could hasten implementation. With the help of these public health workers, releases could also occur in neighborhoods where the project had limited access, either because these areas had informal streets and alleys that required familiarity or were tightly controlled by traffickers or *milicianos* (paramilitaries, partly composed of agents or ex-agents of the State, such as police officers and firemen) (Zaluar and Conceição 2007; T. Mendonça 2014). The latter was the case for the clinic we were visiting that day, located at the border of an informal settlement, often referred to as a *favela* or a *comunidade*. In fact, this training session had been scheduled to happen the week before, but had to be cancelled when those at the clinic were caught in the middle of a gunfight as police officers stormed the area. This time around, before we had even started driving, Erick

[75] Different Wolbachia strains have gathered attention due to their ability to alter their hosts' reproductive capabilities. While wMel can engender CI, other strains can change genetic males into reproductively viable females or can enable parthenogenesis—biological capacities that have been described as "feminization," "male killing," and turning males into "useless" or "waste." Because of this, Wolbachia has been defined as a "misandrist," "gender-bending," and "extremely feminist" microbe (Knight 2001; Agapakis 2014; Amarillo 2017; Kirksey 2019).

had called to confirm that today everything was *tranquilo* (tranquil) and that we would be able to reach the clinic.

When we arrived there, the *agentes* were waiting in their meeting room. The five of us wore loose vests, similar to those worn by the *agentes* themselves, with the difference that ours were a turquoise color, while theirs was a darker blue. The resemblance between the two kinds of vests was not a coincidence. On my very first day accompanying the project's activities, Tiago had given me a turquoise vest to wear, explaining how it made it clear that, just like the *agentes*, those in the *Wolbachia* project were also, in a sense, *profissionais da saúde* (health professionals). Our vests also had the words SAÚDE | FIOCRUZ emblazoned on the back. This conveyed our association with the Oswaldo Cruz Foundation. Due to its long history of health research and its renowned and free healthcare services, Fiocruz enjoys a reputation among health professionals and the broader community as a trustworthy institution.[76] Our vests—in their similarity with *agentes'* clothing and bearing the recognizable Fiocruz name—granted us a kind of protection and credibility as we moved through Rio.

Patrícia, Ricardo, Tiago, and Erick, however, wore an additional uniform underneath their vests: Patrícia and Ricardo wore dark blue polo shirts and Tiago and Erick white shirts—both of which bore the logotype of the *World Mosquito Program*, written in English, on their sleeves. Operating in eleven countries, this is a global program to deploy *Wolbachia*-infected mosquitoes, with headquarters at Monash University in Australia and generous funding from the Bill and Melinda Gates Foundation.[77] While the releases in Rio were spearheaded by Fiocruz researchers, they were also conducted as part of this global

[76] In recent years, perhaps because it is such a renowned scientific institution, Fiocruz has been the target of anti-science attacks. A well-known example was a publicly funded study (that cost 7 million reais; around 1.3 million dollars) about drug usage, which was at first censored by the national government (during Michel Temer's presidency). The study, the largest ever conducted about drug use in the country, went against right-wing narratives that there is a "drug epidemic" wrecking the nation. After a battle in the courts, researchers managed to make their study public (T. Dias and Garçoni 2019).

[77] In 2018, the Gates Foundation had funded $125 million dollars to WMP's endeavor (WMP 2018). For critical analysis of the foundation's role (and power) in global health and, in particular, its "philanthrocapitalism," see Sridhar and Batniji (2008), Birn (2014), and McGoey (2015).

initiative, overseen and coordinated by "the Australians," as they were often referred to by my Brazilian interlocutors.

The training session was led by Patrícia, head of the project's entomology team, and Ricardo, head of the release team. They explained how the modified mosquitoes would be delivered once a week in plastic tubes and how the project had created maps marking the places where a tube—each containing around 150 mosquitoes—should be opened. The two also demonstrated the best way to open the tube to make sure that all the insects would fly out. Then, they described how *Wolbachia* worked; here, Patrícia did most of the talking. A Portuguese molecular biologist and medical entomologist, she had been based in Brazil for a few years but had just recently been hired to coordinate the mosquito rearing facility, after a Fiocruz researcher had left the project. She answered, in detail, all of the many questions the *agentes* had. After all, these training sessions were, implicitly, venues for convincing these workers that releasing the very insect that they had been trying to kill—in some cases for decades—was a sound idea. Thus, Patrícia described how lab results evidenced *Wolbachia*'s capacity to hinder viral transmission, how the *World Mosquito Program* was going to measure and monitor this microbial spread in Rio, and how releases were underway in other places in the world.

"Well, you keep talking about this *World Mosquito Program*," one of the *agentes* interrupted, exaggerating the English intonation, "but when they told us about these releases, they said it was a Fiocruz project. Are you part of Fiocruz or not?" Patrícia promptly answered, "We are based at Fiocruz and we work with Fiocruz scholars but this is a *World Mosquito Program* project." As she said this, one could feel the tension in the room rise. Several *agentes* started speaking at the same time, protesting that they did not want to be "guinea pigs" for this international experiment, that they had only agreed to this "crazy idea" of releasing mosquitoes because they thought it was a Fiocruz project, an institution they knew and trusted, and that they were skeptical, if something went wrong, that this *World Mosquito Program*, these foreigners, would not just leave and abandon them to deal with the aftermath.

Then Ricardo, who had been mostly quiet as Patrícia discussed *Wolbachia*'s science, spoke in a voice that somehow managed to stand out even among the cacophony of complaints: "I understand your concerns." Ricardo had been part of the project since its early phase and, previously to that, had worked for years in the Ministry of Health. "The person heading this project is Dr. Leandro, who was a postdoc in the Australian research group that discovered the effects *Wolbachia* has on mosquitoes," Ricardo explained and, as he was speaking, the room grew gradually quieter. "Nowadays, Dr. Leandro is a Fiocruz researcher. He is the one that brought this strategy to Brazil. Fiocruz and the Ministry of Health decided to support this idea, and now there are many Brazilian researchers working on it. *You* know how bad cases can get; *you* know how the current methods are not working." Among the *agentes,* there were many emphatic nods and a murmur of agreement. Ricardo continued, "Brazilian science and public health will provide the answers that we need to finally control these diseases."

Several times during my fieldwork, I noted how researchers and technicians oscillated between defining the *Wolbachia* project as part of a national science and public health endeavor operated by Fiocruz and as part of a global health initiative led by the *World Mosquito Program*—usually called WMP (the acronym letters, in Portuguese, considered to be much easier to say than the English name). Tiago described this oscillation when we later discussed the events at the clinic, "Patrícia should have known not to say it like that." He sighed. Tiago was a technician from the engagement team and, therefore, much more used to talking to people about the project. "We know that it is Fiocruz's name that opens doors, even if it is because we are WMP that we have funding that allows us to do these releases at all."

Anthropologists examining global health initiatives and priorities have demonstrated how these can weaken or disturb public health infrastructures and local dynamics of knowledge production (Prince and Marsland 2013; Crane 2013; Biehl and Petryna 2013; Benton 2015; Yates-Doerr 2015). In this chapter, however, I investigate how my interlocutors defined the *Wolbachia* project as belonging to and advancing a national scientific/public health agenda and, simultaneously, a global health priority. As part of Fiocruz, the project continued the historical tendency in Brazil to amalgamate scientific research and public health

interventions, taking its place in a long lineage of attempts to develop state-of-the-art technologies and techniques to address mosquito-borne diseases (Stepan 1976; Löwy 2001; Hochman 2016). Meanwhile, as part of WMP, the project exemplified the increase of global health funding available for and attention directed towards mosquito-borne diseases, as concern over zoonosis in general has risen around the world (Nading 2015; Sodikoff 2016; Kelly, Keck, and Lynteris 2019).

Drawing on ethnographic fieldwork and interviews conducted with technicians, researchers, and *agentes*, I examine how implementing the *Wolbachia* project required my interlocutors to strategically navigate between global and national but also city, neighborhood, planetary, and even organismic and molecular scales. As environmental anthropologist Anna Lowenhaupt Tsing (2005) has argued, those implementing a project often conjure scales by creating—at times contradictory—commitments, articulations, collaborations, what Tsing calls "scale-making." After all, scales are always, as many geographers have already pointed out, relational, performative, emergent, and political (Swyngedouw 1997; Howitt 2003; N. Sayre 2005; Neumann 2009).

I argue that those implementing the *Wolbachia* project conjured and navigated these scales by mobilizing different mosquito ecologies. What this means is that beyond the relations the *A. aegypti* establishes during its life cycle, its seasonality or even its geographical distribution, here I am interested in examining the "pragmatics of scale" within mosquito ecologies—what linguistic anthropologists E. Summerson Carr and Michael Lempert (2016) have called the reflexive study of scalar distinctions, the recognition "that scale is always a matter (and a materialization) of a carefully fashioned perspective that orients actors in particular ways" (14). Mosquitoes then become what STS scholar Gabrielle Hecht (2018) has defined as an "interscalar vehicle," connecting stories and scales usually kept apart and allowing me to think, imagine, and travel—alongside my interlocutors—across these scalar distinctions.

Because of Rio's ecological history, proponents of the *Wolbachia* project framed the city as providing the ideal setting to deploy the bioengineered mosquitoes. To understand such framing, I draw on

and expand Hannah Landecker's (2016) proposal for a "biology of history"—the study of how history has reshaped the very substance of today's biological world (in Landecker's case, particularly the microbial world). Thus, I examine how public health knowledge and practices have historically shaped mosquitoes' bodies, while extending my analysis beyond biological organisms to wider relations between mosquitoes, microbes, and humans. In a word, into ecologies.

Rio de Janeiro's *ecology of history* was utilized to create promissory claims about possible futures— futures here understood as metanarratives that predict, guide, promises, and reveal (Rosenberg and Harding 2005). To put it differently, modified *A. aegypti* in Rio de Janeiro were being harnessed to craft the "future history" of mosquitoes—to borrow a phrase and analytic from anthropologist of water Andrea Ballestero (2019)—in an uncertain world marked by national and planetary transformations. Attending to the politics and materialities of scale-making, I describe and analyze the multiple ways my interlocutors mobilized past and prospective mosquito ecologies.

This chapter shows how the *Wolbachia* project hoped to transform the biopolitics of infection and the geopolitics of ecological knowledge production, as it navigates through scales marked by ambivalent motivations, unequal geographies, and racialized histories in what I call a *(future) ecology of history*. While many anthropologists of global health have analyzed how scales matter when projects are designed and implemented (Biehl and Petryna 2013; Mason 2016; Adams 2016; Farman and Rottenburg 2019), I add to these studies by identifying how these scales can also shape the meanings of the past and the imagined possibilities of the future.

Rio's Recurrent Outbreaks: Past Failures and Future Threats

Oswaldo Cruz's yellow fever campaigns in Rio spurred efforts to eradicate the mosquito, launching national anti-mosquito campaigns, and stimulated biomedical research in the country, helping to institutionalize

science in Brazil and to promote Brazilian science's national and global standing (see Chapter 1). Established by Cruz and now carrying his name, Fiocruz—currently an institution within Brazil's Ministry of Health—most clearly represents this legacy. In its website, Fiocruz is defined as "the most prominent institution for science and technology of health in Latin America" (FIOCRUZ 2016). When releasing the *Wolbachia*-infected *A. aegypti*, my scientist interlocutors were simultaneously continuing and radically transforming this legacy. Deviating from what has been done for more than a century, the project aimed to work *with* the *A. aegypti*, instead of killing them. To legitimize such a profound shift in multispecies relations and public health practices, the group mobilized the renowned reputation Fiocruz (and Brazilian science more broadly) has acquired since its foundation.

Despite more than one hundred years having passed since Cruz's public health campaigns, contemporary techniques recommended by the Ministry of Health remain essentially the same: urging or coercing humans to destroy breeding spots and employing larvicides and insecticides, often chemical ones. Not only have these techniques produced just temporary and limited epidemiological results, they have also created a new problem. Because of the country's lengthy, continuous, and unsuccessful history of attempting to control the *A. aegypti,* mosquito populations across the country are now resistant to insecticides (Braga and Valle 2007). Therefore, the legacies of Cruz's campaigns are not only an institutional presence—in public health practices and scientific research groups—but they have also been embodied by the mosquitoes themselves. To put it differently, *A. aegypti* bodies have been shaped by the 20th century logic of control and by decades of war against the insect (Löwy 1997; 2017; E. Russell 2001). There is here—to paraphrase Landecker (2016)—an insect biology of history.

Rio de Janeiro symbolizes Brazil's history and past failures in controlling mosquito-borne diseases: the 1900's campaigns in the city marked a new epoch for anti-mosquito efforts and the 1980's dengue protests galvanized, once again, a national response against the *A. aegypti.* But Rio also epitomizes future concerns. The city not only has a largely insecticide-resistant *A. aegypti* population and increasingly deadly outbreaks, but in addition the *agentes*, tasked with inspecting homes, are often barred from entering, due to

widespread distrust and fear of violence. Because of that, Rio was conceived by both Brazilian and foreign researchers as the ideal, albeit challenging, setting for vector control trials. Without using insecticide or requiring *agentes* to go inside homes, the *Wolbachia* strategy promised to solve, or at least alleviate, the persistent and difficult to control outbreaks of dengue, Zika, and chikungunya.

Even further, the city was envisioned as a glimpse into possible future conditions elsewhere, as the climate change-driven geographic expansion of the *A. aegypti* reaches parts of Europe and the United States. But although planetary environmental changes are fostering (new) mosquito ecologies in these northern hemisphere places, the *A. aegypti* is not a novel species in these regions. As a vector for yellow fever, before the 20th century, it caused deadly epidemics in Barcelona, New Orleans, and Philadelphia, among other cities (Coleman 1987; Miller 2005; Willoughby 2017; Olivarius 2019). With extensive use of chemical insecticides (including the infamous DDT), combined with improvements in sanitation and health infrastructures, residents in these areas managed to drive away the mosquitoes and the pathogens they can transmit (Packard 2009).[78] More recently, however, hitchhiking in the constant global circulation of commodities and people, the *A. aegypti* and the disease-causing viruses managed to return to these regions—a shift often described in the media as well as in scientific circles as the mosquito-vector "invading" new territories (Wolf and Hall 2020).

This swift spread of the mosquito across the globe and the increased (potential) threat for those in Europe and North America has stimulated funding of novel proposals to tackle this growing health concern, given that the techniques used to locally eliminate the insect in the past will probably not work today. In that case, the difficulties faced by the Brazilian government in addressing mosquito-borne diseases are predicted to be the same conditions that governments elsewhere will have to confront in the future. In other

[78] Although Randall M. Packard's book The Making of a Tropical Disease discusses malaria, a disease caused by a plasmodium parasite which is transmitted by a different mosquito—the Anopheles—the argument about the historical disease geopolitics is very similar (see also, Kelly and Beisel 2011). What distinguishes the two diseases, however, is that there is a vaccine for yellow fever (Benchimol 2001).

words, the *A. aegypti* in Rio—as it thrives in urban landscapes, carries multiple viruses, and is impossible to control, owing to insecticide resistance—embodies past failures and future threats. New strategies, like the *Wolbachia* approach, attempt to provide a solution for this (future) challenge: modify the insect itself so it can be deployed in tackling the pathogens it can transmit.

"Remember to tell them that we release both males and females because each has a specific role to make the strategy work," said Fabrício, from the *Wolbachia* project's entomology team. We were entering the car, after an "engagement activity" in one of Rio's public schools. The *Wolbachia* project had started to collaborate with a few public-school teachers so that students could rear and release their own microbe-infected *A. aegypti*. The class would receive a box filled with eggs of *Wolbachia*-infected *A. aegypti* to soak them in water. By inspecting the mosquito daily, the children could learn about the different stages in the insect's life cycle: from egg to larva to pupa to adult. For the *Wolbachia* team, it was an opportunity to explain why now some mosquitoes were not just being allowed to live, but were even being reared to be released. These activities were organized and overseen by the engagement team but, today, in this first visit to the school, Fabrício—a biology major and one of the first technicians hired by the project—had come along to talk to students about the mosquito's biology.

Fabrício's recommendation highlights the twofold transformative reproductive labor of the *Wolbachia*-infected mosquitoes. Different from the other modified mosquitoes also being deployed in Brazil, such as the transgenic and irradiated *A. aegypti* (see Chapter 3), where only non-biting males are released, the *Wolbachia* approach requires both males and females. While only the infected-females pass the microbe to their progeny, the infected-males, when mating with uninfected females, engender the cytoplasmic incompatibility that reduces the overall number of *A. aegypti* without the bacterium. Both female and male reproductive labors, together, are crucial for *Wolbachia* to spread and establish itself into the wild *A. aegypti* population—a process scientists call "*Wolbachia* invasion" (e.g., Hoffmann et al. 2014; Dutra et al. 2015; Garcia et al. 2019).

"We release these mosquitoes, and nature does its part. We have to do the releases only for a few weeks, because it is the mosquitoes themselves that will continue and maintain this project." This was how both researchers and technicians would usually explain the *Wolbachia* project. Therefore, the transformative reproductive labor performed by these bioengineered mosquitoes was mobilized by proponents to define the *Wolbachia* strategy not only as "self-sustaining," but also as "natural." But by instrumentalizing mosquito's biological reproductive capacities alongside the bacterium's reproductive alterations, the *Wolbachia* team went a step forward: the aim was to coopt the *A. aegypti*'s "invasion" with an "invasion" of their own. The bacterium transforms the *A. aegypti* into a non-vector while also inverting the vectorial direction in relation to the mosquito-microbial spread. That is to say, in the (future) ecology of history envisioned by the *Wolbachia* project scientists, living alongside mosquitoes, even as they expand to new lands, would not be an alarming health concern—as long as these insects are hosting the microbe.

Naturalized Brazilians

"Who here has had dengue or knows someone who has had dengue?" This was how Iara would start her presentations about the *Wolbachia* project. A technician from the engagement team, she often gave talks at healthcare centers, schools, and community gatherings to explain why mosquitoes were now being released. After asking this question, Iara would tell the audience to look around and notice the number of raised hands: almost always it was every single person in the room, including her and me. A very charismatic speaker, Iara would use this moment to assert how dengue and other mosquito-borne diseases were an extremely relevant issue and that addressing them was utterly important and urgent.

Iara would then go on to give more details about the novel *Wolbachia* strategy, mentioning that it had been developed in Australia and that the first releases had also been done there. "But Australia has 60 cases of dengue per year—this number we might have it in just one street during an outbreak here in Rio,

right?"[79] People would nod or voice an "uh huh" in a sorrowful agreement. Iara would continue, "So although they have already tested this technology in the lab and made releases in Australia, it's the releases here in Rio that will validate the effects of *Wolbachia* in controlling diseases." To put it differently, while the *Wolbachia* strategy had been developed and first tested in Australia, it was in Rio—with its recurrent outbreaks and its alarming high number of cases—where the approach could have more meaningful results, yielding clear and more tangible epidemiological data.[80]

However, to deploy the modified mosquitoes in Rio, I found that researchers and technicians had persistently to "nationalize" the project, adapting it to the city's environmental conditions—so that local *A. aegypti* could mate with the modified ones, spreading the microbe—and transforming it into a legibly *national* endeavor—so that local humans could view releasing *more A. aegypti* as a public health solution. Modified mosquitoes had to become sort of "naturalized Brazilians." What I refer to as "naturalized Brazilians" entails more than the transformation of a nonhuman animal, shaped by particular national histories, into a resource—what scholars such as Sarah Franklin (2006; 2007) and Sakari Tamminen (2019) have analyzed as the crafting of a nation's "biowealth." The dual meaning of *naturalized* here portrays both how the *Wolbachia* strategy had to be made into a Brazilian project but also how Rio was made to be the "natural" place to test the strategy. Brazilian "nature" turned into both a generalizable and exemplar mosquito ecology.[81]

The strategy had been developed after a group of researchers in Australia managed to use microinjections to transfer the bacterium from the fruit fly *Drosophila* to *A. aegypti* embryos (McMeniman

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[79] In Australia case notifications are higher than that, but the majority are cases of people infected abroad. While the number of autochthonous cases is relatively small, because of the A. aegypti's presence, there is always the risk that just one infected person might start an outbreak (Australia 2019; Akter et al. 2019).

[80] After releases in Australia, field trials were also conducted in one site in Viet Nam and two sites in Indonesia, countries that also have a high incidence of dengue (Dutra et al. 2015, 3).

[81] For ethnographic investigation into "ecologies of comparison," see Choy (2011); also Lowe (2006).

et al. 2008; Ritchie 2014).[82] Later, the Brazilian scientist (Dr.) Leandro, who had been postdoc at this group, became a Fiocruz researcher and decided to employ the approach in Brazil. With funding from Fiocruz, the Brazilian Ministry of Health,[83] and the US-based Foundation for the National Institutes of Health, with resources from the "Grand Challenges in Global Health Initiative" of the Gates Foundation, Dr. Leandro spearheaded efforts to test the strategy, collaborating with several other Fiocruz researchers with different disciplinary backgrounds, from entomologists to community engagement experts. At the time the initiative, undertaken as a Fiocruz project, was named "*Eliminar a Dengue: Desafio Brasil*" (Eliminate Dengue: Brazil Challenge).[84]

In 2012 around four thousand eggs from *Wolbachia*-infected *A. aegypti* were shipped from Australia (IBAMA license 11BR005873/DF). Prior to release, however, these "Australian" mosquitoes had to be backcrossed with "Brazilian" ones: bacterium-infected females were mated with local (wildtype) males collected from four different districts in Rio de Janeiro (Paquetá, Jurujuba, Belford Roxo, and Vila Valqueire). The mating process was repeated for nine generations to create an *A. aegypti* population that would be infected with *Wolbachia* but have a "Brazilian" genetic background (Dutra et al. 2015).[85] In other words, "nationalized" through reproduction, these insects would contain the genetic heritage of Rio's *A. aegypti*, shaped by efforts to control past and recurring epidemics, while at the same time hosting the microbial infection that could transform these mosquitoes into a solution for ongoing and future

[82] First experiments were done with the strain wMelPop because it had been shown that the microbe caused mosquitoes to die prematurely, which would shorten their time as a possible vector. Later experiments showed Wolbachia was also blocking the infection of dengue virus. Thus, another, less virulent strain (wMel) was adopted, one which hinders viral replication but does not affect the insect's lifespan as much (Ritchie 2014, 365).

[83] The Ministry of Health funding came through the Secretaria de Vigilância em Saúde (Secretariat of Health Surveillance) and the Departamento de Ciência e Tecnologia from the Secretaria de Ciência, Tecnologia e Insumos Estratégicos (Department of Science and Technology of the Secretariat of Science, Technology and Strategic Inputs).

[84] Smaller parts of the larger project also included collaborations with researchers from other universities.

[85] This backcrossing was maintained in total for 17 generations, before releases were approved; subsequently, every five generations, a new round of males from a Rio de Janeiro wild population (10%) was added to "refresh the genetic pool" (Garcia et al. 2019, 4).

epidemics.[86] This newly fabricated lineage (called *w*Mel_Br line) was the very embodiment of the mosquito's (future) ecology of history.

With this new "nationalized" *Wolbachia*-infected mosquito line and approval from governmental agencies, trials in the city began, with pilot releases conducted in peninsular neighborhoods, in more remote parts of the city.[87] Starting in September 2014 and lasting for 20 weeks, around 180,000 mosquitoes of the "Brazilian strain" were released throughout the lower-middle-class community of Tubiacanga, a neighborhood in a more remote area in the north part of Rio, located in a lowland coastal area that is surrounded by the Guanabara Bay and the Galeão International Airport.[88] Monitoring during this first trial showed that the *Wolbachia* continuously spread across the *A. aegypti* population in the first weeks of releases. These numbers, however, later plateaued and, once releases stopped, the microbe did not manage to establish itself in the local mosquito population—in the scientists' parlance, there was no *Wolbachia* invasion. Fiocruz researchers investigated the matter, concluding that these results were probably due the *A. aegypti* population in Tubiacanga being highly resistant to pyrethroid insecticide (Garcia et al. 2019).

Although the *A. aegypti* used for the backcrossing had been collected in Rio de Janeiro and had a significant prevalence of the pyrethroid resistant alleles—as do most *A. aegypti* populations across Brazil—after several generations inside the laboratory, the trait became less and less common, going from a 68% to 3.5% prevalence (Garcia et al. 2019). The National Research Ethics Committee (CONEP) had authorized releases under the condition that there should be no changes to the community's or the municipality's vector control strategy practices; because of that, insecticide was still being widely used during releases. The

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[86] There are strange echoes here with early 20th century (human) "whitening" policies that embraced miscegenation and pivoted (heterosexual) reproduction to create a new (miscegenated-White) Brazilian national body (Chapter 1).

[87] Releases were first authorized by the National Research Ethics Committee (CONEP, CAAE 02524513.0.1001.0008); then later by three Government agencies: IBAMA (Ministry of Environment), ANVISA (Ministry of Health) and MAPA (Ministry of Agriculture).

[88] In this first round the protocol was to release, early in the morning, around 50 mosquitoes (which were 4-6 days old) in front of one in every four houses "The total number of mosquitoes released per week increased over time, starting with 7,500 on week 1 and ending with 15,000 on week 20" (Garcia et al. 2019, 5).

released mosquitoes, thus, not resistant to pyrethroid, were more affected by the insecticide, hindering their capacity to mate and reproduce and, consequently, jeopardizing *Wolbachia*'s capacity to spread and maintain itself in Tubiacanga's *A. aegypti* population. For future releases, researchers had to not only do the backcrossing but also conscientiously select for insecticide resistance alleles. That is to say, yet another step had to be added in the lab to make the modified mosquitoes as "naturally local" as possible.

Then, in 2015, the Zika epidemic spotlighted the *A. aegypti* and Brazil,[89] making the (future) threat of mosquitoes crossing borders and moving up towards the U.S. and Europe more alarming and more tangible—and changing the (possible) stakes of the *Wolbachia* project. With different approaches under development to modify mosquitoes, there was a race to be the first group to produce clear epidemiological data. In this context, pilot trials became plans to release mosquitoes in many neighborhoods across Rio. In the course of this expansion, several Fiocruz researchers left the project. When I talked with some of these researchers, they all mentioned the *Wolbachia* strategy's potential and were optimistic about its success but that felt that there was significant pressure from "the Australians" to validate and implement the technology. As one of these scientists put it, "I left because it was no longer a research experiment, it was about getting it done."

Therefore, this expansion also meant another shift: from being primarily a scientific experiment undertaken mostly by Fiocruz researchers and their students, as the *Eliminate Dengue: Brazil Challenge* project was, towards becoming a *World Mosquito Program* initiative. As a communication technician explained, the group needed a recognizable brand to facilitate plans to start operations in other cities in Brazil and in other countries. In other words, although Rio releases were still undertaken as part of Fiocruz, results had to be connected to a global endeavor, if the group wanted to make general claims about

[89] For more on the alarmed and affectively charged discourse of emergency and inevitability, see Oikkonen (2017). The Zika virus epidemic also drew attention to the social and personal impact mosquito-borne diseases have in families and communities, especially in a context in which disabled people face social barriers and a lack of public policies that address their needs (A. C. R. da Silva, Matos, and Quadros 2017; Williamson 2018; Lustosa Alves 2019; Fleischer and Lima 2020).

efficacy—or future efficacy—elsewhere. This expansion/transition was visibly noticeable during my fieldwork: the website was renovated, new uniforms provided, publicity materials redone, and more than one hundred people, most of them technicians, were hired.

In January 2018, WMP/Fiocruz also signed a "technical cooperation agreement without transfer of resources" with the Municipality of Rio de Janeiro. WMP would train the *agentes*, so that they could help with "engagement activities," as well as with releasing and monitoring of the *Wolbachia*-infected mosquitoes.[90] The inclusion of the *agentes* not only facilitated the project's expansion in the city but also supported plans for expansions elsewhere, proving an opportunity to develop a "protocol" for training sessions. These would be necessary because, I was told, the goal was that in future locations, WMP workers would only train local health workers, who would undertake the entire operation, albeit still under the WMP's supervision. These workers were part of the national health system, and having them explain the strategy, conduct releases, and monitor results, (re-)fashioned the project as a public health initiative. Therefore, incorporating these *agentes* also resulted in another arrangement to turn the project into a "naturalized Brazilian."

Navigating Racialized Ecologies

"If it works here, we can make it work anywhere else in the world." This was how Dr. Jack, the Australian medical entomologist and coordinator of the global WMP endeavor, explained the relevance of the Rio-based releases during one of his many visits. Throughout my fieldwork I noticed how the city was often presented as the epitome not only for environmental and epidemiological challenges but also for urban challenges that the project might face in other locations, especially in Global South cities across the world:

[90] The plan was that the community health workers would undertake the "engagement activities" and the endemic disease control agents would release and monitor the mosquitoes. However, because of an overall shortage of health workers in Rio, both groups ended up doing both types of activities.

the traffic jams, the populous landscapes, and the deadly violence besetting the city. And it was during the task of releasing the modified mosquitoes that these challenges were most vividly experienced.

Although on a global scale, the *A. aegypti* species is swiftly spreading to new regions, the individual mosquito usually does not fly long distances. Therefore, it was up to humans to navigate Rio's checkerboard of high-security gated communities and difficult-to-access low-income neighborhoods to release the *Wolbachia*-infected insects. To accompany the technicians from the release team, I was told to arrive at Fiocruz—where the mosquito rearing facility was located—at 4:30 in the morning. Once there, I moved towards the group of men who were drinking coffee and eating crackers, while others organized plastic crates filled with tubes, putting them inside small mini-van-like (*Fiat Doblo*) gray cars. I noticed that the cars had stickers (one on each side, and a third one on the back), with the same words that had been emblazoned on the turquoise vests that I and the release technicians were wearing: SAÚDE | FIOCRUZ. Just like our vests, these stickers were there to provide us a kind of protection and credibility as we moved through Rio releasing the much-hated, blood-sucking *A. aegypti*.

Just as the first streaks of light appeared, the release technicians got into the cars, with two men in each. I joined Kevin, the driver, and Paulo, who sat in the back seat, next to the crate with tubes teeming with mosquitoes. We sat inside the car, waiting for *just* the right time to leave. It had to be early enough to avoid rush hour traffic—in the heavy congestion, the release ride would be too long, making it more strenuous for technicians and mosquitoes alike—but, for our safety, not under the cover of darkness. Not only could the lack of light put the release technicians in a dangerous situation, but also a car driving slowly, especially in the dark, could be seen in Rio as a potential threat, provoking suspicion in passersby.

As we waited, Kevin opened an app on his phone, showing it to me. "Here is the route we will do today. We have been doing this route once a week for the last five weeks, so we already kind of know it by now," he said, while placing his phone on a car mount. "But I will keep the app open, to make sure we are going the right way." As Kevin said that, the release team coordinator knocked on the car's window: the sign that it was time to go. Kevin started driving, but continued talking. "The data team made this route for

us. The red line shows us where we should go, so I pay attention to that. Now, these red dots along the way mean a release. I drive slowly so Paulo has enough time to open a tube for each of these dots." After a short pause, Paulo added, "And we will have to keep doing this route until they have data proving that the *Wolbachia* has been established into the *A. aegypti* population in that area."

As we drove, Kevin explained that every time they got a new route, the first step was to do a "*reconhecimento*": a reconnaissance to identify the areas in which the release technicians said they did not feel "comfortable entering." The data team had already made the routes based on maps from the Municipality, excluding neighborhoods considered to be areas of "social vulnerability," that is, with low indicators for urban infrastructure, quality of life, and income—areas where it would be the *agentes* who would do the releases. However, as Kevin told me, "These divisions within the city are always changing, the lines the municipality drew might not make sense anymore. The *reconhecimento* is to feel where the lines are now." I asked both of them many times how they discerned whether an area in the city was safe, but the answers were usually elusive. "You can feel it," Paulo replied, "Something changes in the air. You start feeling like you are constantly being watched and it would be unwise to enter."

"To enter" or not was an issue not only for the release team but also for those in the engagement team, who also had to navigate the city to explain the *Wolbachia* strategy to Rio residents. The topic was often a cause of heated disagreement between technicians. On one side there were those like Iara who considered that, although safety should always come first, it was paramount to reach as many people as possible because, as she put it, "everyone had the right to know this project was going on." She argued that the project should coordinate with *agentes*, community leaders, or other well-known residents from these neighborhoods considered to be "too dangerous," so that they could enter alongside the technicians.

An outspoken Black feminist, Iara was herself a resident of an area defined as dangerous, and the two of us often had long conversations about the city's racialized unequal histories and geographies. Iara's home was the very result of these institutionalized historical inequalities: a state-built apartment in the *subúrbios*, where her mother had been relocated to live in the 1970s. Iara's mother, alongside others living in a

community in the hills of Gávea, located at Rio's wealthier south side, had been displaced so that a tunnel could be built (see Chapter 1). For Iara "entering" should be considered a political act. After all, it meant not reproducing the historical disregard towards those living in the *subúrbios* and *favelas*. It meant countering the selective presence and absence of the state in these communities, which left them to fall into what medical anthropologist João Biehl (2005) has called as "zones of social abandonment" (see also Goldstein 2003).

On the other hand, there were those like Mariana, who argued that entering these areas was simply too risky. She complained that the coordinators promoted the importance of reaching as many people as possible to inform and explain about the project but that these coordinators were rarely the ones who had to enter neighborhoods considered to be too dangerous. "The *diretoria* (managers) are always telling us how important it is to let people know we are releasing mosquitoes, that it is our duty to go everywhere to tell people about the project, that people have the right to know what is happening. I know it is important…" Mariana took a deep breath. After a short pause, she looked straight into my eyes and said, "But they are not the ones putting themselves at risk. They expect us to enter, and we end up doing it because we need this job." Although the technicians were a diverse group of people, all the coordinators (the *diretoria*) were White. For Mariana, then, having to enter certain neighborhoods was the byproduct of precarious, hierarchical labor conditions—an illustration of racialized class differences within the project.

When discussing whether they should enter or not, neither the release nor the engagement technicians mentioned the race of those living in the neighborhoods considered to be unsafe—but these were almost always majority-Black communities, marked by poverty as a result of economic oppression, forced displacement, and governmental neglect (J. H. C. Vargas 2005). In these neighborhoods, there was indeed the risk of gunfights or perilous episodes (for example, two technicians were once stopped at gunpoint and questioned about their presence there). However, it should not be left unsaid that those most affected by this violence are not those choosing to enter or not, but those who live and work in these areas, who

experience, daily, the pernicious effects of Brazil's inequitable and racialized urban history (Leite 2012; M. Franco 2014; Penglase 2014; T. Mendonça 2014; Denyer Willis 2018).

For part of my fieldwork the state of Rio de Janeiro was under "federal intervention": from February 2018 to January 2019, the National Army was able to "exercise operational control over all state organs related to public safety." During this period there was a striking increase on the number of police killings and on the number of killed police officers, with those most lethally affected by this violence being Black young men (Barbon and Nogueira 2018; but see also Rocha 2014; Farias, Lago, and Efrem Filho 2020). Therefore, in these neighborhoods, mosquito-borne diseases were considered as just yet another threat to their existence. Or as a resident put it during a public engagement activity, when an engagement technician argued for the importance of addressing the pathogenic viruses transmitted by the *A. aegypti,* "Dengue might kill, but what really kills are 'stray bullets,' which always end up somehow finding their way into the Black people around here."

It was, however, not only in low-income neighborhoods that the technicians faced challenges. In gated communities, the housing of choice for the rich, segregated from the rest of the city by high electric fences and watchful armed private security, entering was generally impossible. Because the project's success depended on *Wolbachia*-infected mosquitoes reaching and mating with as many wild *A. aegypti* as possible, the release technicians tried different ways in: they would talk first with security guards, who usually would tell them they needed to go through a complicated bureaucratic process (this was almost always was a dead end); they would talk to the *síndicos*, managers of these gated communities, who would create a series of obstacles and demands (again generally leading nowhere). Hence, barred from entering these areas, the technicians would resort to driving around these fortified enclaves, as they opened tubes and tried to release the mosquitoes upward, towards the gated community, in the hopes these insects would manage to cross the physical and class barriers these walls represent (see Caldeira 2000).

The project had means to pay for cars for the technicians to conduct the releases; the *agentes,* on the other hand, usually did this work on foot. Moving by car or by foot can be understood not only as two forms of releasing mosquitoes, but also a representation of two ways to provide healthcare. With the car, technicians could drive through an area faster, conducting releases at a much faster pace so that, once *Wolbachia* was established, they could proceed to the next route—an approach that was possible because they had generous funding to conduct a temporary global health project. By walking the *agentes* went slower, but they also could greet familiar residents who passed by and they could be seen and recognized, granting them access to parts of the city the project could not enter—something that was possible only because of a comprehensive public health infrastructure.[91]

But as they conducted these releases on foot, *agentes* were more prone not only to being bitten but also to hearing passersby complain about being bitten One day, as I was walking with one of these health workers, Gustavo, he mentioned that in the beginning people found it bizarre that now, after telling these residents for years about the importance of not letting mosquito live and breed, he was going around releasing them. He had to explain the project over and over, so many times, making him even more tired than usual. Gustavo had another job: at night he worked as a security guard. It left him exhausted, but he needed it to pay his bills. As we walked, we discussed the ongoing dismantling of the healthcare system, as he complained about the low salary and the complete disregard the municipality had for health workers like him. “They have not even sent us uniforms in such a long time,” Gustavo told me. “Luckily, I don’t even need one. I’m known here. My face is my uniform. Do not worry, with me here, you are safe.”

There is a parallel, thus, between the *Wolbachia* project’s implementation and my own presence in Rio. As a (White) Brazilian researcher, I could only afford to conduct long-term ethnography because I was being financially supported by fellowships paid in dollars. And as an anthropologist who was there,

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[91] Analyzing the community health worker’s “andanças” (walks), the anthropologist Carolina Nogueira (2016, 98) has argued that “care is woven by the 'andanças'.” Through ethnographic descriptions she shows how there are “threads and traces of bonds that are produced by and through the walk.”

temporarily, to collect data, I could only move across some neighborhoods because alongside me there was an *agente,* who had worked there for years. As I investigated the deployment of the *Wolbachia*-infected mosquitoes, I was keenly aware of how my research, and myself as a researcher, were also navigating scales, entangled in the unequal, racialized histories of science-making in Brazil. Therefore, not only is the (future) ecology of history racialized but also its study.

Vectors of Health

By analyzing how my interlocutors strategically navigated multiple scales—national, global, city, neighborhood, planetary, and even molecular and organismic—this chapter identified how the *Wolbachia* project mobilized different mosquito ecologies: from insecticide-resistant *A. aegypti* populations flying into homes that have become out of reach for *agentes*, to predictions of future mosquitoes moving up towards Europe and the United States. As the *Wolbachia* strategy instrumentalizes the mosquito's biological reproductive capacities and the bacterium's reproductive alterations, it transforms the *A. aegypti* into a no-longer-vector of pathogens. Here, health becomes a multispecies vector that can be manipulated and modified for human benefit. But these vectors are also entangled with particular naturescultures,[92] shaped by racialized histories of exclusion, dispossession, and insecurity. To deploy microbe-infected *A. aegypti* in Rio as both a global health initiative and a national scientific/public health intervention meant navigating the lived geographies of health-making and science-making in an unequal and precarious world.

[92] Although the term is usually naturecultures (Haraway 2008; 2016), the nature singular and cultures plural might allude to the Boasian Western idea of multiculturalism (one nature, many cultures), a tenet that several scholars have questioned (Viveiros de Castro 1996; TallBear 2011; Yates-Doerr and Mol 2012; Sundberg 2014; de la Cadena 2015; Todd 2016).

- Chapter 3 -

THE GEOPOLITICS OF KNOWLEDGE AND MORE-THAN-HUMAN WORK

Irradiated Mosquitoes in the Northeast (Recife and Fernando de Noronha)

After a flight of about an hour, I stepped out of the plane—my skin feeling the sun's warmth and my eyes still adapting to its brightness—and turned on my phone to find several missed calls and unread WhatsApp messages. It was Antônia:[93] "Luísaaa! When do you leave for Noronha? Can you take the mosquitoes with you? I can meet you at the airport! The person who was supposed to take them tomorrow just told us she will have to cancel her trip." I wrote her back to say that I had just landed in Noronha, sending her a photo I took from the plane as it was approaching the island—astonishing rocky formations and lush green vegetation, surrounded by breathtaking shades of blue and green ocean.

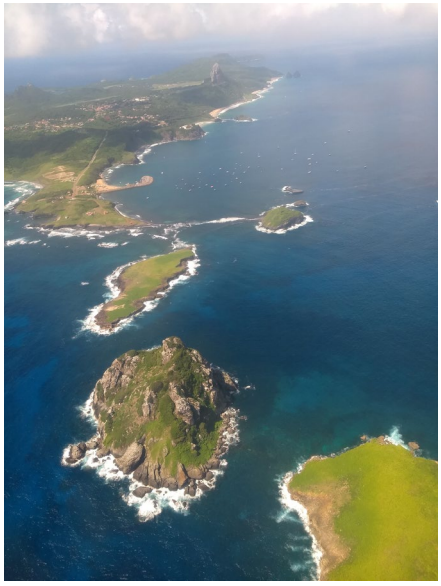

Figure 2: The aerial photo from Fernando de Noronha sent to Antônia

[93] In this chapter, I also primarily use pseudonyms, with most names chosen by my interlocutors themselves. However, some of my interlocutors explicitly asked that I use their real names and I mention aspects of their identities, which means most people from my fieldsite will probably recognize who I am referring to here. Once again, I also use the title Dr. as it was employed by the majority of my interlocutors.

"So beautiful," she texted me back. "You are so lucky! Still cannot believe these mosquitoes get to travel to this paradise but I have never been there!" A lab technician in the Entomology Department at the Aggeu Magalhães Institute in Recife, Antônia worked in the project irradiating male *A. aegypti* mosquitoes. Once a week, these insects were sent to the island of Fernando de Noronha. Sterilized with gamma radiation, these males were expected to engender a sort of *contraceptive* reproductive labor: to mate with the island's wild *A. aegypti* females while inhibiting reproduction and the existence of future mosquito generations.

The Fernando de Noronha Archipelago is comprised of 21 islands and islets, with the eponymous main island administratively divided into two: together with the other islands and islets, 70% of the main island is a National Park, established in 1988 and managed by the Chico Mendes Institute for Biodiversity Conservation; the remainder area is the only inhabited part, governed as a district of Pernambuco (without any municipal elections). [94] In this chapter, I focus on the latter, where residents live and tourists stay—eager to sunbathe on the white-sand beaches, swim alongside turtles and colorful fish, and hike the verdant hills. A UNESCO World Heritage Site since 2001, the archipelago is home to a notoriously diverse marine life, although climate change and warming waters are having profound effects on these ecologies, with a particularly striking increase in coral bleaching (Soares 2018).[95]

Noronha is a favorite among many wealthy celebrities, whose glamorous photos in paradisal sceneries have helped turn the island into an even more famous and coveted—and as a result more

[94] The island of Fernando de Noronha has an area of around 17 km^2 (around 6.56 mi^2), being 10 km (6.21 mi) long and, in its wider part, 3.5 km (2.17 mi), with a perimeter of approximately 60 km (37.28 mi). Tourists are allowed to visit the national park but no construction is permitted. Before Brazil's independence, this strategically located island had been fiercely disputed among Portuguese, Dutch, and French colonial powers interested in naval tactics and colonization aspirations.

[95] The United Nations Education, Scientific and Cultural Organization (UNESCO) designated the archipelago as a World Heritage Site, alongside the islands of the Atol das Rocas Biological Reserve, due in part to its importance for the breeding and feeding of tuna, sharks, cetaceans, turtles, and marine mammals, including the exceptional population of dolphins residing in the Baía dos Golfinhos. The islands are also home to the largest concentration of tropical seabirds in the Western Atlantic (UNESCO 2001).

expensive—travel destination.[96] This "paradise" also hosts a growing *A. aegypti* population. Public administrators and health officials worry that an outbreak would not only be disastrous for local residents and temporary workers (who depend on the island's medical infrastructure for basic primary care), but would also scare away tourists, devastating a local economy that depends entirely on their visits. Ecological regulations protecting Noronha's biodiversity forbid the use of chemical insecticide. It was in this context that the deployment of irradiated *A. aegypti* males was being tested as an alternative to control mosquitoes and the pathogens they can transmit.

After collecting my backpack and paying the environmental preservation fee (73.52 reais for each day in the island),[97] I took a shuttle to Josué's house—though because the paved street did not reach the house, and the heavy rain the day before made it impossible for the van to navigate, I walked the last two blocks on foot. Josué was an *agente de combate à endemias* who had converted most of his home into rental rooms for tourists and the occasional researcher, in order to supplement his salary as a health worker.[98] Later, I learned that this was extremely common. Only registered residents can own land on the island, but the exorbitant living costs and high demand for accommodation have led many families to cram into one small room or even a shed (*barracão*), while renting out their home (Pernambuco 2016).[99] The room in

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[96] In 2018, a famous actress, Bruna Marquezine, went viral (and became a meme) after posting a photo of her diving in the island with a caption of "Noronhe-se" (se being the reflexive pronoun in Portuguese, the translation would be something like "Noronha-yourself") (R. Evangelista and Dierkes 2018).

[97] The U.S. dollars–to–real conversion rate fluctuated considerably during my fieldwork, with the real becoming increasingly devalued (the trend continued and it is even more devalued at present). When I went to Fernando de Noronha, US$1 was around R$3.75; thus, the fee cost me about US$ 19.80 per day. When converted to dollars, this might not seem much, but it's a steep amount for most Brazilian tourists.

[98] He charged me the "special rate for researchers," 280 reais per night (normal rate, he said, was 330 reais). This was by far the most expensive accommodation I had during my multi-sited fieldwork in Brazil. Josué lived in Noronha with his son, while his wife and older daughter had moved to the mainland, living with family in Natal, capital of the also northeastern state of Rio Grande because, he told me, costs there were lower and schools were better.

[99] Several islanders told me that wanting to maintain control over who could own land on the island was the reason behind why being born on the island had been "forbidden." In 2004, Noronha's only maternity ward was deactivated, on the grounds that the average of 40 births per year did not justify the cost of maintaining it. Thus, in their seventh month of pregnancy, women are sent to the continent, where they stay until they give birth, enduring isolation and emotional stresses (Schvarsberg 2015; C. Costa 2015; Nin 2021). Land ownership rules were also updated in 2020, part of an effort to address the housing deficit in Noronha. The District Housing Policy changed some of the criteria to avoid having people owning land/houses on the island but living on the mainland (Pernambuco 2020).

which I was staying had just been remodeled, Josué told me a few days later. As we drank coffee on his porch, overlooking the exuberant greenery surrounding the house, he said, "I have plans to add another room, but I'm doing it slowly. Many people build in a hurry here, eager to make fast money. But it's very expensive to bring things to the island." To illustrate how prices were inflated, Josué mentioned that one brick could cost around 3 reais on the island, compared to 0.35 a unit in Recife. Then he added, "The result is that there are a lot of badly constructed houses out there."

Exploring the island either by myself or with Josué, other *agentes* or health officials, I noticed peculiar architectural styles: buildings with multiple added-on rooms, visibly different from the main structure, constructed of varying materials that gave the entire assembly an odd shape and, at times, questionable stability; hotels with lavish entrances but with hidden shabby and overcrowded quarters for workers, built in such a way that they often looked flimsy and insalubrious. And even though materials on the island were expensive, there seemed to be construction and expansion happening on every available plot of land—most of it using the cheapest, make-do materials available. Noronha's tourism boom and resulting swift urbanization was putting growing pressure on the island's infrastructure. I was warned, for example, that water distribution was recurrently interrupted due to high demand. Residents mentioned that the tourists did not understand the particularities of life in the island and demanded, for example, constant water for extremely long showers. Therefore, most houses had placed multiple tanks (*caixas d'água*) to store water or even collect rainwater—creating the perfect conditions for the *A. aegypti* to flourish.

"People often think Noronha is paradise on Earth, a luxurious vacation destination, but that is not the full picture," Dr. Sandra pointed out in our first conversation about the irradiated mosquito project. "There is a lot of poverty there. Many people are living under horrible conditions… They just don't show that in the brochures." Dr. Sandra was one of two researchers leading the vector control project on the island. A medical entomologist at the Aggeu Magalhães Institute, she and her team were responsible for managing the insects' breeding and rearing, organizing their shipment to the island, and evaluating the strategy's outcome. Her collaborator, Dr. Josiane, a researcher in the Department of Nuclear Energy at the

Federal University of Pernambuco (UFPE), also in Recife, led studies to calculate the irradiation dosage that the male *A. aegypti* should receive.

Besides controlling mosquito-borne diseases to improve health conditions, another factor motivated Dr. Sandra's interest in developing a project in Fernando de Noronha: the possibility of working in an island environment. She had other ongoing projects that involved releasing irradiated sterile mosquitoes in more remote neighborhoods in Recife but, in her opinion, Noronha promised for the best results in deploying this strategy. As she put it, "The smaller the geographic contiguity, the more constrained the material [male mosquitoes] you are releasing." In other words, the strategy of sterile insects would be more effective on the island because all released males would stay in the targeted area, mating with the wild females and, because of this contraceptive reproductive labor, reduce the mosquito population. Even though since the 1950s irradiated males have been deployed across the world to control insect species considered to be pests, so far, no success has yet resulted from deploying irradiated *A. aegypti,* only other mosquitoes, such as *Culex* and *Anopheles* (Knipling 1955; Dyck, Hendrichs, and Robinson 2005; Dame et al. 2009).[100]

While *Culex* and *Anopheles* bite both humans and other animals and can thrive in sparsely populated environments, the *A. aegypti*, due to its anthropophilic preference, proliferates in urban spaces. Noronha is a small island, but it also shares characteristics present throughout Brazilian cities: informal,

[100] Developed in the 1930s-40s, the strategy of releasing individuals of the pest species to introduce sterility—the sterile insect technique (SIT)—has successfully controlled populations of screwworm flies, tsetse flies, fruit flies, and moths (Hendrichs, Robinson, and Dyck 2005). More recently, funded by the International Atomic Energy Agency (IAEA), several projects have been revamping this technique to adopt it in mosquito species harmful to human health (Helinski et al. 2008; IAEA 2013; Bond et al. 2019; IAEA 2021; Oliva et al. 2012; Vreysen et al. 2021). Irradiation is the most common method to induce reproductive sterility, although chemicals have at times also been used. The anthropologist Sandrine Dupé was part of a multidisciplinary group assessing the use of SIT to control the Aedes albopictus in the island of Réunion, a French overseas department and region (see Oliva et al. 2012 for more on the project; see Dupé 2015; 2019 for more on anthropological analyses of human-mosquito relations). Some proponents of transgenic mosquitoes argue their strategy is a continuation or a variant of SIT—even when transgenic males are not fully sterile—while at the same time claiming the genetic strategy overcomes SIT's shortcomings (Reis-Castro and Hendrickx 2013).

dense urbanization; precariously built shacks next to luxurious buildings; overcrowded housing conditions; and inadequate infrastructure. For Dr. Sandra and her collaborators, Noronha was the ideal site for testing the strategy because it combined both the conditions of an urban Brazilian landscape and the small, "contained" area of an insular environment—following a long history of islands being seen as "natural laboratories" (Greenhough 2006; Gugganig 2021). "For now, we are starting small, doing releases in a more isolated part. The island is so outbreak-prone. We have to do something!" Dr. Sandra told me one day, with determination in her eyes. Her plan was to eventually reduce, or even suppress, Noronha's *A. aegypti* population, so inspection and surveillance could focus on avoiding the insect's reintroduction from the mainland, targeting places such as the constantly arriving ships and planes.

"In Noronha, there is a serious issue in finding and retaining personnel to work in public health. The salary is already higher than what *agentes* get paid here in Recife, but it is still not enough for the high cost of living. Besides, people there can make a lot more money working with tourism," Dr. Sandra explained. Away from the island and aware of this staff shortage and high turnover, she knew that the vector strategy could not be too labor intensive or require much training and infrastructure. "That is why we do everything we can in Recife: mosquito rearing and irradiation, counting eggs to measure population size… It would be easier, probably even more effective, to do some of this work there. But that is just not feasible." Carrying out most of the activities in the Aggeu Magalhães also meant that Dr. Sandra and her team had to share space and equipment with other researchers and students. "It's hard sometimes, you know, because we have to adapt to what we have available here. It's not like we have a bio-factory just to produce these mosquitoes and we have very limited funding. So, we must improvise to make it work!"

The Aggeu Magalhães, a well-known and renowned research institute, is linked to the Ministry of Health.[101] However, besides the sweeping budget cuts for science and education in Brazil, some of my

[101] Inaugurated in 1950, the institute focused at first on the study of schistosomiasis, a disease caused by parasitic flatworms called schistosomes that live in certain types of freshwater snails and that can cause abdominal pain, enlarged liver, and blood in the stool or urine. The institute was first linked to the national government in 1958,

interlocutors in Recife deemed that research being done in the Northeast—a historically marginalized region—was undervalued and underrated in a national scientific arena comprised mostly of researchers affiliated with institutions from the South and, in particular, from the Southeast, including in the national funding agencies. For example, a 2018 study showed that researchers in the National Council for Scientific and Technological Development's Advisory Committees were 59% from the Southeast and 20.8% from the South (G. Nascimento 2018, it also revealed that nonwhite researchers constituted only 7.8% of participants—5.5% *parda*; 2% *amarela*; and 0.3% *preta*).[102] Cognizant of long-standing regional inequalities, Dr. Sandra and others at the institute judged that, while budget cuts were disastrous for Brazilian science in general, they were particularly devastating for Brazilian science done from the Northeast.

Therefore, irradiated mosquitoes were released in the hope of putting these insects to work in addressing mosquito-borne diseases, when there were added limitations on the possibility of humans to carry out that task, either because of the shortage of health workers in Noronha or because the island was too distant and expensive for researchers to access or because the project had to be undertaken with insufficient funding. The sterile males were conscripted into controlling their own population, with the gamma radiation expected to transform their reproductive capacities into a contraceptive reproductive labor. To put it differently, in a context where chemical insecticide is forbidden, mosquito mating itself was operationalized into a form of insecticide.[103]

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incorporated in the National Institute of Rural Endemics (INERu). Then in 1976, the Aggeu Magalhães, alongside other regional centers, became special units of the Oswaldo Cruz Foundation, within the purview of the Ministry of Health.

[102] Although it should be noted that there was no information for 17.9% of participants.

[103] In a forthcoming article at Environmental Humanities, I also examine this transformation of reproductive capacities in transgenic mosquitoes but call it "deadly reproductive labor" (Reis-Castro, forthcoming) Calling it contraceptive, however, highlights how the irradiated mosquito must act as similar to a contraceptive technology, which permits sex at the same time that it inhibits reproduction. While the genetic strategy was developed to eventually turn the mosquito into a potential product, in the case examined here, there was no effort to patent or commodify the insect. Another

However, sterilized insects were not the only agents enrolled to support the development of Northeastern research and science on Noronha—the island itself was also regarded as a key player. That is, the irradiated mosquito's biovalue could only be yielded in a particular geographic location and dependent on a larger more-than-human arrangement. Noronha's location as geographically distant, territorially isolated from the mainland, yet with a constant flow of people and objects arriving and leaving, as well as its dense, yet bounded, informal urbanization created the necessary conditions for the project's implementation. In this chapter, I argue that the combination of the island's geography and its more-than-human life produced a sort of *bio-geographic*[104] *value* for the project, permitting scientists to develop a project that had never been successfully accomplished.[105] In a context where human labor was considered insufficient, expensive, and often erratic, nonhumans were enlisted to do the work.

Expanding the STS literature on more-than-human work and biovalue production, environmental anthropologists Sarah Besky and Alex Blanchette (2019a), in their recently co-edited *How Nature Works: Rethinking Labor on a Troubled Planet*, provide novel ways to conceptualize how work is transformed through its contacts with nonhuman nature in what these scholars call "troubled ecologies." Besky, Blanchette, and the other book contributors ethnographically demonstrate the need to rethink more-than-human work in "a moment of conjoined economic and ecological precarity" (Besky and Blanchette 2019b, 1). I build upon and expand this conversation, by analyzing the bio-geographical value at play in the

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difference is that the transgenic insects were mass-produced in a bio-factory, designed and built specifically for this goal.

[104] As a branch of biology, biogeography documents and attempts to explain the geographic distribution of plants, animals, and other forms of life, either in evolutionary time (historical biogeography) or short-term, ecological effects (ecological biogeography). The field grew out of the work of naturalists such as Alexander von Humboldt (1805) and Francisco José de Caldas (1803). There is a sub-branch that focuses on the specificity of island biogeography (MacArthur and Wilson 1967).

[105] After my fieldwork, researchers published results showing A. aegypti suppression in Cuba—also an island (Gato et al. 2021).

irradiated mosquito project, examining as it emerges from the activities performed together by humans and nonhumans alike, including the island itself.

I here investigate how mosquitoes' reproductive capacities and Noronha's geographic location and more-than-human life were employed by Dr. Sandra and her collaborators as way to leverage Noronha's northeastern location—and the relatively less powerful position of researchers based institutionally in Brazil's northeast—into a project that could develop innovative science with limited funding. Based on ethnographic fieldwork and qualitative interviews with researchers, students, and technicians at the Aggeu Magalhães Institute in Recife as well as with *agentes* and health officials in Fernando de Noronha, I turn my attention here to the geopolitics of knowledge production *within* Brazilian science. This chapter investigates the nested, fractal hierarchies that characterize knowledge production and health interventions in the country—both to do with internal regional discrepancies as well as long-standing racial and class inequalities.

Science from "the Northeast"

"Yes, Brazilian science is truly suffering with the government cutting so much of the research budget, and I'm afraid it will only get worse. But it's not like all of us feel these cuts the same way," Dr. Sandra said, as we walked under the scorching midday sun from the Aggeu Magalhães' building to the Hospital das Clínicas, the university hospital just 300 meters (around 984 feet) away. "With a reduced budget, they can only support a very small number of projects. So, if I or someone else from the department here is competing for a grant with, let's say, a group from USP [the University of São Paulo], a group that already has all the best equipment, all the infrastructure they need for their project, who do you think will be chosen to get the funding?" She looked at me without slowing her pace, letting her grimace be the answer to her rhetorical question. We were on our way to the hospital to hunt down mosquitoes, to capture them with a suction

device (*aspirador*) consisting of a long tube attached to a small battery that could be carried around the waist with a belt.

Dr. Sandra would often go do this field activity herself and most of our conversations happened as we inspected the halls, elevators, and waiting rooms of the Hospital das Clínicas. Besides snaring mosquitoes with the suction device, she and her team of students and technicians had adopted other strategies to control the hospital's *A. aegypti* population. Where there was stagnant water, they scattered the *Bacillus thuringiensis israelensis* (BTI) bacterium, which is a biological larvicide that, once ingested, causes larvae to synthesize lethal endotoxins. In and around the hospital, they placed "disseminating traps," dark buckets containing the chemical pyriproxyfen, which mimics natural insect hormones and prevents larvae from maturing into adults—weaponizing *A. aegypti* natural behavior to lay her eggs across multiple breeding sites, and employing the mosquito to disperse the very chemical that will prevent its future generations. [106] "You cannot imagine how dreadful conditions were when we started," Dr. Sandra told me one afternoon as we examined the hospital's neglected underground level. "I couldn't stand by idly while I knew that so close to us people were being devoured by mosquitoes while waiting to get care."

A talkative and straightforward woman, she would speak passionately about how science should be both about producing new knowledge and having a positive impact on people's lives. In her opinion, researchers had an obligation to broader society, especially those who were affiliated with public institutions (such as the Aggeu Magalhães) and whose research was publicly funded. "It's almost our duty to think of ways to keep going, even with very little money. We establish partnerships, we adapt, and we keep going." In the context of already insufficient funding, Dr. Sandra often talked about the need to innovate in order to continue doing research, including transforming common kitchen and office supplies

[106] This egg-laying behavior is called "skip oviposition." It is unclear, however, if the A. aegypti distributes her eggs throughout several breeding sites to avoid high larval densities where food might be limited or if she does it to minimize the risks associated with these sites—that is, literally not putting all her eggs in one basket (Reiter 2007; Abreu et al. 2015). For more on these disseminating traps, see Abad-Franch et al. (2015).

into lab and field instruments. “We need to do our work with very limited funding! To make things worse, so much of what we need is produced abroad. Because of the dollar’s value, prices now are exorbitant, and it’s impossible to afford anything! We end up having to make a lot of things ourselves.”

Scholars examining science and design in Brazil have analyzed the common practice of using tools and resources at hand to create what might otherwise be unaffordable: a “Brazilian way” to recombine and deviate, known as *gambiarra*, which entails creative practices to make the best out of a situation of material inadequacy and bypass exclusionary socio-economic conditions (Boufler 2006; 2013; Rosas 2008; Pavesi 2017; Labruto 2018; Scott 2020). Here, however, I am less interested in the political and epistemological possibilities of these technological improvisations and more concerned with the historical and structural conditions that compelled Dr. Sandra and others in the Aggeu Magalhães to create *gambiarras*. That is to say, to be able to do science, in the context of deepened under-resourcing, meant having to constantly adapt and improvise.

As a tenured (*concursada*) researcher Dr. Sandra had job stability, but concerns over funding (or lack thereof) were a recurring theme in our conversations. In fact, they were a recurring topic across the board, with the other tenured researchers, the junior researchers and postdocs, the grad and undergrad students, and the lab technicians and outsourced (*terceirizados*) workers: How long would the project be funded? When would the stipend (*bolsa*) be paid? Would there be a call for applications (*edital*)? Would they hire again? My interlocutors frequently connected these financial matters to broader considerations about the challenges of doing science in Brazil and, more specifically, of doing science in the Brazilian Northeast. In particular, they would denounce the geopolitics around “Brazilian science”: the long-standing regional disparities in funding and the belittlement of their work in the national scientific arena.

The controversy involving the Zika virus and the mosquito species *Culex quinquefasciatus* was often brought up by some of my interlocutors to illustrate how science done in the Northeast was not given its due credit. *C. quinquefasciatus* can be a vector for the parasitic worm *Wuchereria bancrofti* that can

cause lymphatic filariasis, a severe and debilitating swelling in the arms, legs, breasts, or genitals. After decades of campaigns the worm/disease has been almost eliminated from Brazil, except in Recife's metropolitan region (Ramesh et al. 2018; Xavier et al. 2019).[107] Contrary to the *A. aegypti*, which prefers laying eggs in clean water, the *C. quinquefasciatus* prefers water rich in organic material, such as wastewater, proliferating in places with inadequate sewage system—unfortunately the case for parts of Recife's metropolitan region. Several of Aggeu Magalhães' researchers studied this species, which was also reared in the institute's insectary, alongside *A. aegypti*.

Before I started my fieldwork, when the Zika epidemic was still ravaging the country, Aggeu Magalhães' researchers found evidence that the Zika virus could also replicate in *Culex*.[108] This important finding was disregarded, some of my interlocutors asserted, because it had not been made by a research group based in Brazil's Southeast/South and because the principal investigator was young, a woman and, perhaps most significantly, a *nordestina* (Northeasterner) (Guedes et al. 2017; Roundy et al. 2017; Ayres et al. 2017; Lourenço-de-Oliveira et al. 2018; for more on this controversy, see Löwy 2019).[109] In her study of the Zika epidemic, the anthropologist and bioethicist Debora Diniz (2016a, 8) also discusses how the discovery of the virus' vertical transmission shifted "the geography of legitimate science within the country's borders. The doctors who announced to the world the discovery of the new disease were from the Northeast, an area many Brazilians consider inferior within the national landscape." However, while Diniz

[107] In the 1950s, autochthonous transmission was identified in 11 Brazilian cities: in the North, Manaus (AM) and Belém (PA); in the Northeast, São Luís (MA), Recife (PE), Maceió (AL), and Salvador and Castro Alves (BA); and in the South, Florianópolis, São José da Ponta Grossa, and Barra de Laguna (SC) and Porto Alegre (RS). Although Pernambuco is currently the only state with autochthonous transmission, cases have also recently been reported in immigrants in Acre, Mato Grosso, and Santa Catarina (Brazil 2019).

[108] All but one of the researchers are affiliated with the Aggeu Magalhães; the exception is a Brazilian entomologist based in the United States, who studied as an undergrad in Pernambuco.

[109] For more on the geopolitics of scientific research, in particular national and international collaborations in projects related to the Zika virus and the children with Congenital Zika Virus Syndrome, see Lira and Prado (2020).

focuses on researchers and practitioners who have "bedside medicine" experience, my entomologist interlocutors were not working with patients.

Conversations about the deep-rooted deprecatory representations and disparaging treatment given to *nordestinos* were particularly relevant because I was in Recife during Bolsonaro's election. Throughout the campaign, Northeasterners were portrayed by Bolsonaro supporters as stupid, lazy, naïve or incapable of making "rational" decisions, including voting.[110] Although more overtly expressed during the campaign, these depictions follow from a historical categorization of the Northeast as an impediment and threat to Brazil's "progress"—even though it was the region's resources and labor force that constructed Brazil as a modern nation (A. J. B. da Silva and Larkins 2019, 903; also Fontes 2008).

Historian Durval Muniz de Albuquerque Júnior (1999) has investigated how "the Northeast" emerged as a geographically distinct region in the 1920s, through state agencies and local elites promoting the image of deprivation in order to lobby for federal drought relief and agricultural subsidies. Local intellectuals, artists, and screenwriters then consolidated the region's spatiality, forging a social, cultural, and artistic memory of "the Northeast" by reiterating the stereotypes that have become so damaging to the region.[111] In this geographical redrawing, Recife was crystalized as the Northeast's economic, "medical, cultural, and educational mecca" (Albuquerque Jr. 2004, 47)—an important point to highlight since, while

[110] In the Northeast, Bolsonaro lost the election, with more than 70 percent of voters choosing his opponent, Fernando Haddad from the Worker's Party in the final election—the only region in the country in which this was the case. However, even if in smaller numbers, Bolsonaro also had supporters in this region. The anthropologist Benjamin Junge (2019) has written a nuanced analysis of some of the hopes, frustrations, and anxieties of Brazilian voters based on ethnographic research with a "new middle class" Recife family during the period that anticipated the 2018 election.

[111] The author examines in great detail some of the main artistic figures from the Northeast and how they reiteratively represented the region as a space of poverty, oppression, tradition, revolt, history and cultural authenticity. As he put it, "The Northeast, which today appears obvious and is widely taken for granted, was configured during a certain historical era by many hands often working independently and unconsciously" (225). Therefore, Albuquerque Jr. (1999) argues that, ironically, "the invention of the Northeast" and negative image associated with the region, was partially a result of work done by insiders, ranging from sons of declining land-owner families to middle-class radicals.

my interlocutors were doing science from "the Northeast," they were doing so from Recife and from an institute considered to be a reference research center.[112]

Analyzing Brazil's regional geopolitics from the perspective of Southern and Southeastern elites, historian Barbara Weinstein (2015) recounts how the idea of a "Brazilian modernity" was historically construed in opposition to the Northeast, which was portrayed as "a uniformly backward region plagued by droughts, a stagnating economy, and, above all, a wretched population whose very bodies bore the stigmata of their poverty and misery" (4).[113] Weinstein argues that these stereotypes were not by-products of uneven economic development, but "constitutive elements of historically structured spatial inequalities" (2). In this case, regional identities were mobilized to make racialized claims about the exceptional capacity of the South/Southeast and, in particular, of São Paulo to promote progress and modernity. Science was a crucial element in this modernist impulse and, by the 1930s, São Paulo had developed scientific and technological policies and a robust funding scheme to support research in the state (see Schwartzman 1978; Sanches Jr. 2012).

These historical differences and geopolitical imaginaries hinder research and educational development in the Northeast, which, alongside researchers in the North and Center-West regions, receives less support from national funding agencies. For example, in 2018, the Ministry of Education's Coordination for the Improvement of Higher Education Personnel (CAPES) awarded the entire Northeast region 611,678.72 reais in funding for fellowships and grant programs, while just the state of São Paulo received 765,310.34 reais (GEOCAPES 2018).[114] Regional disparity had been decreasing during the 2000s

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[112] After all, highlighting how the Northeast was historically homogenized also entails pointing out internal inequalities within the region. The ongoing research of da Silva Maia with scientists in Aracaju, Sergipe, shows yet another perspective on what making science in the Northeast can mean.

[113] Racialized claims about Northerners' bodies were linked to calls to improve sanitary conditions as a path to "develop" the region (Albuquerque Jr. 1997; Blake 2003). These proposals followed from versions of evolutionary theory in Brazil that made the environment as important as genetic heredity (see Chapter 1).

[114] The Northeast region has a population of around 56.5 million and the state of São Paulo 44.04 million. Pernambuco is the Northeastern state that received the most funding: 125,502.67 reais. In comparison, Pernambuco was awarded 105,929.08 reais in 2020, illustrating the overall trend of reduced funding for science and education in the country.

and early 2010s, when research funding was more abundant and resources were allocated specifically to create and support institutions in these historically neglected regions (Brasil 2016)—a tendency, however, that Dr. Sandra and others predicted that would not withstand the more recent and ongoing budget cuts.

Sociologist Vívian Matias dos Santos (2016) has examined how the gender and regional discriminations endured by *nordestina* scientists can trap them into a vicious cycle in which their research is belittled and receives less funding. Santos indicates, however, that calling attention to the structural challenges faced by *nordestina* scientists should be done alongside racial analysis, since these women tend to be White. That was the case at the Aggeu Magalhães' Entomology Department. While nine of the ten tenured (*concursadas*) researchers and all five public health technicians/technologists with permanent contracts (*concursadas*) were women,[115] most of them were White—illustrating how, even though the Northeast has been historically racialized within national geopolitics, the staggering racial inequalities in Brazilian science cross regional boundaries.

While the sterile mosquito project was being developed as a project by Northeasterners for Northeasterners, it was also an opportunity to showcase the potential of often-undervalued science from the Northeast. "We do so much with so little. Imagine what we could do if we were properly funded," Carlos commented one day, as he prepared the male mosquitoes for irradiation, placing them on a petri dish. Carlos was a master's student examining, among other things, the effects gamma radiation had on the *A. aegypti*'s biological viability (C. M. de Mendonça 2019).[116] Originally from Mutuca, a district from Pesqueira, 200 km (125 mi) inland, Carlos had moved to Recife to study, living with his older sister. Before starting his

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For a commentary on the "perverse inequality in the geography of knowledge produced in Brazil" as it relates to the social sciences and humanities, see P. R. S. M. Costa, Soliva, and Fernandes (2020).

[115] Although this gender ratio is much higher than the national average, fields such as biological and health sciences do have a more significant participation of women researchers (Assis 2018a; for more on women in Brazilian science, see Leta 2003; Assis 2018b; Negri 2020).

[116] Carlos was pursuing a master's in "Human Health and the Environment" at UFPE's Academic Center of Vitoria. His stipend was part of a project from Dr. Josiane (his advisor), but he worked closely with Dr. Sandra (his co-advisor).

graduate studies, he had worked as a lab technician at the Aggeu Magalhães' insectary. Carlos revealed that he cherished being involved in and conducting research but was disillusioned with employment prospects; we had many candid conversations about the challenges and uncertainties of pursuing an academic career. "When I was a lab technician, my stipend once got delayed for three months. Three months!" Such precarity, Carlos and I agreed, prevented those who do not have a security net—who are mostly from low-income backgrounds and from historically marginalized communities—from staying in academia.

Because of financial stresses and career instabilities, while writing up his thesis, Carlos had decided to also study and train to apply for a police officer position.[117] "In academia, chances are you will have a stipend but not a salary, you will have no legal or workers' protection, and you won't even get these years counted towards your retirement. Plus, with all these cuts, there is just an across the board lack of money." As a police officer, Carlos would be paid almost twice the amount of his stipend and, if everything went well, would have permanent, stable (*concursado*) employment. "If there was a job for me here, I would do it. I enjoy doing science and enjoy working with mosquitoes. But as one of my professors told me, 'When the bills are paid, the head can think better.'" Carlos' dilemma and his decision to leave academia echo several other stories I heard during fieldwork in Brazil, especially in a context of diminishing opportunities for researchers that disproportionately affect those outside the more established centers in the South and the Southeast.

Besides Carlos, Antônia was also part of the irradiated mosquito project. A lab technician, she aspired to pursuing an academic career and had already applied twice for the master's program: first, she failed the English exam; the second time she passed all exams but there were not enough stipends available.[118] Antônia was responsible for the daily activities of rearing the *A. aegypti* that would be sent to

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[117] He passed the examination and is now a military police officer in Recife.

[118] After I left Recife, Antônia applied once more, was approved, and is currently a master's student in the Aggeu's Entomology Department—the first one of her family to pursue a graduate program. She is still researching irradiated mosquitoes but no longer in Fernando de Noronha

Noronha. She lived with her family in Camela, a district in the neighboring city of Ipojuca, and traveled to Recife every day on a bus made available to students by Ipojuca's municipality. "Without the bus it would take me more than three hours and I would have to pay so many fares.[119] I'm grateful, but it's hard to depend on it; for example, we are fixed to a certain schedule and during school holidays the bus doesn't even run." To care for the insects, Antônia had to attend to their biological rhythm; a long holiday could be fatal for the mosquito population in the insectary. "I'm lucky that Dr. Sandra is very understanding," Antônia told me the week after Carnival celebrations, when the bus did not run for more than a week. "Since Dr. Sandra lives very close to here. When it's hard for me, she comes to the Aggeu herself and does whatever it is that these mosquitoes need that day." Historical, structural conditions become everyday experiences that hinder the work of those producing knowledge in Brazil. Such limitations are further exacerbated by the diminishing, unevenly distributed funds for research and education in the country.

Rearing and Radiating and Releasing

We had not moved at all over the last ten minutes; all around us, I could hear loud honking, even though the car's windows were completely closed and the radio was broadcasting an evangelical pastor's energetic preaching. Antônia turned towards me in the back seat. "That is why I always leave early," she said. "You never know how traffic will be in this city—but more often than not, it's dreadful." About an hour before, I had seen her use a small suction device to collect mosquitoes from different cages and put them into five plastic containers, each with a label on it: *Casa do Ivo Bomba* [Ivo Bomba's house] or *Quiosque da Conceição* [Conceição's Kiosk], places in Fernando de Noronha where these insects would be released later that day. She then had carefully placed the containers, teeming with mosquitoes, inside a thermal bag that

[119] With the bus, she could leave Ipojuca at 5:10 A.M. and arrive around 6:30 A.M. at the Aggeu—the early ride allowed her to avoid the sluggish morning traffic; to return there was a midday bus but, most days, Antônia would take the evening one, leaving Recife at 7:10 P.M.

she was now holding on her lap. It was midmorning, and we were on our way to Recife's Gilberto Fryre Airport, where Antônia would give these insects to a health official traveling to Noronha.

To implement the irradiated mosquito project with limited funding, Dr. Sandra and her collaborators had to take advantage of the health and scientific infrastructures already in place. For example, instead of paying for an expensive flight or even cargo space to ship these insects, they arranged for health officials who periodically visited the island to take the mosquitoes as carry-on luggage—equipped with an official letter explaining to airport security the reasoning behind a bag filled with live mosquitoes. Because Fernando de Noronha is a state district of Pernambuco and because the cost of living there is so high, most government employees live in Recife while dealing with the island's issues—including the governor-appointed General-Administrator (*Administrator-Geral*), a fact that many of my islander interlocutors commented upon with disdain. Although this arrangement got the mosquitoes to Noronha without any extra project costs, it made the researchers completely dependent on the health officials.

"Sometimes they cancel at the very last minute," Antônia complained one day at the airport as she checked her phone, worried that the health official had not yet arrived. "Because they tell me the flight but not the time they will be here, I come early to make sure I won't miss them." Arriving early and accounting for the expected traffic jams made the ordinarily simple task of meeting someone at the airport incredibly time consuming, usually occupying Antônia's entire morning. Even the ride to the airport was part of an existing infrastructure: Aggeu Magalhães had two cars and hired drivers to support research projects. Since there were several people at the institute who needed to be driven somewhere, Antônia often had to adapt to the drivers' busy schedule.

Rearing spaces were also shared. Aggeu's insectary had cages with mosquitoes (*Culex and Aedes)* populations kept by technicians for experiments, cages with mosquitoes for projects by students and researchers, and cages with *A. aegypti* bred specifically for Noronha. Antônia often had to manage these different demands—for example, to clean cages a student might have left unattended—to maintain a

population large enough to produce the needed males. "With the conditions we have right now, we can only produce and send them a very limited number of mosquitoes," Dr. Sandra told me more than once. "It really slows things down."

Furthermore, while *A. aegypti* is known for its capacity to adapt and survive under a variety of conditions, inside the insectary, temperature or humidity changes can significantly affect the survival and reproduction rate.[120] With no structure in the insectary to regulate these aspects, Antônia and Carlos had to be attuned to the weather forecast, adapting rearing practices so insects could thrive (for example, calculating how a streak of warm days could affect the insects' development time and the amount of food they would consume). Other environmental conditions that could swiftly and significantly affect the caged populations included fungus or ants. Antônia and Carlos were always on the lookout for early signs of these threats.

To prepare for irradiation, pupae (between 24 and 36-hours-old) had to be separated into groups of females and males, based on size difference.[121] The males were then placed in petri dishes (around 500 mosquitoes per dish), lined with moistened paper to limit their movement while keeping them in a humid environment. These males were then taken to the irradiator (Gammacell 220) of UFPE's Department of Nuclear Energy. The equipment had been acquired in 2004 to develop nuclear studies in the Northeast—before that, samples had to be sent to São Paulo for irradiation.

Nowadays, the irradiator is used by several scholars from UFPE and other Northeastern institutions. As a result, Antônia had to negotiate constantly with the irradiator's technician about when she or Carlos

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[120] Anthropologists of health and science Ann Kelly and Javier Lezaun (2017) have detailed how sustaining "an uninterrupted cycle of mosquito reproduction under laboratory conditions" can be a challenging and demanding endeavor—a process entomologists commonly refer to as "colonization." Describing groups of insects as "colonies" is rooted in an idealized view of colonialism as well as of colonization as "natural" (E. C. Brown 2002).

[121] This sex separation—sexing—was done using a device that instrumentalizes body size, considering that males tend to change from larva to pupa earlier and to be smaller than females (C. M. de Mendonça 2019, 32; see also Melo-Santos et al. 2017). If the number of mosquitoes was small, Carlos or Antônia would sometimes sex-separate manually, pipetting the males (also defined based on size difference).

could take the mosquitoes. The machine could only be used for one sample at a time and, while the *A. aegypti* had to be irradiated for less than two minutes, some materials had to stay inside for more than a day. Of course, because males had to be irradiated before health officials took them to Noronha, Antônia had to plan ahead.

Tracking and assessing the project's development was done through the use of ovitraps: small black plastic buckets that the *agentes* filled with clean water, partially submerging a small piece of corrugated cardboard (*palheta*)—luring *A. aegypti* to lay eggs there. The goal of these ovitraps, placed across the island, was twofold: to remove eggs that would eventually become adult *A. aegypti*, aiding efforts to prevent future *A. aegypti* generations, and to estimate the current population, based on the number of eggs collected (Fay and Eliason 1966). However, Dr. Sandra was aware that adopting these devices in Noronha could be challenging, even treacherous: "It's not a lot of work. They have to go clean and change the water in the ovitrap, collect the *palheta*, and put in a new one. But they have to do it at the right time; that is the hardest part! Even if they mix some BTI in the water, there is a risk that the ovitrap becomes a breeding spot." If an *agente* did not act on the ovitrap before the eggs hatched and the juvenile insects became adults—around ten days, perhaps even less in warmer weather (Marinho et al. 2016)—instead of removing mosquitoes, it would aid the *A. aegypti*'s proliferation.

After collecting the pieces of corrugated, treated cardboard, the *agentes* would wrap them with paper towels to reduce the chances of eggs falling, placing them all in boxes. Health officials would then take these boxes to Recife, where Carlos and Antônia would count the number of eggs in each *palheta* using a microscope and a mechanical counter, equipment that were also shared among other researchers, technicians, and students at the Aggeu. When I asked Antônia whether there was a scheduling system to use the shared equipment, she replied, "No, not really. We try to do it all in a friendly manner. Most people here have common sense—not all, but most. For example, Carlos and I never use the microscopes at the same time, since we work on the same project." The need for collegiality to successfully accomplish tasks in a context of limited resources and high demands was a common topic. Another student from Dr. Sandra

once told me, “We often help each other here, it’s the only way we manage. When Antônia is too busy, I help her. Later she helps me.” With a playful smile, she added, “If I’m in a *really* good mood I might even help her count these darn eggs—the worst task ever.”

There was constant negotiating, bargaining, and adapting to guarantee the project’s development. All this labor to breed, care for, radiate, ship, and monitor the mosquitoes was exerted so the *agentes* could open the plastic container, releasing the sterile males to control future *A. aegypti* generations and, ultimately, the pathogens these insects can transmit. In other words, as researchers were working at a distance and with a limited budget the hope was that mosquitoes themselves would be able to do the final and decisive work needed to prevent mosquito-borne diseases—suppressing its own population. And the chances of this being successful, Dr. Sandra and her collaborators argued, increased because the project was conducted on an island. Therefore, the distance that made it difficult and expensive to reach Noronha was envisaged as also assisting the researchers, by keeping the insects on target. The island itself made the irradiated mosquito project work.

Work and Life on the Island: ô*ia, entulho,* and mosquitoes

The first place I got to visit in Fernando de Noronha was the trash collection site—providing me with insights about the amount of mostly-hidden-work needed to maintain this “paradise.” After dropping off my things at Josué’s home, I went straight to the *Unidade de Vigilância em Saúde*, the health surveillance unit, located just a few blocks away. It was a one-story building, elevated to minimize the effects of the muddy floods caused by the frequent torrential rains. I knocked on the first door and someone opened it, welcoming me to the refreshing coldness of the air conditioner. I greeted the health official, Marcos, whom I had met a few days before at his office in Recife. He managed the Unit’s activities but lived “on the continent,” as people on the island would say, and traveled periodically to Noronha. Marcos had also just arrived—we had travelled on the same flight, although we had not seen each other—and he was distributing

some new boots he had brought with him. After giving me a quick tour of the unit, Marcos mentioned that they had just received notification of a dengue case from someone living at the housing (*alojamento*) for workers from the trash collection company. A team was about to leave to inspect the area and he asked me if I wanted to go with them.

I joined the four men outside—Augusto, Davi, Edison, and Geraldo—who were loading the back of a four-door pickup truck. They insisted that I sit next to the driver, Davi, even though I was by far the slimmest and the three other men were quite crammed in the back. We took the BR-363—the highway that cuts through the island—towards the facility managing solid waste in Noronha. "Everything disposed of is collected and brought there, where workers have to screen and sort everything manually," Augusto told me as we drove to the opposite side of the island. "Only organic waste which can be composted stays here, such as leftover fish or fruit peels. Recyclables and like 'trash-trash', for example diapers or toilet paper, have to go to Recife." He then added, "Oh, glass stays here as well. It could be sent to the continent to be recycled, but construction materials here are so expensive that they grind the glass to make sand." Commenting on how exorbitant prices were, one of the other men in the car, Edison, mentioned that, while in Recife a cubic meter of sand cost around 60 reais, the same amount could cost up to 3,000 reais in Noronha—a staggering 500% difference.

Once we arrived at the waste facility, while the others were taking out equipment parts from the truck, Augusto moved closer to me. "Look at all these bags," he said, almost whispering. "A tourism boom also means a trash boom." There were several dozens, perhaps even hundreds, of large sturdy white bags piled across the terrain, reaching heights taller than me. "They ferry the trash to the continent, but only once or twice a month. Meanwhile, everything stays stored in these 'big bags'[122] to not contaminate the soil and to withstand the weather." There were so many bags that the area had caught my attention from the plane,

[122] They referred to them as "big bags," in English but with a Portuguese accent.

a large white stain surrounded by lush green—although at the time I had not realized that it was a sea of trash bags. Augusto looked around and sighed. “I have only been here for a few months, but we already had to visit this place a few times.” A veterinarian by training, Augusto had recently started working as the local manager for the health surveillance unit, living on the island while his wife and daughter stayed back home because, as he later told me, the pay was better than what he could get caring for pets in Recife.

Augusto pointed to an open, roofed space at some distance from us. “Over there is a very large table where they unload all the trash, so that it can be sorted.” I asked what to me seemed like an obvious question, “Why not have people separate their trash at home?” He looked at me with a wry smile. “That *has* been tried… Three times they have launched a program, with educational campaigns to explain how to do it and why it’s so important. I don’t know if people don’t care or don’t get it, or if too many tourists just couldn’t be bothered, but the trash would come all mixed up anyway. Marcos argues that people will only comply if we start charging fines.” After a short, reflective pause, Augusto said, “Meanwhile, these young men are brought to the island to do it by hand. It can be a dangerous job—but it would be unnecessary, if each person just did their part!”[123] By then, the other men had assembled two motorized sprayers and were pouring in a mixture of water and the BTI larvicide. “Most places alternate between using this and the chemical one,” Geraldo explained. “But here we can only use BTI.”[124] Geraldo, who was an *agente*, turned on the loud diesel engine and, with Augusto’s help, put the straps on to carry the sprayer like a backpack.

I joined Geraldo as he walked around the white maze. He was wearing hearing protection earmuffs, so having a conversation was difficult; but, once in a while, he would stop, getting closer to comment on something. “You see these little water pools all over the bags? It’s an ideal breeding spot. We try to get rid

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[123] Several anthropologists have examined how waste picking and waste separation are labor-intensive activities that cause illness and injury and how, while essential for urban infrastructure, these workers are often belittled and underpaid (Nagle 2013; Reno 2015; Fredericks 2018; Doron and Jeffrey 2018; Zhang 2019).

[124] Indeed, the Ministry of Health even recommended rotating between the two types, to prevent the development of resistance to these products (Brasil 2001).

of them and we do all this spraying, and it might help for a bit, but soon it will rain again, washing away the larvicide and forming new pools. Not much more we can do…" He shrugged, and we kept walking. The workers were housed in one-story buildings located just a few meters from the sprawling sea of trash bags. "These boys already have to work with trash. Did their houses really have to be right next to it?" Geraldo turned to me to say, as he sprayed the area close to the housing quarters. "If this place is ideal for mosquitoes, of course these young men will get sick."

As we walked, Geraldo also mentioned he had recently gone back to work as an *agente* after a few years in the tourism industry—the pay was significantly less but this job had a guaranteed and stable salary, plus "workers' rights,"[125] such as paid vacation and retirement contributions. "I was born on this island and, although I don't seem like it, I'm actually rather old," he said with a broad, teasing smile. "Things have changed so much here! Look at all this trash. It's all these tourists coming—Noronha is a fad right now. But I'm afraid this fad will pass and the island's economy will crash."[126]

On the drive back to the health unit, after the spraying and inspections were completed, I asked how many people worked and lived on the trash collection site. "I would say around 60," Edison replied. "They are mostly from cities like Pombos or Vitória de Santo Antão, in Pernambuco's *sertão*" (the semi-arid region in the Northeastern inlands). He also mentioned that almost all workers were young men since it was such a physically demanding job. Augusto then added, "They come and stay six months on the island, then go visit home only for a few days." When I expressed surprise at these working conditions, he said, "They accept this regime because, well, unemployment. There aren't many job opportunities for them in their cities, so they come to work here for a while. It's a very demanding, very challenging job, but they get to send some money home and even start some savings (*pé de meia*)."

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[125] It's a notable difference that, while in the U.S. people would refer to these as "benefits," in Brazil they are considered "rights."

[126] For more on the tourism effects on the island and islanders, see I. Cordeiro (2016).

Unemployment has been rising across the country, with the Northeast having the highest numbers, in particular for young people; in 2019, the unemployment rate in the region for those between 18 and 24 years old was 31.9% (IBGE 2019). Those who went to work at the trash collection site, almost all of them young Black/nonwhite men probably had very few employment alternatives outside Noronha—unemployment rates are even higher among nonwhite Brazilians. In fact, the entire island's tourism industry depended on a constant flow of job seekers from the mainland, workers who at times endured horrible living conditions, workers who were often considered disposable. Life and work on the island were distinctly different depending on class (and class, in Brazil, often also entails race): for the wealthy, mostly White tourists, a breathtaking travel destination, while for the workers, it was a chance for a better life for themselves and their families, even with the distance, adversities, and insecurity—and even if only temporarily.

Fernando de Noronha is a particularly interesting place to examine questions related to labor since this coveted tourism destination was once a forced labor penal colony after Brazil's independence. During the 19th century, the island held the largest concentration of convicts from across the Brazilian Empire. Beattie (2015) has examined how the use of Noronha as a penal colony raised concerns by political elites that being sent to the idyllic island could be seen by convicts, especially by enslaved people, as a "reward." Such reasoning reflected racist stereotypes of poor people and, in particular, Black Brazilians as prone to laziness. Forced labor in the island's plantation and physical punishment were used to ensure convicts did not perceive Noronha as a "paradise."

Back in the car, as we discussed the working conditions of those manually separating the island's trash, I queried whether the workers were at least well-compensated for their arduous and hazardous effort, and for having to stay away from their families for such long periods. Augusto once again replied, "I think their monthly salary is around 1,400 reais," an amount that is higher, but not much higher, than Brazil's minimum salary of 954 reais (in 2018). Augusto continued, "But they get room and board, three meals a

day—and I heard their food is quite good, better than what we get.[127] But then they can earn a lot more making an *ôia*." Never before had I heard that word—*ôia*—so I asked Augusto to clarify. "Oh, it just means having a side hustle, and everyone who comes to work on the island does that."

After the men laughingly teased me for not knowing—and needing to learn—what they called the "rich regional vocabulary," Augusto, now more serious, said, "Making an *ôia* is how people can truly make some money here! For example, those young men at the waste facility: on their day off they might prune some trees for a few hours and get paid 1,000 reais—almost as much as their monthly salary. A lot of them also work as bouncers or security guards at parties, which pays very well." Davi then added, "Labor is incredibly expensive in Noronha!" Indeed, talking to other workers I met during my stay, they described how, while their official job offered only a slightly better pay than what they could get on the continent, it covered room and board, which would otherwise be unaffordable. "But to make some money here you have to be committed to working," a young man from Recife working at a hotel told me. "You can make an *ôia* and earn a small fortune but then, if you are not careful, you end up spending it all on a night out. You must be frugal because everything here costs an exorbitant price."

Everything used or consumed on the island has to be ferried in, and the high demand by tourists—wealthy Brazilians or foreigners calculating expenses in dollars or euros—further inflated prices. As a result, while making money in Noronha is easy, depleting it is even easier. "Many young people come to work here thinking it will be an amazing experience—to be able to live in paradise," Augusto said as we talked about the island's dazzling beauty. It was his day off and, because he knew some workers, he had managed to get us onto a boat that tours in crystalline waters, alongside dolphins. "But those who come for the glamorous life of parties in paradise, well, they usually don't last very long. Because most people don't even consider that they will be crammed in a small room, sharing a bathroom with, I don't know how many

[127] State employees also had their meals included as part of their payment.

people, and not even have much choice over what they eat… plus, here it's pricey to just have a beer to relax." While the tourism industry generated jobs, luring people to come work in a paradisal location, it also greatly increased the cost of living, imposing austerity and even hardship on workers and islanders.

Before coming to Noronha, I had talked to Dr. Sandra who had highlighted how the exorbitant prices also inadvertently worsened the mosquito-borne disease situation. "Nobody wants to discard anything! It's so expensive to bring things to the island that people just keep everything—even if it's broken or falling apart—because maybe they can at some point, somehow, re-use it. As a result, everywhere you go is filled with *entulho*" (which broadly means stuff, from rubble to rubbish). She told me how there had been campaigns to remove some of these materials: in 2015, 18 tons of *entulho* were collected and removed and then, in 2017, 30 tons more (Melo-Santos et al. 2017; *Revista Arquipélago* 2017). Yet, during inspection visits I made with *agentes* or health officials, almost every backyard—from modest houses to fancy hotels—had leftover construction materials, parts of household appliances, and other belongings laying out in the open, accumulating water pools that could easily host mosquito larvae.

"We tell people it's dangerous, that they might be harboring breeding spots," Josué told me when I accompanied him on home inspections, just as we left a house that was particularly full of *entulho.* "But we also have to understand how life on the island is different. I cannot make them throw away something that they might later need, because I know just how difficult it is to afford things here and how often people have to make do with what they have." In a similar way to researchers at Aggeu Magalhães, Fernando de Noronha residents had to resort to creative practices to make the best out of a situation of material inadequacy, caused by historical and structural conditions. That is, islanders often had to adapt and improvise, creating their own *gambiarras*; in order to do so, they needed resources to work from—and that is why they kept all that *entulho*. But these materials that filled backyards created perfect conditions for the *A. aegypti* to flourish and heightening the need for vector control strategies. To put it differently, *entulho* was also in a sense yielding bio-geographic value.

Josué pointed out that instead of forcing people to discard these materials, it would be better to think of ways to ensure that all the *entulho* laying around did not become a mosquito nursery. "A lot of people have empty bottles, so I tell them to keep them upside down; or I tell them to use something to cover everything so they just have to shake it out every other day to remove any stagnant water." Before my visit to the island, in a conversation with the health official Marcos, he mentioned there had once been a campaign to distribute tarpaulin for residents, so they could cover their *entulhos*. However, Marcos told me that the sturdy, flexible, and water-resistant materials had quickly been used for other purposes.

As Josué and I walked across the island, pausing once in a while under a tree's shade to get a break from the sweltering heat, he told me how, in his opinion, many people from the continent did not truly understand how difficult it could be to live and work in Noronha. "Sometimes people come and stay in Noronha for a few months and they think they understand the island, but they don't," he said, shaking his head. Josué was still skeptical about the benefits of deploying irradiated mosquitoes, but he considered that at least an advantage was that the project did not demand—or tried to enforce—behavioral change from the islanders. Mosquitoes, after all, were the ones conscripted into controlling their own population. Or as Josué put it, "Let's wait and see what these mosquitoes can do."

More-than-human work was mobilized to improve living conditions on the island, while also producing innovative research that challenged the belittlement of Northeastern science. Both the research done in Recife and life on Noronha were characterized by historical and structural conditions that compelled people to resort to creative practices to make the best out of a situation of material inadequacy. By also making "nature work" my interlocutors aimed to confront the unequal conditions that have constrained knowledge production and health interventions. However, the very precarity it aimed to address was also what created the conditions for bio-geographic value to be yielded.

Vectors of Health

Noronha's geographic location and more-than-human life were regarded as creating the conditions that made the irradiated mosquito necessary and its implementation successful. In this case, it was not only the insect's reproductive capacities but also the island's features and inhabitants that were instrumentalized—biogeography became a vector that researchers considered in designing and framing their aims. Dr. Sandra and her collaborators aimed to capitalize on this bio-geographical value to produce innovative research, with limited funding and structural constraints. The goal here was to develop a project that could both improve living conditions of islanders and tourists, even if in a small and specific way, while also confronting the long-standing belittlement of the science produced in the Northeast. Here, health is the byproduct of historical conditions, and restructuring such conditions, especially in a context of under-resourcing, often requires adaptation and innovation.

- Chapter 4 -

BORDERLAND SENTINELS

Trapping and Testing Mosquitos in the *Tríplice Fronteira* (Foz do Iguaçu)

Early in the morning, I waited on a corner under Foz do Iguaçu's cold July mist. That day, I had arranged to be picked up by a *mototáxi*[128] driver so I could get to the other side of the Paraná River, in Ciudad del Este, Paraguay. Just before 7 a.m., Jaime arrived, carrying an extra helmet. Driving through the quiet and awakening city, we headed towards the "Friendship Bridge" connecting southwestern Brazil to eastern Paraguay. When we got closer to the river, there was a clear contrast with the neighborhoods we had just passed through. People were bustling about and there was a long, slow stream of traffic, with occasional impatient horns, as the bridge became a bottleneck for the heavy vehicular flow. We joined the motorcycle procession, slipping past the two lanes of cars. Although we were crossing an international border, no one asked for documents or even stopped us. This was a quotidian crossing for the majority of those on the bridge: Paraguayan women who were domestic workers in Brazilian homes; students from all over Brazil who had moved to Foz to study at more affordable Paraguayan universities; and merchants from around the world who lived in Brazil but owned stores in Ciudad del Este.[129]

Foz do Iguaçu is located at the *tríplice fronteira*, the tri-border area between Brazil, Paraguay, and Argentina. [130] A main concern within this borderland is the circulation of drugs and other illegal/smuggled

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[128] Although this chapter examines a multilingual borderland, I have mostly used Portuguese orthography—which is telling of my own identity as well as the identity of the majority of my interlocutors.

[129] Most of these merchants are of Arab or Chinese origins. For an analysis of the historical development of Ciudad del Este as a commercial hub attracting international merchants, from the establishment of the city as a free-trade zone in the 1970s onward to the formation of the Southern Cone Common Market (Mercosul), see Folch (2018).

[130] *Fronteira* in Portuguese and *frontera* in Spanish can mean both border and frontier. In her study of this region from the perspective of borderland Argentineans, political anthropologist Ieva Jusionyte (2015, 9–11) describes her interlocutors' dislike for the expression *triple frontera* because it invoked "the lawless of the frontier, accompanied by an invitation of conquest," preferring instead *tres fronteras* (three border). During my fieldwork, my interlocutors

products (Renoldi 2015; Jusionyte 2015; Schuster 2015).[131] However, public health officials find themselves more often preoccupied with a different type of undetected movement: the circulation of mosquitoes and viruses. These officials have developed a new strategy to map the movement of the *A. aegypti* mosquito and thus to address the pathogenic viruses it can transmit. Their novel approach includes trapping and testing mosquitoes in order to create a strategy that, my interlocutors argued, would not only overcome the political disputes and border bureaucracies in the region but also offer better policies to control mosquito-borne diseases elsewhere in Brazil and in the world.

These public health officials were based at Foz do Iguaçu's *Centro de Controle de Zoonoses,* the Center for Zoonosis Control, or CCZ. Through an agreement between the national Ministry of Health and the municipal government, CCZ had been established in 1999 to tackle zoonotic diseases in the city, with the main goal of controlling a growing rabies outbreak.[132] According to the CCZ director, starting in 2001 dengue became the Center's primary concern, with its staff of health workers, the *agentes de combate à endemias*, tasked with visiting homes to look for and remove mosquito breeding spots. By then, dengue had become an alarming health issue, not just in Foz but throughout Brazil. For that reason, the Ministry of Health developed national guidelines to monitor both epidemiological and entomological conditions across the country (Brasil 2002a; 2005; 2009a).

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voiced no opposition to the expression, although many of them often just used *fronteira*. *Tríplice fronteira* is also the term adopted in official Brazilian documents.

[131] After the September 11 attacks, the United States also suggested that the region harbored "terrorist cells" among the majority-Muslim Arab community, claiming that their local commercial activities financed international terrorism. In 2018, the arrest for tax evasion and identity fraud of an alleged Hezbollah financier, Lebanese-born businessman Assad Ahmad Barakat, made the headlines, resurfacing accusations of terrorist presence in the tri-border area. However, little evidence has been shown of a terrorist network or a structured funding scheme, with the sweeping accusations further stigmatizing and harming the Muslim/Arab communities (Lynn 2008; Karam 2011; R. C. S. de Souza 2017).

[132] The virus was first detected in 1997 in four stray dogs and two domestic cats but by 1998 cases were surging. A health official jokingly recounted, "In the beginning, we were essentially a *carrocinha*" (the car that captures dogs for the pound). Nowadays, the disease is under control among domestic animals, probably due to comprehensive vaccination campaigns, although the same is not true for wild animals, with a high number of infected bats in the region (from 2001 to 2020, 144 out of 3,480 collected bats were positive) (Leandro et al. 2021).

"The current national guidelines for *A. aegypti* control don't work that well in general, but *here* they are even less effective. That is what motivated us to develop something!" That is how Flávio, a CCZ health official, explained me why they were working on a new system.[133] One of the objections my interlocutors had with the current system was the use of a nationwide database of case notifications, the Notifiable Diseases Information System (SINAN), developed by the Ministry of Health to surveil the epidemiological situation. CCZ employees explained to me that, as a compilation of information collected by care providers, this database can be unreliable owing to occasional misdiagnoses or failure to input correct details. It may also be incomplete due to unreported cases (people who do not seek medical care or are asymptomatic).[134]

These shortcomings were further aggravated in Foz, my interlocutors pointed out, because the city had a substantial human population on the move that was difficult to track. The database was often incapable of grappling with the constant stream of tourists, the fluctuating waves of migration, and in particular the continuous border crossers, including Argentinians, Paraguayans, and different Guarani communities. Displaced, persecuted, and accused throughout the last centuries of being "foreigners" on their own land, these local Indigenous communities—the Mbya, the Pãi-Tavyterã (in Brazil known as Kaiowá), the Avá-Guarani (in Brazil called Guarani or Ñandeva), and the Ache-Guayakí—now oscillate between sedentariness and nomadism (M. Azevedo et al. 2008).[135] In this flow of border crossers, there were also the "Brasiguaios," the thousands of Brazilians who, since the 1960s, have settled in Paraguay, lured by the promise of cheap farmland created through deforestation (Wagner 1990).

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[133] Because my interlocutors in Foz do Iguaçu are government workers, their careers might be particularly at risk due to their opinions. For that reason, I do not use any of their real names, have avoided personal characteristics that could identify them, and in some cases have changed small details to further protect their identity.

[134] Adding to these issues, many private clinics do not report their cases (Andrioli, Busato, and Lutinski 2020).

[135] Historically, the Guaranis have been extremely mobile, moving across the region in their search of a "land without evil," the *yvy marã e'y* (Clastres 1975; Pissolato 2004). Throughout the last centuries, these Indigenous communities have been enmeshed in colonial and national border disputes (Ribeiro and Iurkiv 2005; Blanc and Freitas 2018).

Brasiguaios embody many of the particularities of this borderland's histories and geopolitics. Migration started in the late 1950s, intensifying in the '60s and '70s, until it stabilized around 410,000 people in the '90s (Hetherington 2020, 28).[136] These immigrants coupled the interests by the Brazilian military government to have its citizens farming eastern Paraguay's fertile agricultural lands and the plans by then-Paraguayan-president Alfredo Stroessner Matiauda (a military dictator) to "occupy" the country's east, displacing Indigenous peoples along the way. Since then, soy monoculture took over what were once landscapes with thick forests, with most of it being genetically modified beans (Hetherington 2013; 2020).

Most Brasiguaios are descendants of Europeans, especially Germans, who migrated to Brazil in the early 20th century, linked to the country's "whitening" history (see Chapter 1). Many of them came from poverty in Brazil, enduring hardship and xenophobia in Paraguay, where they were regarded with hostility and suspicion (Albuquerque 2009; Blanc 2015). Paraguayans distinguish themselves culturally, particularly through the speaking of Guaraní—the country's other official language alongside Spanish—and accuse the Brazilian migrants of being "invaders" and "a legacy from the dictatorship." On the other hand, Brasiguaios deploy racist and colonialist stereotypes to claim a cultural and technological superiority, defining themselves as "workers" and "pioneers." As environmental anthropologist Kregg Hetherington (2019, 47) has pointed out, many of these Brasiguaios credit their European descent for the agricultural success, which required navigating the complex financial and technological demands of soy farming; in this case, soy became "the crop of whiteness, modernity, and entrepreneurialism." The majority of Brasiguaios still maintain strong ties to Brazil, often seeking medical care in Foz do Iguaçu.

Besides the database's shortcomings—exacerbated in a borderland characterized by border-crossing—CCZ employees also identified flaws with the Rapid Survey Indicators for *Aedes aegypti* (or LIRAa), a methodology developed by the Ministry of Health to survey the entomological situation by

[136] Paraguay changed its law in 1963, allowing foreigners to buy land at the border—a demand by the Brazilian government during border dispute negotiations in the 1960s (Blanc 2019).

estimating the urban presence and distribution of *A. aegypti* (Brasil 2002a; 2005; 2013). While *agentes*' daily routine already included household visits, the difference was that, in order to produce the *Aedes* survey indicators, 20% of the city's households, selected through sampling, had to be inspected within the window of a week.[137] Calculated based on the number of larvae collected and the kinds of containers in which these breeding spots were found, the indicators could be produced quickly, providing municipal administrators, health officials, and *agentes* with an overview of the current entomological conditions. National guidelines recommended carrying out the *Aedes* larvae indicator survey four times throughout the year; this periodic monitoring provided policy-makers and health officials with a baseline and with information about trends and patterns that could be used to evaluate and anticipate infestation rates.[138]

After almost 20 years working with these *Aedes* survey indicators, CCZ employees had identified three shortcomings with the methodology that produced them. First, finding a high number of larvae did not mean that all the juvenile insects would become vectors, either because many of them would die before becoming adults or because they would never carry a pathogenic virus. Another reason was that, although *Aedes* survey indicators were supposed to offer rapid information and feedback, CCZ employees observed that the numbers suffered from a kind of diagnostic delay: they detected an increase of larvae once there were already too many mosquitoes flying around. Finally, and perhaps most importantly, discovering breeding spots could be extremely difficult; the *A. aegypti* not only lays her eggs in stagnant pools that at times have just a tiny bit of water but also spreads her eggs across multiple sites—an advantageous strategy for the species' survival. Locating larvae was limited, too, by the national program's focus on inspecting homes and other private spaces.[139] The *A. aegypti* could lay her eggs out in the streets and her offspring,

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[137] Sampling methods vary based on the city's population size (Brasil 2009a, 73–74).

[138] Furthermore, the national government could more easily coordinate strategies and allocate resources through the introduction of a standardized methodology. In Brazil public health is decentralized, with administration and delivery of care being the purview of municipal governments. The national government, however, stipulates guidelines, coordinates activities, and allocates funding.

[139] See Nading (2014) on how this domestic focus has gendered vector control campaigns (also Wenham et al. 2020). Besides homes, the CCZ team also inspected what is called *pontos estratégicos* (strategic points): businesses where

once they reached adulthood, could fly indoors hunting for blood—leaving a house infested with mosquitoes, even as it might be free of breeding spots.

The *A. aegypti* population should still be monitored, those at CCZ asserted, but that should be done by collecting adult mosquitoes to create "winged indicators."[140] Such entities would be produced through an "entomo-virologic surveillance": traps spread around the city would capture adult mosquitoes, which would be collected, identified, and classified; *A. aegypti* females would then be sent to the recently established Center for Tropical Medicine at the Triple Border to be screened for viruses (the four different dengue serotypes, chikungunya, and Zika).[141] A crucial difference with this strategy, CCZ health officials told me, is that, instead of hunting down the *A. aegypti*, it harnessed the mosquito's reproductive processes and preferences, engendering an *entrapping reproductive labor* in which the insect would be lured into being part of the surveillance system.

My interlocutors also suggested that this new strategy offered an estimate of that fragment of the *A. aegypti* population that might already host—and therefore convey—pathogens. It is only in their winged form, of course, that mosquitoes can act as vectors. Each trap has a number, associated with geographic coordinates, making it possible to track the distribution of mosquitoes across the city and, by screening these insects, pinpoint the location of an infected *A. aegypti*. According to CCZ employees, this would allow them to identify the circulation of pathogenic viruses before there was an outbreak—what Segata

there was a high risk for breeding spots, such as tire shops or junkyards. The main point here is that public spaces, such as streets and squares, were not in purview of these inspections.

[140] I am loosely translating here since they used the words *indicadores de fase alada* or *indicadores de alados*, which literally would be "indicators of those in the winged phase" or "indicators of winged ones."

[141] Their strategy, which they named and copyrighted MÉTODO VIGEntEE (Comprehensive Surveillance and Geoprocessing in Entomology, Endemics and Epizootics Method) would reorganize the "Aedes' control practices under the One Health concept" (Ágora - Feira Soluções para a Saúde 201). Attention to other zoonosis and epizootics were part of the VIGEntEE method, but the mosquito and its pathogens were their flagship.

(2019; 2020), analyzing a similar mosquito surveillance project, has defined as health technologies being imagined as sort of "crystal balls."[142]

Implementing this surveillance system in Foz do Iguaçu—a populous and busy borderland—was strategic, I was told, because coordinating activities between neighboring cities/countries was limited by diplomatic red tape and differences in national health systems. By monitoring and targeting the mosquitoes and the pathogens themselves, the entomo-virologic surveillance system would enable bypassing the need to gather extensive and comparable information about the epidemiological and entomological situation on the other side of an international border. The project was also being implemented in Foz because funding for the project—including the costly state-of-the-art Laboratory of Molecular Biology at the Center for Tropical Medicine at the Triple Border—had been secured through the Itaipu Hydroelectric Dam, a mega construction on the Paraná River, just 15 km (9.3 mi) north of the Friendship Bridge. Co-owned by the Brazilian and Paraguayan governments, the hydroelectric power plant is obliged to redirect part of its profits for the local communities as a form of reparation for the catastrophic environmental and social impacts it has caused (see Itaipu Binacional 2020 for more on the regulation over these financial transfers and resource allocations).

The entomo-virologic surveillance system is thus part of a larger effort by multiple actors in the region to address health concerns and implement health policies across borderlands. To mitigate some of these challenges, Itaipu had supported the creation in 2003 of the Work Group for Integration of Health Actions in Itaipu's Area of Influence, or *GT-Saúde* (*GT-Salud,* for the Spanish-speakers).[143] Bringing together representatives from Paraguay and Brazil (and from 2006 onwards also Argentina), the *GT-Saúde*

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[142] See also E. O. Vargas (2018) for an ethnographic analysis of the multispecies techno-infrastructure present in these systems; and N. dos S. Silva (2020) for an ongoing research on the idea of risk performed through this type of surveillance system.

[143] Originally, the GT Saúde was established to integrate the activities of the two hospitals built during Itaipu's construction to service the hundreds of thousands of workers who had arrived in the region (the number of workers in the construction site reached 40,000 at one point) (Lisboa and Peron 2019, 188–89; Itaipu Binacional 2014).

entails monthly meetings to integrate activities and coordinate possible interventions and, in doing so, it aims to more swiftly address health issues affecting the region (Itaipu Binacional 2003; 2006; PTI 2021). The *GT-Saúde* also manages a budget of financial assistance from Itaipu, which allows groups to apply for specific projects to be funded through it. The CCZ team had requested and received this financial support to fund some of their activities, including going to Ciudad del Este to train Paraguayan health officials and health workers on how to adopt the entomo-virologic surveillance system.

As the CCZ team developed their new proposal to tackle mosquito-borne diseases, two objectives became apparent. Drawing on ethnographic fieldwork at Foz do Iguaçu with the CCZ team and participation in the *GT-Saúde* meetings; interviews with health officials from both Brazil and Paraguay; and document analysis, this chapter examines how these goals can be understood considering the particularities of this borderland. The first objective was to improve the methodologies adopted within Brazil, overcoming the shortfalls of national guidelines' focus on infected humans and larval *A. aegypti*. CCZ employees argued that pursuing scientific innovation from within the public health system placed them in an advantageous situation where they could develop a new type of pest science—one more attuned to the demands, routines, and limitations of vector control campaigns—and also propose a new policy framework that was innovative but also realistic within public health practices. The second objective was to export their project elsewhere and, in particular, to have it adopted regionwide, standardizing vector control practices and easing collaborations across national border lines. Although I consider the actions of the CCZ health officials to have been genuinely aimed at improving the health and well-being of those in the borderlands, their aspirations can also be read within a long history of Brazilian dominance in the region.

In its design, operations, and ambitions, this new vector control strategy is an example of what anthropologists and STS scholars examining public and global health have identified as a shift from prevention towards preparedness and surveillance (Lakoff 2008; Caduff 2012; Samimian-Darash 2013; MacPhail 2014). Located within this new regime of health, the entomo-virologic surveillance system is what anthropologist and sociologist of science Andrew Lakoff (2017) has defined as a "sentinel device,"

which not only signals future threats to both humans and public health, but also permits policy action even when knowledge is incomplete (see also Keck and Lakoff 2013). Social anthropologist Frédéric Keck (2014; 2020) has also examined how warning signals and intervention proposals can occur in different sites and on multiple scales, identifying how sentinels are situated at the border between species (ontological) and between countries (political).

I investigate the development and implementation of the entomo-virologic surveillance system as a sentinel device, analyzing how borders themselves were conceptualized. Here, I ask how this system operates at a triple border, one cross-cut by the geopolitical (Brazil-Paraguay-Argentina), the multispecies (human-mosquito-virus), and the bureaucratic (science-public health-nation). To do so, I borrow from the work of queer feminist and Chicana studies scholar Gloria Anzaldúa (1987) on *borderlands* as zones of ambiguity, contradiction, and as places where inhabitants have "constantly to shift out of habitual formations" (79). I suggest that the borderland positions of the city of Foz (geopolitical), captured mosquitoes (multispecies), and CCZ employees (bureaucratic) are what permit the system to produce both knowledge and interventions, even with incomplete information and even with diplomatic and institutional constraints. Differently from Anzaldúa's theorization, however, borders here are not transgressed by being traversed, but constitutively made of incessant crossing at different levels.[144]

The borderlands analyzed in this chapter are characterized by a ubiquitous "in-betweenness" and, simultaneously, a constant yearning for separation. To grasp such dynamics, I put Anzaldúa's theorization

[144] In Anzaldúa's analysis, as well as in much of the North American literature studying borders, traversing is an occasion of transgression, even subversion, because the border examined is the U.S.-Mexico divide (more specifically, the Texas-U.S. Southwest/Mexican border). However, as political anthropologist and Indigenous studies scholar Audra Simpson (2014, 116) points out, "for Iroquois peoples the border acts as a site not of transgression but for the activation and articulation of their rights as members of reserve nations, or Haudenosaunee, or Iroquois Confederacy peoples." In addition, within Latin American studies there has been critiques that the focus on the U.S.-Mexico borderland reinscribes the continent's unequal power relations by centering the United States in analyses, even if it is to unsettle its Anglo dominance (for example, Mendoza 2014). Just like STS scholars Susanne Bauer, Nils Güttler, and Martina Schlünder (2019), who think with Anzaldúa's work to describe non-human animals at the Frankfurt Airport, I am mindful here on thinking about more-than-human border crossing and borderlands without trivializing the racialized human experience of border violence.

alongside the analytics of *encruzilhada*, or crossroads, as developed by the anthropologist José Carlos Gomes dos Anjos (2006; 2008). In Afro-Brazilian religiosity, crossroads are a sort of ground zero for subjectivization: a place of fragile connections and ambiguous encounters, a place both of dangers and possibilities. Drawing on this spatiotemporal perception, Anjos proposes a theorization about differences that opposes the notion of Brazil as a country of syncretism and miscegenation, yielding a supposed "racial democracy." For Anjos, *encruzilhada*—as a point of coming together that does not result in merging, but in separation as the different paths are followed—offers a better framework to understand race relations in the country. For my own work, the notion of crossroads allows me to reflect on how the entomo-virologic surveillance system requires the blurriness of boundaries while also reinforcing differences and distance.

This chapter investigates how the arrangement among the *city of Foz – captured mosquitoes* – and *CCZ employees* operates through what I call "triple border sentinels," strategically positioning the entomo-virologic system within different borderlands. While several medical and environmental social scientists have examined how biosecurity discourses and protocols tend to focus on managing and controlling ever-permeable and ever-porous borders (Braun 2007; Lowe 2010; Hinchliffe et al. 2013; Nading 2013; Blanchette 2015; Segata, Beck, and Muccillo 2020), in the case discussed here the border itself—its crossing, blurring, and reinforcement—was what yielded value for the project. In other orders, border encounters—these "engagements across difference" (Faier and Rofel 2014, 364)—were necessary in order for the surveillance system to work at all.

What kind of value is accrued from encounters that happen on borderlands or crossroads? Feminist STS scholar Donna Haraway (2010; 2012), expanding the Marxian categories of use value and exchange value, has proposed the notion of "encounter value": value created through relations that are primarily experiential rather than utility-based or market-ready. But what does encounter value look like when it occurs at/across borders? Borderlands, this chapter shows, can be productive sites, albeit marked by tension, and even violence, especially (as is often the case) when characterized by unequal power relations.

Geopolitical Borderlands: War, Energy, and Vectors

"It helped improve the relations between Brazil and Paraguay to facilitate collaboration," replied a health official from a smaller town on the Brazilian side of the border when I asked him about the role and relevance of the *GT-Saúde*'s meetings for disease management in the region. We were on our way to the restaurant, during the meeting's lunch break, after having discussed the increase of dengue cases and the outbreak that seemed imminent. "Because our Paraguayan counterparts, the more technical people, they understand we need to do this together. The problem is usually higher up, with the more political ones; they are the ones who usually don't want to." When I asked him to clarify, he furtively looked around, moving closer to whisper, "They don't trust us." A moment of silence ensued as he stared at me, perhaps so that I could soak in the realization that I was also included here—*us*, the Brazilians.

"But it used to be much worse," the health official then continued. "Many years ago, I remember a meeting where we were examining the number of dengue cases—it had only just started to be a serious issue in Paraguay. There was a map with the distribution of cases, or perhaps it was a table with numbers? To be honest, I don't remember exactly. What I *do* remember is someone who seemed very important storming to our table, taking the paper, shredding it, and saying right to our faces, 'They don't need to know this.'" The health official sighed. "They may have their reasons, you know, not to trust us, but if we are going to address health issues in this region, we have to work together. There is no way either side can do it alone."

Mosquito-borne diseases are a rising health concern in this borderland, where close proximity and constant movement are entangled with a belligerent past and deep animosity. In fact, every time I drove across the "Friendship Bridge," witnessing the endless and unrestricted flow of border crossers, listening to the Spanish, Portuguese, and the *Portuñol* (the mixture of Portuguese and Spanish) spoken on both margins of the Paraná River, it struck me how this intimacy between the two cities seemed to contradict the violent histories and political rivalries that have permeated the region. The tackling of mosquitoes and their

pathogens can be understood as yet another episode in this geopolitical borderland, where collaboration is required even amidst distrust and rivalry.

Even before Brazil, Paraguay, and Argentina were countries, these borderlands were stained during Iberian colonial rule by bloody conflicts. In this region, different Guarani communities were forced out of their lands and suffered genocide and enslavement at the hands of Europeans settlers. Between 1628 to 1632 alone, roughly 33,000 Guaranis were captured by slavers from São Paulo (the *bandeirantes*)—among the largest enslavement raids on South American soil (Austin 2018, 25).[145] Feuding between the Portuguese and Spanish crowns was particularly felt here, a disputed frontier between the two Iberian colonial powers, following a long history of confrontations between Jesuit missionaries and royal authorities, sparring for control of the lands, resources, and peoples (Blanc and Freitas 2018, 5).

This borderland is also marked by haunting legacies of the War of the Triple Alliance (commonly referred to in Brazil as the "Paraguayan War"). Belligerent hostilities in the region escalated when, in 1864, Paraguay declared war against neighboring Brazil and, soon after, against Argentina. Putting historic rivalries aside, Brazil and Argentina banded together, later joined by Uruguay. The three allied countries then ravaged Paraguay, with the war coming to an end in 1870. Historiography of the causes of this war has changed throughout the last century. Earlier studies tended to blame the conflict either on the overweening ambitions of the Paraguayan government to expand the country's regional power and secure land and waterways that granted ocean access for trading; or on the failed external policies of Brazil's decaying Imperial government—the latter promoted by staunch Brazilian republicans who criticized the Empire while still praising the glories of the national armed forces. During the 1960s and '70s, a particularly popular analysis attributed the war to foreign commercial interests, in particular British merchants wanting

[145] Raids were on the Guairá and Tapé regions of Spanish Paraguay, with the captured Guaranis being taken to the São Paulo plateau, 600 km (about 370 mi) away. The numbers of enslaved Guaranis mentioned here, as the historian Shawn Michael Austin (2018, 47) points out, are conservative ones—with estimates ranging widely.

to force Paraguay out of its economic development path.[146] More recently, historical studies have focused on analyzing the war as a result of regional state formation after independence from Iberian colonial rule (for an overview of this historiography, see M. E. C. M. Marques 1995; Doratioto 2002; Squinelo 2002; Kraay and Whigham 2005).

What historians writing about the Triple Alliance War have agreed on, however, is how disastrous it was for Paraguay. Casualties were catastrophic: estimates indicate that over 300,000 Paraguayan lives—60% of the country's pre-war population—were lost either in combat or to hunger and disease, with nine out of ten men in Paraguay dead by the end of the war (Whigham and Potthast 1999; Doratioto 2002; Lambert 2006). In the aftermath, not only was the country humiliated by defeat but also occupied by foreigners and stripped of part of its territory. It goes without saying that previous plans for political and economic development were completely dismantled. Historians have argued that the scale of sacrifice and devastation that Paraguayans endured has profoundly shaped the country's national identity (Whigham 2005; Lambert 2006). Repercussions have been long-lasting and, even though it happened more than 150 years ago, legacies of the war are still an ominous presence in the region, especially in Paraguay, which blames Brazilian aggression for a war that cost them their population and obliterated their economy.

These hostilities and resentments have manifested themselves in regional politics, noticeably flaring up during the other major event that shaped the region: the building in the 1960s-70s of the Itaipu Binacional Hydroelectric Dam.[147] The precise location of the line dividing Brazil and Paraguay was

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[146] Among those who popularized the interpretation that the war was a London plot are the journalist Eduardo Galeano (1973) and the Marxist historian Eric Hobsbawm (1975). These works depict Paraguay as a rising industrial powerhouse and Francisco Solano López, the Paraguayan president at the time, as a leader that, albeit authoritarian, was concerned with the people's well-being—both portrayals are questioned by recent studies (Doratioto 2004).

[147] Resources for energy production have also shaped Paraguay's relation with its neighbor to the north, Bolivia, this time for oil reserves, with the two countries being at war from 1932-1935. Fought in the hot and semiarid lowlands of the Gran Chaco, this conflict was also intertwined with mosquito ecologies: increased human activity and oil activities had expanded the range of disease vectors in the region, including malaria and yellow fever. Starting in 1932, the Rockefeller Foundation started a yellow fever eradication program in Bolivia and, soon after in Paraguay. Historian Ann Zulawski (2007) has examined how Rockefeller experts were aware that the impending war between the two countries would result in a large number of people moving around, contributing to the disease's spread and potentially

contested after the Triple Alliance War,[148] and the shift of interest in the Paraná River—from its commercial (route) to energy potential—triggered more contention (on this shift see, Gómez Florentin 2015). The dispute further escalated in 1965 during a Paraguay-Brazil military standoff, with both countries sending armed forces to the border. Environmental historian Jacob Blanc (2019) has traced how this border conflict was seen by both the Paraguayan and Brazilian governments (two military dictatorships at the time) as an opportunity to (re)define the region's political landscape: for Paraguay, a chance to shed the image of a defeated country, while for Brazil, to assert its geopolitical and economic dominance.

The two countries, however, "found a way to make their border conflict literally disappear" (Blanc 2019, 21). They did this by co-constructing a hydroelectric power plant that would submerge the disputed area for its reservoir. The border conflict itself was never solved: when signing the agreement that led to Itaipu's construction, both countries restated their own interpretations of where the dividing line passed (Blanc 2019, 44). But in Itaipu's website, this moment in history is recounted as "instead of engaging in conflict, the two governments made a wise decision: to join forces" (Itaipu Binacional 2021). The hydroelectric dam was promoted as a blueprint for solving sullied neighborly relations and for advancing regional collaboration and unity (J. C. Cavalcanti 1976). Nevertheless, tensions were not settled—merely internalized. Even though Itaipu was supposed to be a binational endeavor, with parity assured in all aspects of the project and at different administrative levels, in practice the unequal power relations between the two nations was inscribed into the negotiations, with the final deal stacked in Brazil's favor.

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jeopardizing the Foundation's campaigns in other countries (especially in Brazil). Activities to control the mosquito population included spraying petroleum, provided free of charge, over open water sources (Cote 2013, 746). However, during the war outbreaks of yellow fever and, in particular, of malaria were recurrent, with (highland) Bolivians having less resistance and immunity to the disease than the Paraguayans. The Chaco War was the bloodiest international military conflict in South America during the 20th century.

[148] The ambiguity came from different interpretations of the 1872 Treaty of Loizaga-Cotegipe: for Paraguay, the border went up to the Guaíra waterfalls, leaving 20 km (12.4 mi) of uncontested land west to the falls; for Brazil, this stretch belonged to its territory, since the border included the Guaíra waterfalls (Blanc 2019, 23–25; Folch 2019, 9–10).

The terms of electricity ownership and sales are perhaps what best illustrates how a relation portrayed as among equals has *de facto* reinforced Brazil's upper hand. Although the Act of Iguaçu—signed in 1966, formalizing both nations' interests in working together—guaranteed equal rights to energy production, it also specified that the two countries had the prerogative of buying all of the other's unused portion at a "fair price."[149] In other words, while the first provision positioned the two nations as co-equal partners, the former imposed Brazilian dominance by forcing Paraguay (with its significantly smaller population and thus much lower energy demands) to sell its surplus to Brazil (the most populous South American country), at a price far below market value (see Elder 2019 for contemporary ramifications of this agreement).

Under the banner of cooperation but with the threat of war always looming—a war Paraguayans knew they would undoubtedly lose—Paraguay was strong-armed by its neighbor into an agreement that brought Brazil not only financial but also political dividends.[150] After all, "hydropolitics" is at the core of regional geopolitics. As political and environmental anthropologist Christine Folch (2019, 7) points out, here hydroelectricity is not an "alternative" source; contrary to most places in the world, which run their countries by burning fossil fuel, nearly two-thirds of the electricity generated in South America comes from renewable sources, primarily hydroelectric power plants.[151] Located in the most important river basin in the Southern Cone, the construction of a massive dam—chosen as one of the seven Wonders of the Modern World by the American Society of Civil Engineers—set in motion a series of diplomatic treaties and

[149] The Act is available here (Portuguese version): https://www.itaipu.gov.br/sites/default/files/af_df/ataiguacu.pdf. To add salt to injury, the 1973 Treaty later stipulated that financial transactions would be done with the currency available at Itaipu, which meant Brazil would pay in Cruzeiros (the Brazilian currency then). The easiest way for Paraguay to then spend these Cruzeiros was to import Brazilian products (Schilling and Canese 1991, 29).

[150] Brazil's relationship with its neighbor, especially Paraguay, has often been called out as colonialist or imperialistic (Folch 2019, 168), drawing comparisons with the kind of relations and "cooperation" the United States has established with Puerto Rico or Panama (Schilling and Canese 1991, 29; Blanc 2019, 51).

[151] The numbers Folch (2019, 7, 209) gives are that two-thirds of the United States' electricity comes from fossil fuel; in Europe, Africa, and Asia, from two-thirds to three-quarters is derived from coal, oil, and fossil fuels; and in the Middle East, nearly all if it comes from fossil fuels.

multinational cooperation assurances. The need to establish political and economic structures to govern hydro resources at an international level entailed a redrawing of the regional geopolitical landscape.[152] Therefore, Folch (2018, 267) argues, just as the European Union grew out of coal and steel, the creation of the 1991 Common Market of the Southern Cone (Mercosul) can be traced to hydroelectricity—with Itaipu, and therefore Brazil, at the center of it (see also Ferradás 1998).

Completed in 1982, Itaipu not only acted as a catalyst for Brazil's rise as the most powerful South American nation but also profoundly changed the ecological landscape. It prompted an accelerated urbanization process, since a total of 1,350km^2 (around 521 mi^2) were flooded for the reservoir, displacing at least 40,000 people—although numbers are probably higher since Indigenous communities and landless families were also impacted but official Itaipu statistics included only those with legal title (mostly small farmers of European descent) (Blanc 2019, 235). In addition, in a very short period of time, hundreds of thousands workers migrated to the area in order to build the plant (Blanc 2019). The region also grew into a commercial hub owing to the fact that Ciudad del Este became a free-trade zone in the 1970s—an effort by the Paraguayan government itself to hitch onto Brazil's economic ascent (Ferradás 2004; Folch 2018). Driven by favorable currency conversion rates, in the 1990s there was a surge in the "reexport" trade, where goods imported duty-free to Paraguay were purchased by Argentines and, especially, Brazilians, who then resold these products in their own countries. This commercial boom boosted migration and further connected Brazil and Paraguay. This *tríplice fronteira* is now South America's most urbanized and busiest border, with most of this movement happening through the Friendship Bridge (Gimenez et al. 2018).

"It is basically one city. There is a river cutting through it and it's two different countries, but it's one city," the CCZ health official Marília commented, as we drove one day close to the border with Ciudad del Este. Indeed, in this *tríplice fronteira*, the Brazilian-Paraguayan border was the one my interlocutors

[152] In addition to the 1966 Act of Iguaçu (between Brazil and Paraguay), in 1969, Argentina, Bolivia, Brazil, Paraguay, and Uruguay signed the Plate Basin Treaty, stipulating how shared transboundary water resources would be used (Folch 2018, 276).

referred to most frequently. Movement is more intense between these two countries and, while border crossers can move unrestricted through Foz do Iguaçu and Ciudad del Este, the Argentine town of Puerto Iguazu enforces national limits, inspecting documentation to allow entrance (see Ferradás 2004; Seri 2004; Jusionyte 2015 on the Argentine border securitization). Another factor is that Puerto Iguazu is a smaller city, with its 45,000 residents, distant from political and economic centers in Argentina; Ciudad del Este, on the other hand, is Paraguay's financial capital, the second largest city in the country, only trailing the political capital, Asunción. [153]

This high flow of border crossers, this entangled connection between the two cities, meant that if there was an infectious outbreak on one side of the riverbank, the other side would sooner rather than later also experience it. "But while we can easily work together with neighboring Brazilian towns," Marília added, "to coordinate something with Ciudad del Este becomes a matter of foreign affairs, with all the diplomatic challenges that come with it." Itaipu's *GT-Saúde* was established in 2003 out of an awareness of both the need and challenges in coordinating interventions across national border lines. That is, it was a space to facilitate, as international studies scholars Marcelino Lisboa and Vanessa Peron (2019) have pointed out, the implementation of public health policies across borderlands.

An average of 110 people participate in the *GT-Saúde*'s monthly, full day meetings, with costs covered by Itaipu (the location, transportation, and food for those participating). [154] In the morning, representatives from the three countries work together in smaller groups as part of one of the nine technical

[153] Just because the Brazil-Argentina border is less busy and Puerto Iguazu smaller, it does not mean that the border does not have its own geopolitical tensions. For example, historian Frederico Freitas (2021) has examined how both Brazil and Argentina instrumentalized the national parks around the Iguaçu/Iguazu Falls to make territorial claims across the borderlands. That is, the two countries strategically nationalized nature, from the parks' creation in the 1930s until the 1980s, when they took their present shape.

[154] Information and details about the GT-Saúde are based on access to internal documents, including a Project Portfolio from 2003 to 2019: a spreadsheet with all funded projects, divided by technical commissions; events the GT-Saúde had supported or participated; actions undertaken by the group; and other details, including the average of participants in its 173 ordinary meetings. Another spreadsheet details the different objectives of GT-Saúde and of the different commissions within it. Finally, I also was granted access to slide presentations for funding requests.

commissions: endemics and epidemics; indigenous health; mental health; maternal, child and teenager health; elderly health; men's health; accidents and violence; permanent education in health; and worker's health and the environment. After lunch, there is a plenary where participants share health concerns or challenges; the group also discusses how to spend the Itaipu funding allocated to support implementing projects, developing campaigns, and organizing academic or training events, and how ongoing projects are going.

The *GT-Saúde* meetings occur in a mixture of Spanish and Portuguese. Considering that language is an important aspect of Anzaldúa's analytics,[155] the question arises of how the linguistic particularities of these borderlands also shape the interactions happening on them. Portuguese and Spanish are both Romance languages that, although differing in their phonology, grammar, and lexicon, are relatively similar. During meetings people spoke the language in which they were most comfortable and everyone seemed to understand. Sometimes someone needed help translating a term or a sentence, an issue always quickly solved since several participants were fluent in a sort of *Portuñol*.[156] Meetings fluidly moved between the two languages and between a mixture of them. However, occasionally one could hear the notably distinctive Guaraní.

After being repressed for centuries for being an Indigenous language, Guaraní has been "revitalized" in recent decades, nowadays being taught in Paraguayan schools and flaunted by Paraguayans

[155] In Chapter 5, "How to Tame a Wild Tongue, Anzaldúa explores how one's identity is intertwined not only with the language and the way a person speaks but also how other people recognize and acknowledge this person's language. Anzaldúa writes, "So, if you want to really hurt me, talk badly about my language. Ethnic identity is twin skin to linguistic identity—I am my language. Until I can take pride in my language, I cannot take pride in myself. Until I can accept as legitimate Chicano Texas Spanish, Tex-Mex and all the other languages I speak, I cannot accept the legitimacy of myself. Until I am free to write bilingually and to switch codes without having always to translate, while I still have to speak English or Spanish when I would rather speak Spanglish, and as long as I have to accommodate the English speakers rather than having them accommodate me, my tongue will be illegitimate" (60). For more on the importance of language for Anzaldúa, see Herrera-Sobek (2006).

[156] To facilitate comprehension, whenever someone made a presentation, they would speak in one language and put the slides on the other one. Speakers were also at times reminded to speak slower.

to culturally distinguish themselves from neighboring countries.[157] If they wanted, Paraguayans could strategically use Guaraní to make comments that most probably neither the Brazilian nor Argentinian participants would understand. That is, during the *GT-Saúde* meetings and across the *tríplice fronteira* one could hear Anzaldúa's borderlands of mixture and in-betweenness alongside Anjos' crossroads of difference and separation.

Among the *GT-Saúde* nine technical commissions, "endemic and epidemic" has received the most funding for activities, with many being related to vector-borne diseases (leishmaniasis, malaria, yellow fever, and dengue). Geopolitics in this borderland has caused significant ecological effects, with vectors—alongside the pathogens and parasites they transmit—becoming a growing health concern.[158] The flooding of vast land areas to build the hydroelectric and the damming of the River Paraná (slowing down its speed) created favorable conditions for mosquito proliferation (Teodoro et al. 1995; Mitchell 2002). The abrupt migration and rapid urbanization caused by the Itaipu's construction have also exacerbated the risks of urban zoonotic diseases in this borderland, particularly dengue. Finally, the extensive deforestation and monocultural soy production have further aggravated the environmental disturbances and degradation that can make a region more prone to zoonotic outbreaks (Ferradás 2004, 429).[159]

An outbreak in this region can not only be medically concerning but also economically threatening, scaring away the millions of tourists visiting the region every year—most coming to visit the Iguaçu Falls, the largest waterfall in the world—and profoundly harming the local economy that depends on them. Vectors proliferating across border lines have demanded that the three countries collaborate. Because Brazil

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[157] The Paraguayan Guaraní is actually a dialect, since there are variations between the different Indigenous groups speaking Guaraní. For more on the linguistic particularities and history of Paraguayan Guaraní, its revitalization process, the stigmas still associated with it, and connections with Paraguayan nationalism, see Melià (1983); Nickson (2009); Hauck (2014); Galeano Olivera (2019).

[158] Jusionyte (2015) analyzes how Argentinean media reports about the tri-border area portray the region as a potential (and dangerous) entryway for infectious diseases in Argentina—a sort of "epidemiological frontier" (88).

[159] During the 1990s, deforestation rate in this region was among the highest in the world and the highest in South America—the goal was to use this land not just for soy but also cotton (Richards 2011).

has had to deal with these diseases earlier and on a larger scale than either Paraguay or Argentina, much of the expertise and infrastructure proposed for adoption in the tri-border area has followed Brazilian guidelines.

For example, in July 2010, the *GT-Saúde* funded a course on the Rapid Survey Indicators for *Aedes aegypti*, the methodology adopted in Brazilian vector control strategies.[160] Within the *GT-Saúde* there was also a push to implement the entomo-virologic surveillance system across the tri-border area—again, a Brazil-made and Brazil-led effort. In efforts to address mosquito-borne diseases, Brazilian dominance manifested itself once more in this borderland. Even if this time one could argue it was more subtle, more cordial, and more benevolent, this was Brazilian dominance nevertheless.

Multispecies Borderlands: Winged Indicators

"I understand that they want to come here, I do, but it messes everything up... Last week we received a notification of a dengue case in this neighborhood." Letícia, a CCZ *agente*, pointed on a map to an area in the southernmost part of Foz do Iguaçu. "I went there and tried to locate the address they gave us. I kept looking, walking back and forth because sometimes house numbers here are out of order. I had to find it because that is my job. But it didn't exist! It was just a great waste of time." The case notification database and other national guidelines for mosquito-borne diseases are based on a form of more-than-human biopolitics, with governmental practices aimed at gathering knowledge about both (infected) humans and (larval) mosquitoes to implement targeted interventions that should increase the well-being of the former while eliminating the latter (on biopolitics, see Foucault 1976; 1978; on more-than-human biopolitics, see

[160] This methodology (referred to as LIRAa) was developed in 2002/2003, being standardized and included in the Brazilian national guidelines in 2005 (Brasil 2002b; 2002a; 2005; the methodology was updated later, see Brasil 2013).

H. Brown and Nading 2019).[161] By following my interlocutors' arguments that the national guidelines were fraught with flaws and failures, especially when adopted in a borderland region, I examine the entomo-virologic surveillance system as a proposal for a new form of more-than-human biopolitics—one organized around winged indicators.

Throughout my fieldwork, I heard several frustrated complaints about the database's shortcomings, and even ended up being part of a couple of futile searches for houses that did not seem to exist and people whom no one in the street seemed to know. In Foz, the database was unreliable due not only to misdiagnoses and unreported cases (an issue across Brazil) but also because of an influx of patients from out of town seeking medical care. CCZ employees explained that many Paraguayans and Brasiguaios cross the border to be treated through Brazil's free and universal national healthcare system—the SUS.[162] Concerned with being denied treatment or suffering any penalties, those living in Paraguay often give incorrect personal information to the health professionals, particularly fake addresses in Foz do Iguaçu (for different strategies used to access healthcare at the border, see V. A. Nascimento and Andrade 2018).

For those working at CCZ, a fake address was a problem because, in the national guidelines, a case notification triggers a series of targeted actions around the infected person's house, including inspecting for breeding spots and locally deploying insecticide (using a sort of backpack with a motor and a hose to spray the chemical). Letícia and other CCZ employees argued that the entomo-virologic surveillance system could overcome the fake addresses problem and other database inaccuracies by directly tracking mosquitoes

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[161] The anthropologist of science Stefan Helmreich (2009)—drawing on Heather Paxson's (2008) notion of "microbiopolitics," a more-than-human adaptation of Michel Foucault's notion of "biopolitics"—has called this governance of encounters among biological entities "symbiopolitics."

[162] According to the health administrators I interviewed, this demand caused congestion on emergent care. Since primary care is organized according to residency, those living in Paraguay often go directly to urgent care units. In 2007, the Maternal and Child Center was founded to offer prenatal care to pregnant Brazilians living in Paraguay, who before came only for childbirth (F. de Mello, Victora, and Gonçalves 2015). Most administrators seemed sympathetic to those coming to Foz seeking healthcare but thought the national government should offer the city more support. After all, their funding was allocated according to their official population, even though they were providing care to many who did not live there.

and pathogens. This new system would thus also overcome the slowness, and at times sloppiness, of the bureaucratic methodology: case reports were done at the primary and urgent care units by often overworked and tired health professionals. For these reasons, information was often missing (a street name, but no number) or difficult to discern (illegible handwriting)—hindering the effectiveness and speediness of the CCZ team's activities.

My interlocutors also estimated a significant underreporting of mosquito-borne disease cases because some people who are infected never seek medical care since there is no specific treatment for dengue (after numerous outbreaks, many people know the dengue symptoms and self-diagnosis is aided by the ease of web searches).[163] One day, visiting homes with an *agente*, we knocked on a gate and were greeted by an older man. "Ah, you are here… but now I already have dengue." As we inspected the yard for breeding spots (we found nothing), the *agente,* Gabriel, asked the man about symptoms and if he had gone to the doctor. "To the doctor? For what? Why would I go, sit there, waiting, for hours and hours, for someone to look at me for 5 minutes and tell me, 'Drink lots of fluids and rest.'" The man grumbled. "Better to stay home!" Once we left the house, Gabriel commented, "He probably has dengue, but he will never be in the database. It's what we have been telling you: if we just use the database, we have no idea how many cases there are in the city." He then smiled, teasingly, "You should jot that down in this notebook of yours!"

According to my interlocutors, another shortcoming of the database was that the notification linked the disease case to the person's home address; but infection often happens elsewhere, especially considering that the *A. aegypti* is a diurnal biter. In that case, the targeted actions to limit transmission might occur in a part of town with no (infected) mosquitoes. This difference is particularly important in a place where people

[163] Foz also has had cases of Zika and chikungunya but dengue is a much worse and more widespread issue. Anyway, there is also no treatment for these other diseases transmitted by the A. aegypti. Underreporting is a known issue in Brazil; for example, in a 2016 enhanced surveillance study in Salvador, from every 20 patients identified with dengue, only 1 had been reported to the database as having dengue (M. Silva et al. 2016).

might cross international borders daily to work, shop, or study.[164] To that end, instead of trying to keep track of ever-mobile people, constantly traversing across the city and across the border, the system would target the mosquitoes, which tend not to fly too far from where they bite and breed.

In their focus on the adult mosquito, my interlocutors explained their strategy in terms similar to the two other novel vector control strategies analyzed in this manuscript. Even though CCZ officials were not modifying the *A. aegypti*'s body (as *Wolbachia* and irradiation do it), they were still manipulating the mosquito, harnessing its biological preferences, habits, and instincts—instead of simply hunting it down to kill it. While larvae can be difficult to find (concealed, as they are, in breeding sites that are out of reach and out of sight), adult *A. aegypti*, especially the females (driven by their blood hunger) have to approach humans.[165] The *agentes* had only to strategically place traps close to people, and the mosquito would seek them out.

To put it differently, this surveillance method did not need to go after the larvae; instead, because of its biological need for blood to mature eggs and its anthropophilic preference, the *A. aegypti* itself sought humans and, in the process, would get trapped. By exploiting the mosquito's own characteristics, my interlocutors insisted that they could enhance the current approach of simply reacting to an ongoing outbreak, when case numbers were usually already out of control. As the CCZ coordinator put it, they could act in a more forceful (*contundente*) manner and their actions would be more effective because they would be responding to an imminent infection risk—a mosquito with a virus, a vector on the loose.

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[164] Students from all over Brazil have been moving to Foz to study medicine in Paraguay in the last few years. In both countries, medicine is a six-year undergraduate course but securing a spot at a Paraguayan university is less competitive and more affordable. In addition, the surge of Brazilians pursuing studies in the neighboring country was driven by the 2013 Mais Médicos (More Doctors) Program, which allowed doctors with a foreign diploma to practice in Brazil (the program targeted mostly Cuba-trained physicians) (see Facchini et al. 2016 for a special issue examining several aspects of the program). Despite Bolsonaro's termination of the program in 2019, the students with whom I spoke with still planned to continue studying in Paraguay and then transfer credits to a Brazilian university. This relocation would give them a Brazilian diploma but taking part of their classes in Paraguay would cut the overall cost of their education.

[165] Males can also be found close to humans, trailing behind the females.

To harness the mosquito in an effort to address pathogenic viruses, the CCZ team had to snare adult females that had already bitten humans. To that end, they used a spherical shaped, dark colored trap, simulating a shady place—an ideal spot for rest and shelter after blood feeding (Donatti and Gomes 2007). This device (called *Adultrap*[166]) also permitted trapping the insects without killing them, a necessary condition since virus screening with real-time PCR is more reliable if the specimen is alive (Souza Leandro et al. 2019).[167] In this instrumentalization of the *A. aegypti's* reproduction processes and preferences (here, in its broader sense, including egg maturation and rest after blood feeding), the mosquito was conscripted into an entrapping reproductive labor, needed for the entomo-virologic surveillance system to work.

When I visited, I was told there were around 3,500 traps spread in the city, with plans to buy 1,500 more; the goal was to have at least one trap per block, so that each would monitor around 25 houses. A staff of around 90 *agentes* visited each home harboring a trap at least once a month to collect the mosquitoes. Captured mosquitoes were taken to CCZ to be identified and categorized. The living female *A. aegypti* were then sent to be tested for viruses at the Center for Tropical Medicine at the Triple Border, with results usually available the next day.[168] By testing these captured females, my interlocutors asserted that this new system would be more accurate than the national policies dependence on the database of reported cases to monitor the epidemiological situation in the city. That is, screening the *A. aegypti* offered a more precise glimpse into the epidemiological landscape—captured mosquitoes acting as a proxy for infected humans.

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[166] First developed in collaboration with the CCZ team, the trap is now a commercial product sold by a company based in Curitiba (http://adultrap.com.br/).

[167] In the colder months the A. aegypti population dropped in the city; they were still present but it was at times harder to catch them alive. During the months I accompanied the activities of CCZ employees (April to July, fall and winter in the Southern Hemisphere), nights could get particularly cold, with a couple of times in July reaching temperatures below 0 °C (32 °F). During the day temperatures rose enough for a mosquito to survive—if they managed to shelter inside a warm home once night fell. However, if they had been trapped, they usually died; so, the agentes collected a higher percentage of dead mosquitoes.

[168] At the beginning of the project, when they had a more generous funding to rely on, they also tested males, finding a few that were contaminated (most probably because of vertical transmission). With more limited funding they also started testing together all the female mosquitoes captured in a trap.

The CCZ team knew the location of each trap, making it possible to retrace where the infected mosquito had been collected. They also knew how many residents lived in each house where a trap had been placed. By dividing the number of collected *A. aegypti* with the number of residents, CCZ officials wanted to produce a ratio of mosquitoes per human across the different neighborhoods. This way, the winged indicators would also include a sort of "chance of being bitten" estimate. However, this calculation did not take into account unequal urban and domestic landscapes—a persistent deficiency of vector control strategies, old and new (Löwy 2001; Nading 2014; Bueno et al. 2017; Segata 2019; G. Lopes and Reis-Castro 2019). Houses with fewer people living in them, usually more affluent ones, would have a higher ratio; their inflated numbers could result in more attention directed to richer neighborhoods, reinforcing class inequalities already present in the city. My interlocutors were fully aware of this issue and, during my fieldwork, were puzzling over it, trying to find a solution that would permit them not only to gather data about entomological and epidemiological conditions, but also to translate this data in a way that would permit them to grasp the (different) human experiences of living with mosquitoes and pathogenic viruses in Foz.[169]

CCZ health officials were fixated on creating methodologies to accelerate data collection and data analysis,[170] in hopes that they could more swiftly address mosquito-borne diseases—squashing the *A. aegypti*, especially those already infected, even before there was an actual outbreak. Rapid detection and rapid response, I was told multiple times, was the key to successful epidemic control. Lakoff (2017) has described this increasingly common rationality in public and global health as "real time biopolitics," where tools are designed to monitor, with vigilant attention, any transformation that might point to an onset of

[169] As anthropologists Rachel Douglas-Jones, Antonia Walford, and Nick Seaver (2021) have pointed out, "data" is becoming an ever-more-present emergent ethnographic object—data as ubiquitous while also mercurial (see also Boellstorff and Maurer 2015). Here I follow their recommendation to both "develop a sensitivity to the claims made of data's capacity to reshape the world, and […] keep a firm grip on the tools at hand to anchor those claims in specific histories of practice and thought" (15). For another analysis on the use of data collection to manage, record, and manipulate mosquito-borne diseases as a sort of socio-technical entity, see Sanches and Brown (2018).

[170] For more on the datification of nature and its claims of "speediness," see Nadim (2021).

diseases. And as Lakoff indicates, for the surveillance system to function, the data produced by these tools has to be assimilated quickly, almost instantaneously—in "real time."[171]

For CCZ health officials, the political administration of collective human-mosquito-virus life should be based on the winged indicators, located within species borderlands. Even though there is a shift here, the logic guiding this new more-than-human biopolitics remains the same as before: kill mosquitoes so that viruses cannot reach humans. That is, the multispecies blurriness is strategic and temporary—a crossroad. Several anthropologists, historians, and STS scholars have analyzed how sentinel devices are often based on the instrumentalization of nonhuman life to identify future threats and risks to human beings (Keck and Lakoff 2013; Benson 2013; Fearnley 2015; Cummiskey 2020; Keck 2020). Yet, in the case examined here, captured *A. aegypti* and the winged indicators derived from them are not merely producing early warning signals of an outbreak that might affect Foz residents—as a living being "that sends signals on a front line to other living beings at the back line," to use Keck's (2013, 16) words. Winged indicators are also deployed to stand in for mobile, unreliable, and intractable humans, and producing these indicators means blurring the lines between humans, mosquitoes, viruses, and, in particular, the data that monitors and governs them all (see Haraway 1991a).

Bureaucratic Borderlands: National Health and Export Science

"They tell us we cannot use it." Fernando, a CCZ employee, shook his head, noticeably frustrated. "But we're saving lives, we shouldn't have to wait for the number of cases to explode (*estourar).* What about all this poison that agriculture throws at us? Why aren't there strict restrictions for that?"[172] We were in the lab

[171] The epidemiologist Alexander Langmuir has defined this as "epidemic intelligence"; for critical analysis of the term see Fearnley (2010); Caduff (2014).

[172] Anthropologist of toxicities Vanessa Agard-Jones (2014) has discussed a similar ethnographic situation as different scales of what STS scholar Michelle Murphy (2008) calls "chemical embodiment."

at CCZ, as Fernando categorized the mosquitoes captured that day. I could hear the grievance in his words, as he carefully examined the insects. "It just doesn't make sense. We could use so much less insecticide if we were allowed to already fumigate the area with a car once we had detected an infected mosquito. But no, no… We're forced to wait and end up having to use a lot more of it because, by the time they give us permission, the situation is already a disaster."

Based on results from viral screening, proponents of the entomo-virologic surveillance system wanted to override rules and policies restricting the deployment of chemical insecticides. That is to say, they wanted to already be able to fumigate from an automobile, if they found an infected mosquito. This mode of fumigation—known as *fumacê*[173]—is restricted because not only does it have harmful effects for humans and other animals alike, but also because the *A. aegypti* population is highly insecticide-resistant in Brazil, with overuse worsening the situation. In the past, *fumacê* has been used by political authorities throughout the country trying to publicly show off that measures were being taken against the hated and feared mosquitoes. The insecticide, after all, kills not only *A. aegypti* but also all kinds of other bugs, including another mosquito, the abundant and widespread *Culex*—resulting in almost immediate (albeit temporary) relief from constant biting. In fact, during my time in Foz do Iguaçu, I witnessed a resident pleading for *fumacê* to a CCZ worker, who rejected her request by explaining the restrictions.

While *fumacê* is regulated by national guidelines, CCZ health officials described how the state of Paraná had a particularly bureaucratic process governing its usage. "Here, we need to sign a document and send it to the *Ministério Público* (Public Ministry),[174] admitting that all other actions have failed." The 2014 state resolution regulating fumigation asserts the importance of establishing clear criteria and procedures to avoid overuse and the consequent environmental and health harms it could cause. It mandates official

[173] The technical name is *Ultra Baixo Volume acoplado a veículo* (Ultra Low Volume attached to vehicle), or UBV *pesado*/heavy; but even official documents refer to it as *fumacê*.

[174] The equivalent of the District Attorney's office in the United States.

authorization for any fumigation done by car, requiring a city's mayor and municipal health secretary to sign a "term of commitment" and submit it to the Public Ministry (Paraná 2014). "Tell me," the CCZ official continued, "who wants to sign a document admitting failure, especially when cases are low? Look, I'm not defending the chemical (*o químico*). I'm aware it is harmful. But there comes a time in the disease transmission or the epidemiological characterization that you either use the most drastic intervention or you will pay a price." He sighed heavily. "We have a tool to help us to foretell an outbreak; but right now, there is very little we can do other than wait, as we see it getting closer and closer and closer."

For CCZ officials, current policies fell short of their goal to address mosquito-borne diseases—a realization that was proved right every time there was yet another outbreak. Because these diseases are so recurrent in urban centers across the country, they have become enmeshed in political promises and disputes. According to my interlocutors, decades of policymaking limiting political uses of vector control campaigns had made the rules stricter while still failing to remove these campaigns from politicians' influence. The current approach for tackling mosquito-borne diseases, they asserted, was failing. In a quest to improve the existing approach, the Center had established collaborations throughout the last years with research groups from different universities, working jointly on an array of different projects, from investigating *A. aegypti's* insecticide resistance to developing better traps to collect these insects. My interlocutors argued that pursuing new approaches from within the borderland of scientific research and public health implementation allowed them to create proposals and policies that would be innovative while still feasible as a public policy.

CCZ officials also hoped that these collaborations could produce the data needed to convince higher-up bureaucrats of changing the national guidelines. A group of scientists was collaborating with them to measure and assess the entomo-virologic surveillance system. Here, winged indicators were expected to prove the existence of a threat—a vector—that required immediate action. So far, adopting the system had resulted in changes within CCZ's daily practices, but my interlocutors had not managed to

persuade state and national public health officials to modify ruling policies, particularly when it came to fumigation dispersed from an automobile, still regarded only as a last resort solution.

For CCZ officials, the nationally standardized system was also slowed down by its own bureaucracy. Ever concerned with speeding up monitoring and response, my interlocutors wanted to change the system's dependency on an extensive paper trail. They had plans to digitize all the Center's activities, proposing as part of their new surveillance system to create software for *agentes* to input all the collected data using tablets during inspections themselves. However, not all *agentes* were happy with this prospect—highlighting how there were different perspectives within CCZ. Because the tablet had no internet access, the data was uploaded to the cloud database only once the *agente* reached CCZ's WiFi.[175] These workers complained that, throughout the day, the backlogged information, waiting to be uploaded, slowed down the software and, therefore, slowed down the *agentes* themselves. "Sometimes I cannot start inspecting a new house because I'm waiting for the software to work," one of the *agentes* told me. "The ones in the office can have good ideas, but it's us here, in the field, that must figure out its application in practice."

Another complaint often (indirectly) raised by the *agentes* was that the software was designed and adopted to surveil not only mosquitoes and pathogens, but also them—the human workers. The time and location of each visit was saved, permitting one to trace back how an *agente* had spent the day. CCZ officials speculated whether this dissatisfaction could explain the several tablets that had fallen on the ground or in the water—perhaps a Luddite-style opposition to the new digital system.[176] The new tablet/software proposal becomes an example of what several surveillance scholars have pointed out as automation's tight connection with workplace surveillance, either as an unintentional result or as deliberate design feature

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[175] Many agentes preferred going directly home after finishing their day's activities, avoiding having to return to CCZ. If they chose to do that, they then had to use their home's WiFi—another source of contention about the new tablet/software.

[176] Drawing a connection between 19th-century industrialization and the current automation process, STS scholar Ruha Benjamin (2019, 19–20), borrowing from AI scholar Jack Clark, points out that the 19th-century revolt "against machines" by English textile workers—the Luddites—can be understood as a response "directed at the manner in which machinery was rolled out" and its implications for working conditions.

(Ball 2010; Mateescu and Nguyen 2019; Struna and Reese 2020). Here, *agentes* resisting the new digital system could also be understood as an effort to resist the blurriness between different types of surveillance.

During my fieldwork, CCZ officials were still fine-tuning the software, committed to creating a system that could be used in the field to accelerate data compilation. The system's development, however, had been slowed down, affected by the drastic political transformations spurred by Bolsonaro's election. Most of the project's funding had been acquired as part of Itaipu's budget for "social responsibility" initiatives. However, in 2019 Bolsonaro appointed new directors to lead the hydroelectric power plant, most of them military officials, who promoted austerity measures and sharply shifted internal priorities (Itaipu Binacional 2019b; 2019a). It probably also did not help that the Foz's deputy-mayor and municipal health secretariat at the time, Nilton Bobato, had belonged to the Communist Party (PCdoB)—communists are the political nemesis of Bolsonaro and his supporters.[177] Amid all these political seismic shifts, the entomo-virologic surveillance system had felt the reverberations: the CCZ team lost the bulk of its financial support from Itaipu, halting plans to expand the project.

Itaipu's funding had been considered instrumental because the CCZ team strove for the adoption of their surveillance system beyond Foz, in particular across the *tríplice fronteira* region. On my first day of fieldwork, a CCZ employee, Felipe, told me that Foz was designing a vector control strategy to then export it to anywhere else in the world. When I asked, "But why here? Why Foz?," Felipe promptly replied, "I think here we managed to put together an efficient arrangement, both in relation to human resources and laboratory infrastructure. This is what allowed us to develop this novel system." He then added, "Plus, Foz is in a strategic position, we're at the triple border. This means we have a lot of influence, because we have Argentina and Paraguay right next to us. So, it's much easier to take it to other places."

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[177] In March 2019, Nilton Bobato left the Communist Party after being affiliated for 27 years. Many in Foz with whom I discussed this matter understood his leaving as a politically strategic move: in an extremely polarized country/city, PCdoB antagonized too many voters. Bobato was not affiliated to any party for a few months. Then, in August 2019, he joined the Brazilian Democratic Movement (MDB), a more center and "big tent" kind of party.

Felipe's words echoed the phrasing of the 2016 Work Plan for establishing the Center for Tropical Medicine at the Triple Border in Foz do Iguaçu: "Because it is the region's largest municipality, with the largest [health] staff, and because it is constantly subjected to challenges, Foz do Iguaçu has developed and standardized innovative techniques and working methods used in routine practices—which could be shared with other municipalities and even the neighboring countries." (Itaipu Binacional and Fundação de Saúde Itaiguapy 2016). In fact, according to this document, one of the reasons to create the Center for Tropical Medicine was to provide infrastructural conditions for the entomo-virologic surveillance system, supporting and propelling the adoption of this new strategy across the borderlands. Plans had already been underway to implement the system beyond the city of Foz. In 2017, with funding from the *GT-Saúde*, a team of nine Brazilians had crossed the Paraná River and for five days had trained Paraguayan health agents on this new approach, even lending 100 traps for the pilot project. Itaipu's website and local Foz newspapers reported the event with headlines stating that the city was "exporting" the new method to Paraguay (PTI 2017; "Foz 'Exporta' Método de Combate Ao Mosquito Aedes" 2017). CCZ officials had regarded this as the initial phase of a regional effort to adopt their system.

Nevertheless, as CCZ employees bemoaned the fact that their ambitious expansion was paused after Bolsonaro's election, one day during my fieldwork they received news about the launching of a mega vector control operation in Ciudad del Este. As a binational institution, Itaipu's leadership in each country has autonomy to decide how to allocate its resources: while Brazilians had decided to limit funding for vector control strategies, their Paraguayan counterparts had not. "They are doing it without us," commented a CCZ official, with a baffled look, as he saw the WhatsApp videos and photos of the mega campaign. To rub salt into the wound, unbounded by the same regulations that limit CCZ's team, Paraguayans were adopting extensive car fumigation, and even included a new style of fumigation using motorcycles.

Most of my fieldwork was conducted with the CCZ team in Foz, but I did travel a few times to Ciudad del Este. Equipped with my rusty Spanish—basically *Portuñol*—I accompanied for one day the Paraguayan health technicians in their field and lab activities and interviewed three health officials. When

we discussed the adoption of the entomo-virologic surveillance system, these health officials explained that they were still assessing whether the strategy could be helpful in controlling mosquito-borne diseases in the city. Instead of using the Center for Tropical Medicine's services, the Ciudad del Este team was sending the captured mosquitoes to Asunción, more than 300 km (190 mi) away.

The CCZ team had told me that the Paraguayans were not making use of the Center for Tropical Medicine to screen mosquitoes due to bureaucratic challenges of carrying live specimens across the border. When I asked the Paraguayan health officials, however, they told me that they preferred to ship them to Asunción, and quickly changed the subject.[178] These health officials knew that I had been accompanying the CCZ activities and that I am Brazilian, both aspects that probably influenced our brief interaction. But in talking to them, my reading was that Paraguayans were also interested in developing their own health expertise and infrastructure—perhaps a form of resisting yet another form of Brazilian dominance; to reinforce difference and distance, this time institutionally.

Vectors of Health

In examining the development and implementation of the entomo-virologic surveillance system, this chapter focused on analyzing how borders and cross-roads are conceptualized as the system operates through geopolitical, multispecies, and bureaucratic borderlands. By creating and deploying winged indicators, my CCZ interlocutors aimed to reorganize the political governance of collective human-mosquito-virus life, within Brazilian national policies and beyond. Here, health emerges as a cross-cutting vector that is constantly shifting within and between borders. These border encounters transform and reshape international, administrative, more-than-human arrangements.

[178] These Paraguayan health officials knew that I had been accompanying the CCZ activities (and that I am Brazilian), which probably influenced our brief interaction.

- Conclusion -

RACIALIZED ECOLOGIES, EPIDEMIC FUTURES:

"When it Comes to Mosquitoes, the World will Become Brazil"

This is how a leading medical entomologist explained to me the importance of Brazil-based research for tackling mosquito-borne diseases: "When it comes to mosquitoes, the world will become Brazil." Throughout these last years of research, I have heard many similar iterations of this idea from scientists and policymakers across Brazil and abroad. In a world increasingly transformed by anthropogenic action, the *A. aegypti* is predicted to expand its geographical presence. And in such a world, Brazil's current environmental and epidemiological conditions—warm weather; intricate, expanding urban landscapes; proliferating, insecticide resistant *A. aegypti* populations; and human bodies infected with multiple viruses—may, according to my interlocutors, foretell what is to come (and what is, in fact, already happening) elsewhere. But the country is not only considered to be a harbinger of mosquito ecologies and epidemic futures still to come. As this dissertation has shown, Brazilian ecologies are also envisioned, especially by Brazilian scientists and public health officials, as a place to produce knowledge and propose solutions that can be deployed elsewhere.

Political anthropologists Jean and John Comaroff (2012) have asked, "What if we posit that, in the present moment, it is the global south that affords privileged insight into the workings of the world at large?" (1). The authors remind us, as others have done, that "the south" names a *relation*, not so much a fixed geography, and therefore cannot be defined *a priori*. Therefore, the Comaroffs' call for a "theory from the south" aims not simply to flip the north/south dualism but also destabilize and transcend it. Reflecting particularly from an African perspective and about the present and future of global capitalism, they cast the global South as "a harbinger of history-in-the-making" (13). In his study of oceanic waves, the anthropologist of science Stefan Helmreich (2020) has similarly noted that the rising wave heights in

the Oceanic South may be considered to offer an oracular view of changes coming in the global ocean. The pervasive and destructive historical effects of colonization, capitalism, and industrialization position "the south" as also offering privileged insight into anthropogenically changing physical and biological nature.

In a sense, my interlocutors were all proposing different versions of *mosquito theories from the south*. Researchers, technicians, public health officials, students, *agentes* were all developing theorizations that refused the position of "reservoir of raw fact" and questioned the politics of location in knowledge production. My interlocutors also provided different models through which to envision the *articulation* of public health and science, politics and anthropogenic effects, and between Brazil and the rest of the world. Cultural theorist Stuart Hall (1986) has defined articulation as "the form of the connection that *can* make a unity of two [or perhaps more] different elements, under certain conditions. It is a linkage which is not necessary, determined, absolute and essential for all time" (see also Clifford 2001) Or as Indigenous studies and STS scholar Kim TallBear (2013, 13) puts it, articulation means "literally, to conjoin parts together into something neither strictly old and traditional nor completely new and different."

To become *vectors of health*, my interlocutors borrowed, transformed, combined, interpreted, and reconfigured practices, materials, and knowledges to articulate different scales of action in the service of developing and implementing a response to mosquito-borne diseases. This dissertation has examined the multi-sited and multi-scalar dynamics of biotechnological and bioecological research and labor required to harness the *A. aegypti.* My interlocutors modified or manipulated the mosquito to transform it into a newly engineered or enlisted tool: a new kind of *vector*, impelled, through bio-enterprise, toward new naturalcultural directionalities, for blunting the effects of its own pathogenic transmissions.

However, the articulation of new models for health and science have also entailed acts of exclusion. As environmental anthropologist Timothy Choy (2011) has noted, while analyzing environmental knowledge production and practices in Hong Kong, there is a political-economy that enables only some peoples' knowledges to be articulated while others become "unarticulated knowledges," not managing to

be linked and translated across scales and domains. Each chapter in this dissertation has described the discursive conditions, historical contingencies, and environmental materialities that were brought together across the different projects, and identified who and what was made invisible or excluded as these projects were implemented and promoted as Brazilian science.

By ethnographically investigating different projects, this dissertation research was driven by a concern for not covering over or erasing the multiplicities and differences within Brazilian science. In particular, my research aimed at highlighting the differing historical and structural conditions that permeate knowledge production in the country. Is it possible to call attention to the dearth of funding and support offered to Brazilian scientists, while also highlighting the prevailing Whiteness in scientific and public health spaces? Is it possible to confront the global and national geopolitics of knowledge production, while also attending to the internal inequities and the highly stratified system of research and education in Brazil?

Here, then, I would like to reflect on the politics of location in my own research and in anthropology more broadly. Using as a point of departure the 2018 American Anthropology Society's annual meeting, which took place in San Jose as nearby wildfires raged through forests and homes, anthropologist Ryan Jobson (2020) has asked what it would mean to "let anthropology burn." For Jobson, the smoke that breached the convention center "collapsed an artificial distance between the oppressive conditions that preoccupy anthropologists and the seemingly climate-controlled venues where anthropology convenes as an elite professional fraternity" (260); to let anthropology burn, then, would mean to refuse this fictive separation. In response, anthropologists Samar Al-Bulushi, Sahana Ghosh, and Madiha Tahir foregrounded the politics of location in Jobson's call, arguing that it proposes a universalizing politics that reproduces the "spatial myopia" and "spatial enclosure" permeating much of the North American anthropology. Being based in North America, and specifically in the United States, the authors argue, demands grappling with "transnational entanglements and the question of empire." Bulushi, Ghosh, and Tahir therefore assert that it vital to consider "what it means to imagine a radical humanism *from* the geohistorical location of the United States."

Borrowing from their insights, I consider what it means to discuss the geopolitics of knowledge *from* the United States. After all, financial discrepancies were present in interactions with my interlocutors as well as in relation to my humanities and social science colleagues. If knowledge production is afforded by certain material, social, and political conditions—as this dissertation has described—my capacity to conduct and write this research cannot be decoupled from my association with the United States and its entangled imperialistic legacies. As I write about Brazilian science in English to earn a Ph.D. from a renowned university in the U.S., my work reproduces unequal geopolitics of knowledge production, especially evident at a moment when the sciences, particularly the social sciences and the humanities, are under attack in Brazil (Monteiro 2020).

From Brazil, "letting anthropology burn" might perhaps have a different meaning, as it takes me to the haunting image of the Museu Nacional, in Rio de Janeiro, consumed by flames. This 2018 fire, which destroyed almost all (90%) of Latin America's largest anthropology and natural history collections, can be traced back to cuts in spending to federal institutions, hindering highly needed renovation projects (ABA 2018). A lack of funds for maintenance has led to other fires in archival collections in Brazil: in 2020, at the Museum of Natural History and Botanical Garden of the Federal University of Minas Gerais, in Belo Horizonte, and, more recently (July 2021), at the Brazilian Cinemateca, in São Paulo, responsible for preserving the country's audiovisual production (Mega 2020; Agência Senado 2021). Climate change and deforestation have increased the number of uncontrollable wildfires, causing incommensurable devastation, from California to Siberia, Indonesia, and Australia. However, the 2019 fires in the Amazon were probably deliberately caused by farmers, emboldened by Bolsonaro's campaign promises to curtail Indigenous land rights and open more rainforest for agriculture, as well as by his government's ongoing dismantling of environmental policies and slashing of funds for environmental research (Sullivan 2019; S. Hecht 2020; Boadle 2021).

As I was completing this dissertation, the server of Brazil's National Council for Scientific and Technological Development (CNPq) burned (on July 23, 2021). For days, CNPq's platforms were down,

threatening decades of stored information on scientific production and on the careers of scientists from across the country, as well as access to Brazil's scientific operations, including the database on scholarships, funding requests, grant reviews, spending reports. Although, so far, no official explanation has been given, this "data blackout" could have been caused by an overall lack of funding to run the CNPq. An agency within the Ministry of Science, Technology, and Innovations,[179] CNPq now has the lowest budget of the last 21 years; this year's budget is almost half of the amount allocated in 2000 (1.21 billion reais, compared to the 2.3 billions it received in 2000) (Rossi 2021). Access to the platforms has since been partially resumed, but there are still concerns over their stability and functionality. This blackout can be seen as one more fire of destruction—this time virtual—caused by neglect. All of these cases speak to the daunting and disquieting consequences of the lack of public funding, needed to maintain the country's scientific infrastructure and to support its scientific community. Brazilian scientists are already doing research amidst smoke, ruins, and ashes. Fires have in themselves an ambivalence (Fagundes 2019); but just like viruses, their effects are shaped by particular naturescultures, with their potential destructive consequences exacerbated by neglect and mismanagement.

Since my fieldwork, the importance of revealing the many discrepancies, nuances, and multiplicities in the relations between science, health, and environment has become more timely. While I was conducting research for this dissertation project, discussions of global epidemic futures were expected but considered to be relatively distant. But the arrival of the COVID-19 pandemic made such a reality dreadfully tangible. In Brazil, the virus transmission, and its bodily effects, followed from the inequalities that characterize the country. Indigenous and Black (*parda* and *preta*) Brazilians have been infected and have died at higher rates, and are also disproportionately suffering the economic and social impacts caused by the pandemic (M. P. A. dos Santos et al. 2020; Instituto Pólis 2020; Ferrante et al. 2020; APIB 2021;

[179] In June 2020, Bolsonaro reversed Temer's decision, reinstituting the Ministry of Science, Technology, and Innovations and the Ministry of Communications—although this did result in a budget improvement.

there was also a similar trend in the U.S., see Bassett, Krieger, and Chen 2020; Oyarzun 2020; Power et al. 2020). In historically unequal, racialized ecologies, inequalities have become embodied (Gravlee 2009; R. G. de Oliveira et al. 2020). After all, vectors, in their ever-changing directionality and magnitude, can become uncontrollable and devastating when impelled by historical, cultural, and political dynamics of negligence and inequities.

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