Engaging Science, Technology, and Society

THEMATIC COLLECTION: SITUATING MICROBES ORIGINAL RESEARCH ARTICLE

Can the Mosquito Bite? The Multispecies Transmutation of *Wolbachia* Mosquitoes as Biotechnologies of Epidemic Control in Rio de Janeiro

LUÍSA REIS-CASTRO
UNIVERSITY OF SOUTHERN CALIFORNIA
UNITED STATES

Abstract

A bite from the *Aedes aegypti* mosquito can transmit pathogenic viruses such as dengue, Zika, and chikungunya. While public health campaigns have historically focused on eliminating this vector species, a project in Rio de Janeiro, Brazil, proposes to release *A. aegypti* carrying the intracellular bacterium *Wolbachia*. This microbe, passed from female *A. aegypti* to their progeny, would hinder viral transmission, making the bite less of a threat and promoting a more convivial coexistence. In releasing *Wolbachia* mosquitoes, project proponents presented their strategy as a solution for disease control that harnessed "nature," instead of working against it. By juxtaposing historical accounts and ethnographic research in Rio with descriptions of biological processes, this article investigates how the microbe-mosquito dyad was turned into a biotechnology of epidemic control. Proponents of the *Wolbachia* project hoped that a change within multispecies relations—the novel human-bacterium-mosquito relationship—would change other multispecies relations—the historically constituted human-virus-mosquito relationships in Rio and beyond. This shift, which I term "multispecies transmutation," highlights how relational alterations in both biologies and socialities created a new life-form ("*Wolbachia* mosquitoes") and a new form of life (of multispecies coexistence). By tracing the more-than-human biopolitical arrangements put forward by the project, this article explores the recalibration of technoscientific solutions to global environmental health concerns. Multispecies transmutation offers a new framework for understanding the management of multispecies relations, showing how techniques of governance can target not individuals or populations per se, but rather interspecies connections.

Keywords

biotechnology; multispecies ethnography; more-than-human biopolitics; mosquito-borne diseases; Brazil

To cite this article Reis-Castro, Luísa. 2025. "Can the Mosquito Bite? The Multispecies Transmutation of *Wolbachia* Mosquitoes as Biotechnologies of Epidemic Control in Rio de Janeiro." *Engaging Science, Technology, and Society* 11(1): 75–100. https://doi.org/10.17351/ests2023.1555.

To email contact Luísa Reis-Castro: reiscast@usc.edu.

Introduction

"Well, you saw how difficult it can be to change their minds," Tiago said as we walked from the school to the car, his tone a mixture of frustration and amusement.[1] In a more subdued tone, Clarice bemoaned, "It seems they aren't even listening. Perhaps because they have been repeatedly told otherwise, they don't grasp—can't grasp—what we're saying." She carefully placed the projector bag in the trunk, closing it with a thud. "I don't know. . ." Clarice sighed. "Maybe we just need to keep telling them about this microbe and what it does to the mosquito, and, at some point, it won't sound strange anymore."

I had been accompanying Tiago and Clarice for three weeks, visiting schools as part of a project in Rio de Janeiro, Brazil.[2] As "engagement technicians," Clarice and Tiago were tasked with explaining to Rio residents, including school children, how the project planned to deploy a microbe—*Wolbachia*—to address the recurrent outbreaks of dengue, Zika, and chikungunya besetting the city. These diseases are all caused by viruses transmitted through bites of infected *Aedes aegypti* mosquitoes, which are pervasive not just in Rio but throughout Brazil. Due to its anthropophilic preference, this species insists on living alongside humans; more precisely, living (primarily) off humans, sucking blood that females need to mature their eggs. Since its role as a vector was established in the early-twentieth century, public health policies in Brazil have persistently framed *A. aegypti* as a hostile threat to be eliminated. Year after year, ubiquitous campaigns urge residents to reduce the mosquito population by eliminating standing water (which can become breeding grounds), though these efforts yield limited results.

However, as engagement technicians like Clarice and Tiago explained to residents, the *Wolbachia* project offered a different approach to tackling mosquito-borne diseases. Instead of waging war against the insect, they proposed releasing a version of the mosquito-vector that had been biologically modified so its bite would no longer spread pathogens. These modified mosquitoes were infected with *Wolbachia*, an intracellular bacterium that commonly infects various arthropod and nematode species. The expectation was that, inside the insect's body, the microbe would curtail viral transmission and prevent mosquito-borne diseases from reaching epidemic levels.

In other words, the *Wolbachia* team aimed to transform the microbe-mosquito dyad into a biotechnology of epidemic control by deliberately harnessing and intervening in interspecies connections. But to accomplish that, my interlocutors had to release *more* mosquitoes, a significant shift from decades of public health policies and campaigns portraying the mosquito as an "epidemic villain" to be combated (Lopes and Reis-Castro 2019). Since *Wolbachia* is passed from female *A. aegypti* to its progeny, they planned to enroll the insect's reproductive capacities by releasing microbe-carrying mosquitoes to mate with their "wild" conspecifics. They expected that, through reproduction, released individual mosquitoes would change, at a population level, *A. aegypti* in Rio from vectors into non-vectors.

[1] Fieldwork was conducted in Portuguese; translations are mine unless noted. Names are pseudonyms, mostly chosen by my interlocutors.

[2] The project was also being implemented in neighborhoods of Niterói, Rio's neighboring city.

Turning the mosquito from a threat into a tool was only part of the *Wolbachia* strategy. To conduct releases, engagement technicians had to convince residents that mosquitoes were no longer just enemies, but also allies. Justifying this reconfiguration in multispecies relations caused by the "*Wolbachia* mosquitoes"—as my interlocutors called them—was the reason Tiago and Clarice had visited the school that day. During our drive, Clarice mentioned that, especially when presenting to younger children, she used the portmanteau "Wolbito"—a name created by another engagement technician and later formally adopted by the project—because it was easier to say and made the insect seem "a bit more *simpático* (likable)." As the entire *Wolbachia* team was keenly aware, releasing these microbe-carrying insects required remaking long-established affectivities and imaginaries of what it meant to live with mosquitoes (and microbes).

By ethnographically investigating the release of *Wolbachia* mosquitoes/Wolbito as a biotechnology of epidemic disease control, I analyze efforts by scientists and technicians working on the project to transmute a threat into a tool, an enemy into an ally—not only biologically but also socially. I describe these attempts at reconfiguring and governing relationships between mosquitoes, microbes, and humans as "multispecies transmutation." Here, transmutation entails the conversion of two different organisms, *Wolbachia* and *A. aegypti*, into a multispecies dyad, which is then deployed as a biotechnology of epidemic disease control. Multispecies transmutation highlights how both biologies and socialities were altered to create a new life-form (the *Wolbachia* mosquitoes) and a new form of life (of human-microbe-insect coexistence).[3]

Throughout the article, I also remain attentive to the biological and social limits of this multispecies transmutation. For example, the antiviral mechanism of the *Wolbachia* bacterium that underpins this strategy is not fully understood. While laboratory results show a reduction in viral transmission, it is uncertain whether this effect will persist, as evolutionary pressures could lead rapidly evolving viruses to bypass the mechanism. At the same time, although engagement technicians like Tiago and Clarice traveled across Rio explaining that the *Wolbachia* mosquitoes were not an enemy, the inability to differentiate these insects from other mosquitoes limited any changes in socialities. Even when people knew they were encountering a *Wolbachia* mosquito, its bite was still rejected.

Wolbachia mosquito releases in Rio were part the global health initiative "World Mosquito Program," also referred to by the acronym WMP. Headquartered at Monash University in Australia, WMP currently operates in eleven countries, with generous funding from the Bill and Melinda Gates Foundation.[4] Addressing mosquito-borne diseases, as scientists and technicians from the *Wolbachia* project often emphasized, is a global concern. For example, estimates suggest 284 to 528 million dengue cases worldwide, with around 96 million symptomatic, though exact numbers are difficult to pinpoint (Stanaway et al. 2016). Studies show a 30-fold increase in dengue cases over the past 50 years, with 50 per cent of the global

[3] On the relationship between life-forms and forms of life, see: Helmreich and Roosth 2010.
[4] As of 2018, the Gates Foundation had funded WMP with $125 million USD (World Mosquito Project 2018). For critiques of the foundation's "philanthrocapitalism" and impact on global health, see: Birn 2014; McGoey 2015.

population in over 100 countries living in areas where they might contract the disease (Harapan et al. 2020). My interlocutors also noted that urbanization and climate change are expected to worsen the spread of mosquito-borne diseases (Iwamura, Guzman-Holst, and Murray 2020)—further urging humans to learn how to live with *A. aegypti*.

While the *Wolbachia* strategy is implemented across different countries, I focus on how the project was undertaken in Rio de Janeiro. In Brazil, these releases were led by researchers from the Oswaldo Cruz Foundation, or Fiocruz, a public health institution within Brazil's Ministry of Health. Established in 1900 as the Serotherapy Institute (*Instituto Soroterápico*) to produce serums and vaccines, Fiocruz is described on its website as "the most prominent institution for science and technology of health in Latin America" (Fiocruz 2016). Known for its free healthcare services and long history of medical research, especially in vaccines, Fiocruz is widely regarded as a trustworthy institution.[5] Members of the *Wolbachia* project would often—implicitly or explicitly—leverage this reputation in their efforts to promote the *Wolbachia* mosquitoes. As I detail later, Fiocruz's history is intertwined with the histories of mosquito control in Brazil, with the first large-scale campaigns against *A. aegypti* being led by the man whose name the institution now bears. By proposing to harness mosquitoes, instead of simply killing them, the *Wolbachia* project both continued and redefined this legacy.

Following insights from multispecies ethnographies and contributing to this special issue's focus on situating microbes, this article explores how relationships between humans, mosquitoes, and microbes are culturally and historically specific, shaping each other's conditions of existence and coexistence (Haraway 2008; Kirksey and Helmreich 2010; Todd 2016). Anthropologists examining the nexus between multispecies relations and health have studied technoscientific interventions that disturb and redefine how humans and their "companion species" (both wanted and unwanted) live together, especially in the age of pandemic risks (Lowe 2010; Porter 2019; Keck 2020; Blanchette 2015).[6] What does it mean to consider such relations not just as transformed—as others have described—but as transmuted? How does the *Wolbachia* mosquito project rearrange not only multispecies relations but also the assumed role of technoscientific solutions in addressing health concerns? And what kind of biopolitical arrangements are being put forward?

Understanding the multispecies transmutation of *Wolbachia* mosquitoes requires attending to both their social connections and biological materialities. Guided by a long tradition of STS scholars, I draw on and juxtapose historical accounts and ethnographic research with descriptions of biological processes to make "theory out of science" (Franklin 2007; Paxson and Helmreich 2014; Roosth and Schrader 2012; Landecker 2016). For that, I gathered a range of empirical sources: scientific literature on this strategy; ethnographic fieldwork with scientists, technicians, and the public health workers collaborating with them, conducted in Rio de Janeiro from November 2017 to July 2018; archival research and document analysis; and

[5] Perhaps because it is such a renowned scientific institution, Fiocruz has been the target of anti-science attacks, particularly during Jair Bolsonaro's government.
[6] On "companion species," organisms making us materially and discursively what and who we are, see Haraway, 2008.

qualitative interviews with researchers involved in *Wolbachia*-related research in Brazil, Australia, and the United States.

Multispecies transmutation, I demonstrate in this article, helps us grasp how the *Wolbachia* strategy hoped to make use of a microbe to intervene, simultaneously, on mosquitoes' bodies, their population dynamics, and their relationship with humans and viruses. My analysis not only elucidates a technoscientific project striving for global presence but also advances a new framework for understanding the management of multispecies relations and efforts to intervene in the connection between health and the environment. I argue that the *Wolbachia* strategy reveals a broader trend in which the explicit target of biopolitical interventions is not just the management and governance of populations or individuals, but their interspecies connections, including through the creation of new life forms.

Multispecies Transmutation

Joining other scholars in this special issue, this article adds ethnographic contour to the situatedness of relations between humans and microbes—and in my case, also mosquitoes. To do so, I describe how a technoscientific health project, which instrumentalizes mosquitoes and microbes to remake deep-rooted multispecies connections, asks residents to navigate ambivalent and ambiguous relations with non-human urban cohabitants. Further, I investigate how scientists and technicians brought the microbe-mosquito dyad into being, both biologically and socially. By referring to bacterium-carrying *A. aegypti* as "*Wolbachia* mosquitoes" ("*mosquitos Wolbachia*" in Portuguese) or "Wolbito," my interlocutors clearly denoted a multispecies construct engineered by biotechnological means. In this process, mosquitoes went from a disease vector, despised and worthy of elimination, to a praised ally against the very pathogens it can spread. Combined, the microbe-mosquito dyad was transmuted into a biotechnology of epidemic control.

But what do I mean by *transmuted*? Transmutation was the term used by naturalists in the eighteenth and nineteenth centuries to describe the alteration of one species into another. While the idea that organisms could undergo transmutations was not a new or radical concept in early nineteenth-century Europe, French naturalist Jean-Baptiste Lamarck was among the first "to argue that this was an essential feature of life on Earth and that complex life forms," including humans, had evolved from simple beginnings (Tanghe 2019, 75). Building on Lamarck and others, the "transmutation hypothesis" proposed that current species had their origin in older ones, emerging through gradual and "successive transmutations of organic forms into new forms" (Galera 2017, 59). Transmutation—particularly the Lamarckian version—asserted that these changes from older organic forms to new ones occurred in individual living bodies. In other words, singular organisms would change form to adapt to their environments, and their offspring would inherit those changes. Transmutation linked changes in individual organisms to population-level changes through reproduction.

By introducing *Wolbachia* to *A. aegypti*, scientists also expected to induce a change of form within individual mosquito bodies that would lead to population change, as *Wolbachia*-carrying mosquitoes mated with their wild counterparts, disseminating the bacterium to the next generation. The *Wolbachia* mosquito would remain an *A. aegypti*, but now different, no longer a (efficient) vector—transmuted into a new life form. However, the change of form and its ramifications were not limited to individual organisms: they occurred through and because of multispecies relations. Stated differently, scientists from the *Wolbachia* project hoped that the change introduced through certain multispecies relations (the novel human-bacterium-mosquito relationship) would change other multispecies relations (the historically constituted human-virus-mosquito relationships in Rio and beyond). A multispecies transmutation.

In proposing the concept of multispecies transmutation, I am therefore not attempting to revive proto-evolutionary ideas. Instead, I wish to highlight two related aspects: the construction of a new life-form and the deployment of this multispecies dyad to foster new forms of relationships among humans, mosquitoes, symbiotic bacteria, and pathogenic viruses. Although the *Wolbachia* project uses "life to manage life," it does not fit within the "probiotic turn" described by geographer Jamie Lorimer (2020) in rewilding and biome restoration efforts. Proponents of the *Wolbachia* strategy did not frame their investigation and intervention as being about ecosystems; there was no effort to nurture and modulate ecological dynamics. Instead, their approach resonates more with the "antibiotic ways of managing life," characterized by "systematic efforts to secure the Human through the control of unruly ecologies" (ibid., 2). Thus, the *Wolbachia* strategy exemplifies how even projects that use life to manage life can follow the twentieth-century logic of command-and-control, albeit recalibrated to do so by harnessing multispecies relations. In this case, the virus will be controlled not through chemicals but by instrumentalizing multispecies relations through the deployment of *Wolbachia* mosquitoes—a "symbiopolitics" unfolding simultaneously in mosquito bodies and environments (Helmreich 2009; Opitz and Folkers 2025).

Because it remakes deep-rooted interspecies affectivities and imaginaries, the transmutation of *Wolbachia* mosquitoes engenders ambivalent and ambiguous relational practices, especially since the project did not result in a definitive transformation of multispecies relations. Brazil's National Research Ethics Committee (CONEP) authorized releases on the condition that the project would not request changes to municipal or individual vector control practices (Azambuja Garcia et al. 2019). Consequently, the *Wolbachia* strategy was deployed alongside long-established quotidian practices and public health policies that define the mosquito as an enemy that encroaches upon human homes and bodies. Even as *Wolbachia* mosquitoes were released, mosquitoes, in general, were still understood to be a threat—and therefore, killable.

Other social scientists investigating modified mosquitoes have analyzed the ambivalence engendered by rendering mosquitoes from a threat into what STS scholar Uli Beisel and evolutionary biologist Christophe Boëte (2013) call a "flying public health tool" (see also Nading 2015, 2021; Onaga and Reis-Castro 2024). Different modified mosquito strategies all operationalize the insect's reproductive capacities in the quest for human health. Yet, unlike other methods, such as transgenic or irradiated approaches that reformulate "mosquito breeding and mating into a sort of deadly reproductive labor" (Reis-Castro 2021, 325; see also Barla 2024), the *Wolbachia* strategy does not deploy modified insects to suppress their own population. Instead, the goal is to create a new (transmuted) life-form—the *Wolbachia* mosquitoes—and, along the way, change multispecies relationships among humans, mosquitoes, bacteria, and viruses.

The *Wolbachia* mosquitoes are a response to decades of anti-mosquito campaigns that failed to impose an "interspecies separation" (Kelly and Lezaun 2014). As medical anthropologist Alex Nading (2014) has shown, even within these anti-mosquito campaigns, there is no sharp interspecies divide but a continuous process of mutual transformation among people, pathogens, vectors, and their surroundings. In his ethnographic study of practices to address dengue by reducing the *A. aegypti* population in Nicaragua, Nading demonstrates the need for attending to the "politics of entanglement," which "undermines simple spatial, social, and species barriers" that usually drive public health campaigns (ibid., 11). In other words, eradication policies are technically, ecologically, and epistemically flawed because they fail to account for the politics of entanglement (Nading 2021).

In Brazil, while the initial aim of public health campaigns was to eradicate the insect, there was a realignment in the early-twenty-first century toward controlling *A. aegypti*. Even if the mosquito could not be eliminated, the hope was to keep its population low enough to prevent disease outbreaks. In Rio and other cities across the country, there was already what could be called a resigned coexistence with this mosquito that insists on encountering humans. The *Wolbachia* project proposed to modify the terms of entanglement, representing a shift within more-than-human biopolitics by moving away from an aspiration for separation that never materialized.[7] The goal became to intervene bio-politically in the administration of life in both its biological and social aspects.

As a concept, multispecies transmutation highlights this shift and how techniques of management and governance no longer target the mosquito population per se, but rather interspecies connections—what Sven Opitz and Andreas Folkers (2025) describe as symbiotic engineering. In this case, the biopolitical arrangement works towards accepting the mosquito's presence by transmuting the material-semiotic meaning of its bite. *Wolbachia* mosquitoes reconfigure interspecies relations so that humans, mosquitoes, and microbes could more convivially coexist as urban cohabitants. This coexistence, however, was still partial and uneasy; the piercing of the skin remained an unwanted intimacy for humans, even if it could become less of a health threat.

The *Wolbachia* strategy also differs from other novel vector-control approaches in that it uses a microbe to modify the mosquito. By analyzing the bacterium's transformative effects, this article also contributes to the burgeoning field of social studies of microbes (Benezra, DeStefano, and Gordon 2012; Paxson and Helmreich 2014; Brives, Rest, and Sariola 2021; Hendy et al. 2021; Brives and Zimmer 2021). Alongside scientific developments in microbial research, social studies have increasingly analyzed human relationships with microbes in relation to health (Wolf-Meyer 2017; Cañada, Sariola, and Butcher 2022; Nayiga et al. 2022; Hinchliffe 2022), food (Paxson 2013; Cintrão and Dupin 2020; Münster 2021; Evans and Lorimer 2021; Kikon 2021), and the environment more broadly (Helmreich 2009; Lyons 2020; Bradshaw 2022; Daniel 2023). These scholars are interested in the political, ecological, economic, social, and epistemological connections of "withnessing" with microbes (Atkinson in Brives, Rest, and Sariola 2021, 24).

For instance, examining "eco-enzyme brewers" in southern China who ferment their household waste, environmental anthropologist Amy Zhang (2021, S300) traces how they mobilized "the unknown

[7] Michel Foucault ([1978] 2009) discusses biopolitics through the example of smallpox and eighteenth-century inoculation/variolization. While biopolitics has always involved the more-than-human, some scholars have questioned the human exceptionalism within the biopolitical framework (Brown and Nading 2019; Pinto-García 2022).

potential of microbes to neutralize and to reincorporate waste back into bodies and environments in an act of fortification." Zhang shows how microbes became a method of ecological remediation. Similarly, *Wolbachia* proponents were invested in harnessing the material effects of microbes not to address toxicity, as in Zhang's example, but rather viral transmission. In the following sections, I investigate this relationship between the *Wolbachia* bacterium and pathogenic viruses, which, though not technically classified as microbes, are also agents acting at a microscopic level.

While engagement technicians bemoaned the challenges of rendering this multispecies transmutation legible, they also recognized its strangeness. "How can I convey that a microbe can change what it means to be bitten by a mosquito? We can't even see *Wolbachia*," Clarice remarked after one "engagement activity." Multispecies transmutation hoped to profoundly transform the politics of urban cohabitation. Yet, the material effects of *Wolbachia* occurred at a microscopic level. As the editors of this special issue argue, examining the practices that make microbes' invisible transformative capacity perceptible and legible is crucial to understanding "how the microbe comes to be in relation to the conditions that produce it" (Cañada, Sariola, Rest 2025). Following this cue, I next discuss how engagement technicians mobilized "nature" in various ways to justify and legitimize the invisible transformations of this multispecies transmutation.

On the Nature of Transmutation

"After we release these mosquitoes, nature does the work for us," or "Wolbito will finally control the recurrent outbreaks in this city"—such sentiments were repeated throughout my fieldwork in Rio. For my interlocutors, transmutation also meant delegating the "work" of stamping out diseases to "nature," namely the mosquito-microbe dyad (cf. Besky and Blanchette 2019). Project proponents regularly reminded residents—and the ethnographer asking so many questions—that after weeks of sustained releases, the bacterium would, theoretically, maintain itself within *A. aegypti* populations, with no need for further releases. Thus, my interlocutors described their strategy as "self-sustaining" because it harnessed the biological processes of nonhuman others. By releasing *Wolbachia* mosquitoes that would mate with their wild conspecifics, scientists and technicians claimed both effectiveness and "naturalness." "Nature" was doing the work.

In presenting the project's use of a microbe to modify *A. aegypti*, my interlocutors framed the *Wolbachia* mosquitoes as a "natural" intervention (Amarillo 2017). *Wolbachia* proponents emphasized this rhetoric particularly when comparing their strategy to the genetic engineering approach used in other Brazilian cities (Reis-Castro 2021). They leveraged *Wolbachia's* "naturalness"—or at least its "more natural" nature—assuming this would ease Rio residents' acceptance of the *Wolbachia* mosquitoes. "Nature" was invoked to foster a sense of safety within the reconfiguration of multispecies connections.

Mentioning the widespread presence of *Wolbachia* infection in other insect populations was another way my interlocutors depicted the project as "natural." One day, I accompanied Tiago and another engagement technician, Erick, to a community meeting on Rio's north side. After Erick explained that scientists had introduced *Wolbachia* to *A. aegypti*, a resident inquired whether the microbe was *seguro* (safe) for humans. Following a scripted response, he replied, "This microbe infects insects, not humans.[8] And while *Wolbachia* doesn't occur naturally in *Aedes aegypti*, it's very common in other insects." Erick shifted his gaze from the resident and looked across the audience. "Everybody here knows the *caruncho* [weevils], that little beetle we sometimes find crawling among the beans?" There were a few timid nods. "At home, we clean and sort through the beans, removing any insect that might be there," the technician continued, "but if we eat out, chances are that we've already munched on some carunchos." At that remark, several grimaces, sounds of disgust, and laughter filled the room. "If you've eaten carunchos, which everyone here probably has, there's a chance that they might have been infected with *Wolbachia*" (see also Opitz and Folkers 2025). "Nature" enabled a sense of familiarity within emerging imaginaries and affective connections of knowing and living with more-than-human life.

Outlining the *Wolbachia* project's strategic claim of "naturalness" is not intended to reinforce rigid, often moralistic claims about what "nature" is or should be—a dichotomizing argument that has already been shown to be fraught (Nading 2015; see also Franklin 2007; Haraway 2008; Paxson and Helmreich 2014; Roosth 2017). Nevertheless, by framing the instrumentalization of biological processes as "natural," technicians and scientists could present this biotechnological intervention as something already latent within the microbe and the mosquito (Helmreich 2007).

Moreover, situating this multispecies transmutation within the realm of nature allowed project proponents to justify and legitimize their endeavor, since they knew that deploying the microbe-mosquito dyad challenged deeply-rooted multispecies connections. Multispecies transmutation not only occurred through and because of multispecies relations but these relations also defined how proponents depicted the project. In other words, transmutation involved claims to the natural in the reconfiguration of biological and social multispecies worlds. "Nature" enabled the shift from eradication to coexistence.

From Eradication to Coexistence

Grasping the ramifications of this multispecies transmutation requires understanding the historical constitution of *A. aegypti* as a winged enemy. In 1881, Cuban physician Carlos Finlay theorized this species' role in transmitting yellow fever. Then, in 1900, experiments conducted in Havana by the U.S. Yellow Fever Commission confirmed the "mosquito theory" (Espinosa 2009). Experts then designated the mosquito as the weak link within disease transmission, targeting it in worldwide public health campaigns to stamp out yellow fever (Löwy [2001] 2005, 14). Deemed an embodiment of human harm and death, *A. aegypti* came to be defined not only ecologically, but also ontologically by its vectorial capacity (cf. Silva Maia 2020).

In Brazil, the first large-scale anti-mosquito initiative was led by physician and bacteriologist Oswaldo Cruz in Rio de Janeiro. In 1902, newly-elected president Rodrigues Alves entrusted Cruz with ridding Rio, then Brazil's capital, of its pestilences.[9] From 1903 to 1907, Cruz led a draconian public health

[8] As noted, *Wolbachia* also infects other arthropods and nematodes.

[9] These anti-mosquito campaigns occurred alongside other sanitary policies such as mandatory smallpox vaccination and rat trapping for the plague.

campaign: *mata-mosquito* (mosquito-killer) brigades forcibly entered homes to destroy receptacles with standing water and fumigate with chemical insecticides (Benchimol 2001). Despite widespread unpopularity, the campaign yielded positive epidemiological results. The mosquito was locally eliminated, curbing yellow fever outbreaks. Building on this success, Cruz transformed the Serotherapy Institute—the campaign's logistical and scientific base—into an institute for experimental medicine, renaming it the Manguinhos Institute of Experimental Pathology—which would then later once again be renamed to honor Cruz. Manguinhos scientists played a central role in expanding sanitary campaigns across Brazil, including those targeting *A. aegypti* and other vectors (Cukierman 2007; Hochman [1998] 2016).

By 1958, after decades of war-like campaigns, *A. aegypti* was considered eradicated from Brazil. However, by 1968, reports indicated the insect's presence in the country (Fraiha Neto 1968; Franco 1969). This resurgence might have been due to reintroduction, or perhaps *A. aegypti*, whose eggs can remain dormant for months, was never fully eliminated. During the 1970s and 1980s, alongside increased urbanization, the anthropophilic mosquito flourished in cities across Brazil. Since then, *A. aegypti* became the primary vector for other pathogenic viruses. In 1981, Brazil recorded its first dengue outbreak—in Boa Vista, capital of the northern state of Roraima (Osanai et al. 1983). Afterward, cases quickly mushroomed nationwide. From 2015 onward, the emergence of two other viruses heightened concerns over *A. aegypti's* vectorial capacity: chikungunya, characterized by joint pain and inflammation (arthritis) that can persist for years after infection, and Zika, linked to fetal malformation and babies born with health issues known as congenital Zika virus syndrome[10] (for a more detailed history, see Lopes and Reis-Castro 2019).

Despite more than one hundred years having passed since Cruz's anti-mosquito campaigns, contemporary techniques remain essentially the same. Current public health policies in Brazil, however, no longer strive to eradicate the mosquito, a goal the Ministry of Health deemed "technically unfeasible" in 2002 (Ministério da Saúde 2002). Instead, new guidelines conceded to *vigilância* (surveillance), with a system to monitor and manage *A. aegypti* population sizes. This shift away from eradication reflected a resigned coexistence: a recognition that separation was impossible, even if it was still aspired to.

This surveillance system relies on the work of *agentes de vigilância em saúde* (health surveillance workers), who visit homes looking for breeding spots and applying insecticide when needed.[11] Through these activities, their goal is to *control A. aegypti*: while the mosquitoes may still be present, their numbers should not reach levels that could trigger outbreaks. However, as they disclosed when I accompanied their work, even these agentes perceive their inspections as merely a stopgap. "What we do is *enxugar gelo* (literally, to dry ice, meaning a futile task)," one of these agentes, Gustavo, jokingly remarked as we walked together.

[10] Zika was also linked to *Guillain Barré* cases, though these received less media attention in Brazil. While the virus can also be transmitted through bodily fluids (e.g., semen), Brazilian public health campaigns focused exclusively on vector control (Reis-Castro and Nogueira 2020).

[11] The Ministry of Health typically refers to them as *agentes de combate às endemias* (workers countering endemic diseases), but I use the term preferred by Rio's workers.

In conversations with Rio's agentes, they would also describe how it had become increasingly difficult to inspect homes. Although these public health workers are usually known in the areas they work, widespread distrust and fear of violence in Rio led residents to bar agentes from entering homes. Unable to do inspections, these workers are hindered in their efforts to keep the *A. aegypti* population at bay. Considering this context, technicians and scientists would once again position the *Wolbachia* project within the realm of nature, detaching the strategy from the all-too-human realm of politics. The strategy promised to bypass human issues, so the argument went, since mosquitos were released on streets and alleys—flying on their own to find a home and blood meal. This separation was however an illusion, most drastically illustrated in the unfortunate times when technicians were stopped at gun point or caught in gunfire.

Discussions about violence during my fieldwork also showed my interlocutors' awareness that mosquito-borne diseases were only a small fraction of the plethora of issues in Brazil—issues exacerbated and unequally felt because of the country's vast inequalities and inequities. Yet, scientists behind the *Wolbachia* project argued that using mosquitoes to curb epidemics could at least produce a specific, located, and measurable difference in people's lives (Good and Good 2012; Redfield 2018). They framed the transmutation of the mosquito-microbe dyad as a way to remove one quotidian, recurrent harm: the furtive threat of an infected bite (see Reis-Castro 2020 for limits to this argument).

If coexistence was inevitable, project proponents argued that multispecies transmutation could foster more convivial relations between humans and mosquitoes. *Wolbachia* mosquitoes would become more tolerable urban cohabitants—their bites would still be an annoyance, but no longer a dreadful and relentless health threat. Therefore, the strategy entailed considering the ethical and political possibilities of coexisting with *A. aegypti* beyond the framework of elimination (Sims 2021; Schroer 2021). Or rather, of accepting the presence of this mosquito that has long insisted on living alongside—and living off—humans. In the next section, I explore how researchers hoped to move this shift from eradication to coexistence from the laboratory into an urban context, examining biological theories and explanations on the transformative material possibilities of microbes.

From Threat to Tool: The Biologies of Multispecies Transmutation

The *Wolbachia* strategy exemplifies a trend within mosquito sciences that acknowledges the limitations of current vector control methods. But this transmutation of multispecies relations was an unexpected outcome. In 2009, after four years and around 10,000 microinjections, a group of researchers in Australia successfully infected *A. aegypti* by transferring *Wolbachia* from the fruit fly *Drosophila* to mosquito embryos (McMeniman et al. 2009; Carvalho and Moreira 2017). Initially, researchers used a strain called *w*MelPop, which had been shown to cause mosquitoes to die prematurely. The hope was to reduce the insect's lifespan and, in turn, their time as potential vectors.

Focusing on vector longevity to address mosquito-borne diseases, though uncommon, is not new. As STS scholar Ann Kelly (2016, 139) notes, mid-twentieth-century Soviet entomologists working with *Anopheles* mosquitoes (malaria vectors) developed techniques that "could indicate what proportion of mosquitoes were surviving long enough to pose a public health threat, and thus provide a more nuanced model of transmission upon which to base a program of malaria control." The use of the *w*MelPop *Wolbachia* strain adapted this Soviet approach by employing a microbe to reduce mosquito longevity. Thus, the reasoning behind using this strain was not to engender a transmutation. The *A. aegypti* would still be a (possible) vector, even if its vectorial capacity was reduced by a shortened life.

Researchers shifted gears when later experiments revealed that, besides killing mosquitoes more quickly, *w*MelPop also hindered dengue virus infection. Would it be possible, they wondered, to reduce mosquitoes' capacity to transmit viruses and turn these insects into non-vectors—or at least inefficient ones? This approach reframed the weak link in disease transmission: no longer the *A. aegypti*, but rather the virus itself. Instead of anti-vector, targeting mosquitoes as the enemy to be destroyed, this method would be antiviral, targeting the pathogens within mosquitoes' bodies.

However, this antiviral effect would not be achieved by aiming at the virus per se, but instead through instrumentalizing the bacterium. To pursue this, another, less virulent, *Wolbachia* strain—*w*Mel—was adopted, which hampered viral replication without significantly affecting the insect's lifespan or "fitness" (Walker et al. 2011; Ritchie 2014, 365). Researchers were putting forward a multispecies reconfiguration: a biological transmutation that also aimed to engender a social transmutation, allowing humans to live alongside *A. aegypti* without having to regard them as a pervasive health threat.

Since these earlier experiments, laboratory studies have corroborated that *w*Mel can reduce *A. aegypti's* capacity to transmit dengue, Zika, chikungunya, and even yellow fever, a virus that has crept back as a (potential) urban health concern in Brazil (Frentiu et al. 2014; Dutra et al. 2016; Aliota et al. 2016; Rocha et al. 2019).[12] While the goal is to transform the mosquito from a vector into a non-vector, *w*Mel does not fully block viral transmission. According to *Wolbachia* scientists, however, the microbe would hinder transmission enough to prevent disseminated infection. Model predictions for dengue virus, for example, suggest the bacterium "would reduce the basic reproduction number, *Ro*, of DENV transmission by 66–75%" (Ferguson et al. 2015). Epidemiologically, this means that even if the *Wolbachia* strategy works as planned, occasional cases of dengue, Zika, or chikungunya may still occur. As my interlocutors explained to me, in Rio, the goal of deploying *Wolbachia* mosquitoes was not necessarily to prevent every single case of mosquito-borne diseases but to reduce them, countering the recurrent epidemics.

Yet, there is so far no scientific consensus on the underlying mechanism for *Wolbachia's* antiviral effect. Since this mechanism is what enables the biological transmutation of *Wolbachia* mosquitoes, let me briefly discuss the two main hypotheses for how the bacterium hinders viral dissemination (Lindsey et al. 2018; Pimentel et al. 2021). The first hypothesis suggests that *Wolbachia* activates the mosquito's immune system, a process known as immune priming. As STS scholar Túllio da Silva Maia (2018) notes, *A. aegypti* not only acts as a vector but is also infected by these pathogens, with entomological studies showing that these viral infections result in reduced longevity, fitness, fecundity, and oviposition rates (see Sylvestre, Gandini, and Maciel-de-Freitas 2013; Kramer and Ciota 2015). According to this theory, if a *Wolbachia*-carrying *A.*

[12] Yellow fever has two transmission cycles: sylvatic (*Haemagogus* and *Sabethes* mosquitoes) and urban (*A. aegypti*). Though no urban cases have occurred since 1942 and a vaccine exists, peri-urban outbreaks with high mortality happened between 2016 and 2018.

aegypti bites a person infected with chikungunya, for instance, the mosquito would develop a stronger and faster immune response against the virus than its conspecific without the bacterium.

The second hypothesis proposes that *Wolbachia* competes with the virus for cellular resources, limiting viral development. Dengue, Zika, chikungunya, and yellow fever are RNA viruses that rely on "specific cellular resources, the integrity of intracellular membranes for replication, and the host translation apparatus for virus protein production" (Pimentel et al. 2021, 5). Therefore, disturbances caused by *Wolbachia* could interfere with virus replication. In both hypotheses, the bacterium prevents the viruses from developing in the insect's gut and salivary glands, thereby largely reducing *A. aegypti's* ability to spread pathogens.

However, it is also this focus on interspecies interactions that calls into question the approach's continued efficacy. Most notably, questions have been raised about the evolutionary pressures *Wolbachia* may impose on both viruses and *A. aegypti* (Yen and Failloux 2020). Evolutionary changes in the mosquito could reduce or eliminate the bacterium's antiviral effects, while viruses may evolve to overcome this inhibition. Moreover, given the rapid evolution of viruses, the effects of these pressures are uncertain. The transmutation of *Wolbachia* mosquitoes is underpinned by interspecies relations that are not stable in time, a particularly important point when the bacterium's viral reduction mechanism is not fully understood.

For this strategy to succeed, *Wolbachia* needs not only to interfere with viral replication but also to disseminate and maintain itself throughout Rio's *A. aegypti* population. That is, the multispecies transmutation must occur within individual mosquito bodies while also leading to changes at the population level. Here, *Wolbachia's* ability to alter its hosts' reproductive capabilities is crucial. The microbe is maternally inherited through the egg cytoplasm, the gelatinous liquid that fills the inside of a cell. Across the *Wolbachia* genus, different strains have evolved various mechanisms to more efficiently spread through host species. Some *Wolbachia* strains can change genetic males into reproductively viable females or enable an asexual form of reproduction in which embryo growth and development occur without sperm fertilization, known as parthenogenesis. *Wolbachia's* biological capacities have been described by pundits and science writers as "male killing," "feminization," turning males into "useless" "waste" and, because of this, *Wolbachia* has been defined as a "misandrist," "gender-bending," and "extremely feminist" microbe (Knight 2001; Agapakis 2014).

Anthropologists and STS scholars have examined the gendered political and epistemological ramifications of *Wolbachia's* capacity to engender reproductive alterations in its hosts—what Eben Kirksey (2019) calls the bacterium's "queer tricks" (see also Kirksey and Helmreich 2010, 558–59). For example, anthropologist Claudia Patricia Rivera Amarillo (2017) investigated how the *Wolbachia* mosquito project in Colombia was framed within "*ideología de género*" (gender ideology) narratives, pushed by conservative politicians and activists across Latin America to argue that an imposition of feminist and queer values supposedly threatens "Christian values." Interestingly, the strain used by the project neither transforms genetic males into reproductively viable females nor enables parthenogenesis, and in Brazil, I saw no association between the project and "gender ideology."

Yet, *w*Mel does engender a reproductive alteration that favors infected mosquitoes, albeit a less spectacular one. This strain triggers something known as cytoplasmic incompatibility, which causes eggs of uninfected females to die when fertilized by the sperm of infected males. This mechanism reduces the number of mosquitoes without the bacterium in the "wild" population: infected females pass the microbe to their progeny (whether they mate with infected or uninfected males); uninfected females, however, produce no offspring when mating with infected males. By releasing both female and male *Wolbachia* mosquitoes, the project helps "push" the bacterium throughout Rio's *A. aegypti* population.

Stated differently, the project re-orders more-than-human biopolitics by instrumentalizing the mosquito's reproductive capacity alongside the bacterium's reproductive alterations to transmute the *Wolbachia* mosquitoes. Transmutation operates between two poles, paralleling Michel Foucault's ([1976] 1978) now famous formulation of bio-power. In its capacity to hamper virus replication, *Wolbachia* manipulates and reconfigures the mosquito body on an individual level—what Foucault, describing humans, called "anatomopolitics." Nevertheless, it is the cytoplasmic incompatibility that ensures *A. aegypti*, as a population, becomes infected with the bacterium. And as in the Foucauldian analysis, sex becomes the key pivot that connects the two poles of body and population.

Multispecies transmutation signals a shift in the biopolitical mechanism deployed to achieve human well-being. Instead of trying to govern *A. aegypti* by reducing its population, the *Wolbachia* project governs encounters between humans, mosquitoes, and microbes. As a biotechnological intervention and a biopolitical project, the *Wolbachia* strategy aimed to administer multispecies life in both its biological and social aspects. In the next section, I examine how the strategy aimed to foster new multispecies imaginaries and affective connections that were simultaneously folded into previous ones.

From Enemy to Ally: The Socialities of Multispecies Transmutation

A few weeks before releases began in a neighborhood, engagement technicians would visit local public schools. But explaining the transmutation engendered by the *Wolbachia* project to students and other residents could be challenging. As the opening vignette illustrates, some days were particularly frustrating. That day, Tiago, Clarice, and I arrived mid-morning at a school on Rio's north side and were ushered to the auditorium—a large room with a small stage and colorfully decorated walls. Clarice turned on her laptop, connecting it to a portable projector. Young children, around 8- to 10-years-old, were shepherded in under the attentive eyes of their teachers. I helped Tiago distribute a colorful half-page pamphlet, featuring a mosquito with small green dots on its body, winking amicably. As we handed out the pamphlets, the children sat cross-legged on the floor, whispers and muffled giggles coming from across the room.

Clarice greeted the students, who replied *bom dia* (good morning) in unison. "My name is Clarice, that is Tiago and Luísa. We're here to introduce a new project coming to your neighborhood. But first, an important question: who here has had dengue or knows someone who has had dengue?" Most technicians started their presentations with this question, evoking the prevalence of mosquito-borne diseases in people's lives and communities. Known in English as "breakbone fever," dengue can cause body aches, eye pain, headaches, extreme fevers, rash, occasional nausea/vomiting, and, in its most severe form, internal hemorrhage. But dengue can also cause mild or almost no symptoms, making it hard to diagnose and distinguish it from other prevalent illnesses. Yet, in response to Clarice's question, most children raised their hands. "Me!" several exclaimed, some standing up in their excitement to participate. "Everyone in my house had it last year," gushed one student in the back. With a more reticent attitude, the adults also raised their hands. "It's easier to ask who hasn't had dengue," a teacher commented ruefully.

"Right, dengue is a widespread issue. And who knows how it's transmitted?" Clarice asked. Again, many children raised their hands; some responded, "*O mosquito da dengue*" (the dengue mosquito), while others declared proudly, "The *Aedes aegypti*." "That's correct," the engagement technician continued. "We get these diseases when an infected *Aedes aegypti* mosquito bites us, and this little insect is everywhere." Some students interjected, speaking simultaneously, sharing stories of when they had inspected their homes and found mosquito larvae. "Yes, we cannot leave any standing water, so it can't lay its eggs," Clarice said, trying to manage the chattering children. "While we need to keep destroying breeding spots, today we're presenting a new way to tackle dengue as well as Zika, chikungunya, and yellow fever. As we saw by the raised hands, we must do more to reduce the high number of mosquito-borne disease cases," she added, reminding the audience of Rio's dire epidemiological context.

"We're here to introduce Wolbito," Clarice announced. Hoping to make the *Wolbachia* mosquitoes more welcoming, she not only used the portmanteau but also picked up a stuffed mosquito toy with the same friendly face and green dots as in the pamphlet. "Wolbito is an *Aedes aegypti* with a microbe inside—a very tiny organism that we can't even see with our eyes. The microbe is called *Wolbachia*, and because of it, Wolbito doesn't transmit diseases, unlike other *Aedes aegypti* mosquitoes that can make us sick." She paused here, looking across the room to ensure the children were listening. "We'll release these *Wolbachia* mosquitoes throughout Rio, including this neighborhood. Wolbito will help control the endless cases of mosquito-borne diseases that plague this city."

Tiago then projected a whiteboard animation. Dense with information, the video outlined *A. aegypti's* worldwide spread and its vectorial capacity. It used the green-dotted mosquito to explain how this new method instrumentalized a bacterium "naturally occurring" in insects—again illustrating how the project framed itself as harnessing "nature." The animation also recounted how the method was developed by researchers in Australia who first released *Wolbachia*-carrying mosquitoes in Queensland, northeastern Australia. Finally, it detailed how, after successful attempts to disseminate the microbe, the project was expanding to other parts of the world in the hopes of "protecting the health" of those living where dengue was transmitted.

After the video, Clarice asked what the children had learned. One child, sitting in the first row, replied, "We must destroy the mosquito *focos* (breeding spots)." Clarice smiled, "Yes, you're right. But the *Wolbachia* strategy is proposing something new." She briefly explained the project again, using the stuffed animal. Then, another student raised their hand to report how, in their house, bottles were always kept upside down to avoid collecting water. Once more, Clarice praised the child's action but outlined how the *Wolbachia* project was different, how *Wolbito* would not transmit dengue and other pathogens. Twice more, students raised their hands to share mosquito-killing practices, and twice more, the technician lauded the children's actions while patiently explaining how the *Wolbachia* project offered a novel solution to address mosquito-borne diseases.

Finally, Clarice said, "It's like *Wolbachia* is a vaccine. We get vaccinated to not get sick, right?" The children nodded, staring attentively at the engagement technician. "Because of this microbe, the mosquito doesn't get sick; if it's not sick, it won't make us sick. Wolbito is different, but we can't see *Wolbachia*, so we cannot distinguish it from the other *Aedes aegypti*." She was still smiling, though I noticed a hint of exasperation in her voice. "You can continue doing all these great things to avoid *focos*, but we're proposing a sort of vaccinated mosquito. Wolbito won't transmit diseases; it will prevent them. Do you understand?" The students nodded, although their expressions were hard to read.

We had to visit another school, so Clarice thanked the children for listening and encouraged them to share what they had learned with their parents and neighbors. Several of our visits were to schools, following the trend of targeting children for engagement activities (Nading 2014, 140). As Tiago explained, young students were seen as efficient "disseminators" of knowledge, explaining information about the *Wolbachia* project when asked about their day at school. Here was another anticipated individual/population dynamic, where individual children were expected to create a change in awareness at the community level.

After the presentation, as I helped the technicians pack, Clarice said, "I know it's not exactly like a vaccine," seemingly justifying herself to the ethnographer who she knew was taking notes. "But I didn't know how else to phrase it to get the message across. This project is so different from everything they've heard." Although not common, engagement technicians sometimes described the *Wolbachia* mosquitoes as vaccinated. In this case, my interlocutors were referencing a different, more prominent history pertaining to the material effects of microscopic agents inoculating and preventing diseases to foster healthier bodies and communities—one in which the mechanism was also at first also not clearly understood (Foucault [1978] 2009). But since Fiocruz is most well-known for its vaccine production, calling Wolbito a vaccinated mosquito also helped link the project to the institution's trustworthiness. Technicians drew on various biological and social histories to make the multispecies transmutation more familiar.

So, *Can* the Mosquito Bite?

Investigating colonial development and science in Egypt, political theorist Timothy Mitchell (2002) examines the efforts to control both the Nile River and the *Anopheles gambiae* mosquito, the malaria vector. He analyzes these efforts through the lens of "techno-politics," which he defines as "a certain way of organizing the amalgam of human and nonhuman, things and ideas, so that the human, the intellectual, the realm of intentions and ideas seems to come first and to control and organize the nonhuman" (ibid., 43). As Mitchell demonstrates, however, this techno-political power is an illusion; at every turn, the river and the mosquito adapted to and circumvented the technologies and policies designed to contain them. In his call to consider these as important examples of agency beyond the human, Mitchell asks, "Can the mosquito speak?"

Building on Mitchell's analysis, one can argue that mosquito eradication campaigns are a quintessential example of the twentieth-century conviction that technical expertise and scientific reason could explain, simplify, and "solve" the world's issues, driving humans to shape and control the environments around them. The *Wolbachia* mosquito recalibrates this conviction. While still relying on a technoscientific solution to "solve" mosquito-borne diseases, it acknowledges the limitations of earlier projects, aiming to work *with*, instead of simply against the mosquito. In other words, there is a recognition of nonhumans as social actors—of their agency, if you will—but this recognition is followed by a drive to harness that agency. Multispecies transmutation signals this shift within more-than-human biopolitics, where life is used to impose a command-and-control logic.

My interlocutors emphasized how they instrumentalized mosquitoes and microbes—their behaviors and bio-materialities—when promoting their approach. By framing this multispecies transmutation as using "nature," they justified and rendered legible the alterations in biologies and socialities—from lab practices and public policies to everyday interactions. Multispecies transmutation reveals how *Wolbachia* mosquitoes are portrayed as a "natural" change that would enable convivial coexistence as the bite would no longer pose a health threat. Yet, it was precisely the bite that challenged the potential conviviality of this coexistence.

First, residents could not differentiate between *Wolbachia* mosquitoes and their uninfected counterparts. During engagement activities, the most common question was what to do if they now encountered a mosquito. Iara would often humorously respond, "If you see a mosquito, spray insecticide or throw a shoe at it. Do what you must do! Don't let it bite you—you don't know what it carries." *Wolbachia's* material effects were invisible to the naked eye (even scientists equipped with microscopes could not clearly grasp what was happening at the microscopic level). This indistinguishability between bacterium-infected and uninfected *A. aegypti* elicited an ambivalent coexistence: the bite could be harmless, but it might also be a threat.

However, even the bite of *Wolbachia* mosquitoes was still unwanted. During fieldwork, I accompanied release technicians Kevin and Paulo as they drove a pre-determined route, opening tubes teeming with mosquitoes. I sat next to Kevin, the driver, while Paulo sat in the back with the crate filled with tubes. Kevin set the air conditioner to the coldest temperature possible and, despise my efforts to discreetly adjust the vents, I was freezing. "I should have told you to bring something warmer," Kevin remarked apologetically, as I shivered, my teeth chattering. "But we need the temperature cold. These mosquitoes are too hungry."

When I did not understand the connection between the mosquitoes and the cold temperature, Paulo explained, "I leave the window open just enough to be able to put my hand out to open the tube. And I'm careful to remove the cover only when the tube is completely outside." While he spoke, Paulo demonstrated his technique. "I'm also mindful of the wind direction, so it blows the mosquitoes away. But all this effort isn't enough—they always manage to sneak back inside." Kevin added, "But the cold keeps them a bit more still." With a smile, Paulo handed me a small plastic racket that discharged an electric current. "Take this. Hunting these mosquitoes might help keep you warmer." Whenever he spotted a mosquito, Paulo would call out, urging me to swiftly kill it.[13]

The technicians knew that for the project to succeed, *Wolbachia* mosquitoes had to eventually bite residents, including themselves. They were aware these insects did not transmit diseases, yet they did not want mosquitoes feeding on them. Although (human) blood was needed to mature the next generation of microbe-carrying mosquitoes, the *A. aegypti* piercing the skin remained an unwelcome encounter. Multispecies transmutation strived for a more convivial coexistence, but this was still partial and uneasy. The bite was less of a threat, but it remained a somatic reminder of an intruding interspecies intimacy.

[13] In another paper, I discuss this as an example of the limits of "taming" the mosquito (Reis-Castro and Lee 2024).

Acknowledgements

Thank you to my interlocutors for not only allowing me to join their daily activities but also patiently and thoughtfully answering my never-ending questions. The Casa Oswaldo Cruz's Graduate Program in History of Science and Health and the Social Sciences Zika Network hosted me in Rio, helping me secure access to accompany the *Wolbachia* project. Many people have generously commented on versions of this paper; in particular, I thank Alberto Morales, Andrew Lakoff, Harriet Ritvo, Joel Ferrall, John Hartigan, Maggie Davis, Peter Redfield, Riley Taitingfong, Shaoyu Tang, Sook Lin Toh, Stefan Helmreich, Thais Valim, and Túllio da Silva Maia. Micha Rahder offered crucial editorial support and guidance. Barbara Marques was a lifeline during the final adjustments. This article greatly benefited from the anonymous reviewers' feedback. Thanks to the *ESTS* editorial collective and the special issue editors, Jose Cañada, Salla Sariola, and Matthäus Rest. I'm grateful, as always, to the #AnthroCoWrite folks for the co-working sessions. Fieldwork research was funded by the Social Science Research Council, the National Science Foundation—Cultural Anthropology Program (BCS-1823376), and the Wenner-Gren Foundation (Gr. 9677), and the Wenner-Gren Foundation.

Author Biography

Luísa Reis-Castro is an Assistant Professor of Anthropology at the University of Southern California (USC), United States. Her research explores the social, cultural, political, and historical dimensions of scientific knowledge about more-than-human relations. Her first project examines techno-scientific initiatives in Brazil that harness mosquitoes to tackle the viruses they transmit, investigating what these projects reveal about the geopolitics of knowledge production in an unequal world increasingly affected by human activity.

References

Agapakis, Christina. 2014. "*Wolbachia*: The Misandrist Bacteria." *The Toast*. March, 3, 2014. https://web.archive.org/web/20220626201255/http://the-toast.net/2014/03/03/wolbachia-the-misandrist-bacteria/.

Aliota, Matthew T., Emma C. Walker, Alexander Uribe Yepes, Ivan Dario Velez, et al. 2016. "The *w*Mel Strain of *Wolbachia* Reduces Transmission of Chikungunya Virus in *Aedes aegypti*." *PLoS Neglected Tropical Diseases* 10(4): 1–13. https://doi.org/10.1371/journal.pntd.0004677.

Amarillo, Claudia Rivera. 2017. "*Aegypti*: Ideología de Género, Feminismo y Extinción" [*Aegypti*: Gender Ideology, Feminism, and Extinction]. *Sexualidad, Salud y Sociedad—Revista Latinoamericana* [*Sexuality, Health, and Society—Latin American Journal*] (27): 199–219. https://doi.org/10.1590/1984-6487.sess.2017.27.11.a.

Azambuja Garcia, Gabriela de, Gabriel Sylvestre, Raquel Aguiar, Guilherme Borges da Costa, et al. 2019. "Matching the Genetics of Released and Local *Aedes aegypti* Populations Is Critical to Assure *Wolbachia* Invasion." *PLoS Neglected Tropical Diseases* 13(1): 1–23. https://doi.org/10.1371/journal.pntd.0007023.

Barla, Josef. 2024. "Making Death Through Producing Life: Necrovalue and the Political Economy of Death." *BioSocieties*, ahead of print, December 18, 2024. https://doi.org/10.1057/s41292-024-00346-x.

Beisel, Uli, and Christophe Boëte. 2013. "The Flying Public Health Tool: Genetically Modified Mosquitoes and Malaria Control." *Science as Culture* 22(1): 38–60. https://doi.org/10.1080/09505431.2013.776364.

Benchimol, Jaime Larry, ed. 2001. *Febre Amarela: A Doença e a Vacina, uma História Inacabada* [*Yellow Fever: The Disease and the Vaccine, an Unfinished History*]. Rio de Janeiro: Editora Fiocruz.

Benezra, Amber, Joseph DeStefano, and Jeffrey I. Gordon. 2012. "Anthropology of Microbes." *Proceedings of the National Academy of Sciences* 109(17): 6378–81. https://doi.org/10.1073/pnas.1200515109.

Besky, Sarah, and Alex Blanchette, eds. 2019. *How Nature Works: Rethinking Labor on a Troubled Planet*. School of Advanced Research Seminar Series. Santa Fe: University of New Mexico Press.

Birn, Anne-Emmanuelle. 2014. "Philanthrocapitalism, Past and Present: The Rockefeller Foundation, the Gates Foundation, and the Setting(s) of the International/Global Health Agenda." *Hypothesis* 12(1): 1–27. https://saludpublicayotrasdudas.wordpress.com/wp-content/uploads/2015/04/birn_philantrocapitalism_2014.pdf.

Blanchette, Alex. 2015. "Herding Species: Biosecurity, Posthuman Labor, and the American Industrial Pig." *Cultural Anthropology* 30(4): 640–69. https://doi.org/10.14506/ca30.4.09.

Bradshaw, Aaron. 2022. "Can Microbes Be Active Participants in Research? Developing a Methodology for Collaborating with Plastic-Eating Microbes." *Environmental Humanities* 14(2): 284–302. https://doi.org/10.1215/22011919-9712379.

Brives, Charlotte, Matthäus Rest, and Salla Sariola, eds. 2021. *With Microbes*. Manchester: Mattering Press. http://doi.org/10.28938/9781912729180.

Brives, Charlotte, and Alexis Zimmer. 2021. "Ecologies and Promises of the Microbial Turn," in "A Microbial Turn?" edited by Charlotte Brives and Alexis Zimmer, special issue, *Revue d'Anthropologie des Connaissances* [*Review of Anthropology of Knowledge*] 15(3), n.p. https://doi.org/10.4000/rac.25068.

Brown, Hannah, and Alex M. Nading. 2019. "Introduction: Human Animal Health in Medical Anthropology," in "Human Animal Health in Medical Anthropology," edited by Hannah Brown and Aelx M. Nading, special issue "Human Animal Health," *Medical Anthropology* 33(1): 5–23. https://doi.org/10.1111/maq.12488.

Cañada, Jose A., Salla Sariola, and Andrea Butcher. 2022. "In Critique of Anthropocentrism: A More-than-Human Ethical Framework for Antimicrobial Resistance." *Medical Humanities* 48(4): 1–9. https://doi.org/10.1136/medhum-2021-012309.

Cañada, Jose A., Salla Sariola, and Matthäus Rest. 2025. "Situating Microbes Within Complex Ecologies." *Engaging Science, Technology, and Society* 11(1): 5–20. https://doi.org/10.17351/ests2023.2735.

Carvalho, Fabiano, and Luciano A. Moreira. 2017. "Why Is *Aedes aegypti* Linnaeus so Successful as a Species?" *Neotropical Entomology* 46: 243–55. https://doi.org/10.1007/s13744-017-0520-4.

Cintrão, Rosângela Pezza, and Leonardo Vilaça Dupin. 2020. "Microbiopolítica e Regulação Sanitária: Desacordos Entre Ciência e Saberes Locais Na Produção Dos Queijos Minas Artesanais" [Microbiopolitics and Sanitary Regulation: Disagreements Between Science and Local Knowledge in the Production of Artisanal Cheese in Minas Gerais]. *Horizontes Antropológicos* [*Anthropological Horizons*] 26(57): 239–74. https://doi.org/10.1590/S0104-71832020000200009.

Cukierman, Henrique. 2007. *Yes, Nós Temos Pasteur: Manguinhos, Oswaldo Cruz E a História da Ciência No Brasil* [*Yes, We Have Pasteur: Manguinhos, Oswaldo Cruz, And the History of Science in Brazil].* Rio de Janeiro: Relume-Dumará.

Daniel, François-Joseph. 2023. "Industrializing Bacterial Work: Microbiopolitics, Biogas Alchemy, and the French Waste Management Sector." *Science, Technology, & Human Values* 48(5): 1223–44. https://doi.org/10.1177/01622439221119851.

Dutra, Heverton Leandro Carneiro, Marcele Neves Rocha, Fernando Braga Stehling Dias, Simone Brutman Mansur, et al. 2016. "*Wolbachia* Blocks Currently Circulating Zika Virus Isolates in Brazilian *Aedes aegypti* Mosquitoes." *Cell Host & Microbe* 19(6): 771–74. https://doi.org/10.1016/j.chom.2016.04.021.

Espinosa, Mariola. 2009. *Epidemic Invasions: Yellow Fever and the Limits of Cuban Independence, 1878–1930*. Chicago: University of Chicago Press.

Evans, Joshua, and Jamie Lorimer. 2021. "Taste-Shaping-Natures: Making Novel Miso with Charismatic Microbes and New Nordic Fermenters in Copenhagen." *Current Anthropology* 62(S24): S361–S375. https://doi.org/10.1086/714851.

Ferguson, Neil M., Duong Thi Hue Kien, Hannah Clapham, Ricardo Aguas, et al. 2015. "Modeling the Impact on Virus Transmission of Wolbachia-Mediated Blocking of Dengue Virus Infection of *Aedes aegypti* Neil*.*" *Science Translational Medicine* 7(279): 279ra37. https://pubmed.ncbi.nlm.nih.gov/25787763/.

Foucault, Michel. [1976] 1978. *The History of Sexuality—Volume 1: An Introduction*. Translated by Robert Hurley. New York: Pantheon Books.

———. [1978] 2009. *Security, Territory, Population: Lectures at the College De France, 1977–78*. New York: Palgrave Macmillan. https://doi.org/10.1057/9780230245075.

Fraiha Neto, Habib. 1968. "Reinfestação do Brasil Pelo *Aedes aegypti*: Considerações Sôbre o Risco de Urbanização do Vírus da Febre Amarela Silvestre na Região Reinfestada" [Reinfestation of Brazil by *Aedes aegypti*: Considerations on the Risk of Urbanization of the Wild Yellow Fever Virus in the Reinfested Region]. *Revista do Instituto de Medicina Tropical de São Paulo* [*Journal of the São Paulo Institute of Tropical Medicine*] 10(5): 289–94. https://patua.iec.gov.br/handle/iec/2089.

Franco, Odair. 1969. *História da Febre–Amarela No Brasil* [*History of Yellow Fever in Brazil*]. Rio de Janeiro: Ministério da Saúde—Departamento Nacional de Endemias Rurais [Ministry of Health—National Department of Rural Endemic Diseases]. Accessed May 27, 2025. https://bvsms.saude.gov.br/bvs/publicacoes/0110historia_febre.pdf.

Franklin, Sarah. 2007. *Dolly Mixtures: The Remaking of Genealogy*. Durham: Duke University Press.

Frentiu, Francesca D., Tasnim Zakir, Thomas Walker, Jean Popovici, et al. 2014. "Limited Dengue Virus Replication in Field-Collected *Aedes aegypti* Mosquitoes Infected with *Wolbachia*." *PLoS Neglected Tropical Diseases* 8(2): 1–10. https://doi.org/10.1371/journal.pntd.0002688.

Fundação Oswaldo Cruz [Oswaldo Cruz Foundation] (Fiocruz). 2016. "A Fundação" [The Foundation]. (webpage). Accessed December 10, 2016. https://portal.fiocruz.br/pt-br/content/fundação.

Galera, Andrés. 2017. "The Impact of Lamarck's Theory of Evolution Before Darwin's Theory." *Journal of the History of Biology* 50(1): 53–70. https://doi.org/10.1007/s10739-015-9432-5.

Good, Byron J., and Mary-Jo DelVecchio Good. 2012. "'To Make a Difference. . .': Narrative Desire in Global Medicine." *Narrative Inquiry in Bioethics* 2(2): 121–24. https://doi.org/10.1353/nib.2012.0046.

Harapan, Harapan, Alice Michie, R. Tedjo Sasmono, and Allison Imrie. 2020. "Dengue: A Minireview." *Viruses* 12(8): 1–35. https://doi.org/10.3390/v12080829.

Haraway, Donna J. 2008. *When Species Meet*. Minneapolis: University of Minnesota Press.

Helmreich, Stefan. 2007. "Blue-Green Capital, Biotechnological Circulation and an Oceanic Imaginary: A Critique of Biopolitical Economy." *BioSocieties* 2: 287–302. https://doi.org/10.1017/S1745855207005753.

———. 2009. *Alien Ocean: Anthropological Voyages in Microbial Seas*. Berkeley: University of California Press.

Helmreich, Stefan, and Sophia Roosth. 2010. "Life Forms: A Keyword Entry." *Representations* 112(1): 27–53. http://dx.doi.org/10.1525/rep.2010.112.1.27.

Hendy, Jessica, Matthäus Rest, Mark Aldenderfer, and Christina Warinner. 2021. "Cultures of Fermentation: Living with Microbes: An Introduction to Supplement 24." *Current Anthropology* 62(S24): S197–S206. https://doi.org/10.1086/715476.

Hinchliffe, Steve. 2022. "Postcolonial Global Health, Post-Colony Microbes and Antimicrobial Resistance." *Theory, Culture & Society* 39(3): 145–68. https://doi.org/10.1177/0263276420981606.

Hochman, Gilberto. [1998] 2016. *The Sanitation of Brazil: Nation, State, and Public Health, 1889–1930*. Translated by Diane Grosklaus Whitty. Urbana: University of Illinois Press.

Iwamura, Takuya, Adriana Guzman-Holst, and Kris A. Murray. 2020. "Accelerating Invasion Potential of Disease Vector *Aedes aegypti* under Climate Change." *Nature Communications* 11: 1–10. https://doi.org/10.1038/s41467-020-16010-4.

Keck, Frédéric. 2020. *Avian Reservoirs: Virus Hunters and Birdwatchers in Chinese Sentinel Posts*. Durham: Duke University Press. https://doi.org/10.1215/9781478007555.

Kelly, Ann H. 2016. "Seeing Cellular Debris, Remembering a Soviet Method." *Visual Anthropology* 29(2): 133–58. https://doi.org/10.1080/08949468.2016.1131494.

Kelly, Ann H., and Javier Lezaun. 2014. "Urban Mosquitoes, Situational Publics, and the Pursuit of Interspecies Separation in Dar Es Salaam." *American Ethnologist* 41(2): 368–83. https://doi.org/10.1111/amet.12081.

Kikon, Dolly. 2021. "Bamboo Shoot in Our Blood: Fermenting Flavors and Identities in Northeast India." *Current Anthropology* 62(S24): S376–S387. https://doi.org/10.1086/715830.

Kirksey, Eben. 2019. "Queer Love, Gender Bending Bacteria, and Life after the Anthropocene," *Theory, Culture and Society* 36(6): 197–219. https://doi.org/10.1177/0263276418769995.

Kirksey, Eben, and Stefan Helmreich. 2010. "The Emergence of Multispecies Ethnography," *Cultural Anthropology* 25(4): 545–76. https://doi.org/10.1111/j.1548-1360.2010.01069.x.

Knight, Jonathan. 2001. "Meet the Herod Bug." *Nature* 412(5): 12–14. https://doi.org/10.1038/35083744.

Kramer, Laura D., and Alexander T. Ciota. 2015. "Dissecting Vectorial Capacity for Mosquito-Borne Viruses." *Current Opinion in Virology* 15: 112–18. https://doi.org/10.1016/j.coviro.2015.10.003.

Landecker, Hannah. 2016. "Antibiotic Resistance and the Biology of History." *Body & Society* 22(4): 19–52. https://doi.org/10.1177/1357034X14561341.

Lindsey, Amelia R. I., Tamanash Bhattacharya, Irene L. G. Newton, and Richard W. Hardy. 2018. "Conflict in the Intracellular Lives of Endosymbionts and Viruses: A Mechanistic Look at *Wolbachia*-Mediated Pathogen-Blocking." *Viruses* 10(4): 1–29. https://doi.org/10.3390/v10040141.

Lopes, Gabriel, and Luísa Reis-Castro. 2019. "A Vector in the (Re)Making: A History of *Aedes aegypti* as Mosquitoes That Transmit Diseases in Brazil." In *Framing Animals as Epidemic Villains: Histories of Non-Human Disease Vectors,* edited by Christos Lynteris, 147–75. London: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-26795-7_6.

Lorimer, Jamie. 2020. *The Probiotic Planet: Using Life to Manage Life*. Minneapolis: University of Minnesota Press.

Lowe, Celia. 2010. "Viral Clouds: Becoming H5N1 in Indonesia," in "Multispecies Ethnography" *Cultural Anthropology* 25(4): 625–49. https://doi.org/10.1111/j.1548-1360.2010.01072.x.

Löwy, Ilana. [2001] 2005. *Vírus, Mosquitos e Modernidade: A Febre Amarela No Brasil entre Ciência e Política* [Viruses, Mosquitoes, and Modernity: Yellow Fever in Brazil between Science and Politics]. Translated by Irene Ernest Dias. Rio de Janeiro: Editora Fiocruz.

Lyons, Kristina M. 2020. *Vital Decomposition: Soil Practitioners and Life Politics*. Durham: Duke University Press.

McGoey, Linsey. 2015. *No Such Thing as a Free Gift: The Gates Foundation and the Price of Philanthropy*. London: Verso.

McMeniman, Conor J., Roxanna V. Lane, Bodil N. Cass, Amy W. C. Fong, et al. 2009. "Stable Introduction of a Life-Shortening *Wolbachia* Infection into the Mosquito *Aedes aegypti*." *Science* 323(5910): 141–44. https://doi.org/10.1126/science.1165326.

Ministério da Saúde [Ministry of Health]. 2002. *Programa Nacional de Controle da Dengue (PNCD)—Instituído em 24 de julho de 2002* [*National Program for Dengue Control (PNCD)—Established on July 24, 2002*]. Brasília: Fundação Nacional de Saúde [National Health Foundation].

Mitchell, Timothy. 2002. *Rule of Experts: Egypt, Techno-Politics, Modernity*. Berkeley: University of California Press.

Münster, Daniel. 2021. "The Nectar of Life: Fermentation, Soil Health, and Bionativism in Indian Natural Farming." *Current Anthropology* 62(S24): S311–S322. https://doi.org/10.1086/715477.

Nading, Alex M. 2014. *Mosquito Trails: Ecology, Health, and the Politics of Entanglement*. Berkeley: University of California Press.

———. 2015. "The Lively Ethics of Global Health GMOs: The Case of the Oxitec Mosquito." *BioSocieties* 10(1): 24–47. https://doi.org/10.1057/biosoc.2014.16.

———. 2021. "Eradication Against Ambivalence." In *Mosquitopia: The Place of Pests in a Healthy World*, edited by Marcus Hall and Dan Tamïr, 183–94. London: Routledge. https://doi.org/10.4324/9781003056034-16.

Nayiga, Susan, Laurie Denyer Willis, Sarah G. Staedke, and Clare I. R. Chandler. 2022. "Taking Opportunities, Taking Medicines: Antibiotic Use in Rural Eastern Uganda." *Medical Anthropology* 41(4): 418–30. https://doi.org/10.1080/01459740.2022.2047676.

Onaga, Lisa, and Luísa Reis-Castro. 2024. "'Ambivalent Insects' as Tools and Targets." *Isis* 115(1): 152–56. https://doi.org/10.1086/728886.

Opitz, Sven, and Andreas Folkers. 2025. "Symbiotic Engineering: Insects, Microbes, and the Space of Vector Control." *BioSocieties*, ahead of print, February 25, 2025. https://doi.org/10.1057/s41292-025-00349-2.

Osanai, Carlos H., Amélia Paes de Andrade Travassos da Rosa, Amazonia T. Tang, et al. 1983. "Surto de Dengue em Boa Vista, Roraima (Nota Prévia)" [Dengue Outbreak in Boa Vista, Roraima (Preliminary Note)]. *Revista do Instituto de Medicina Tropical de São Paulo* [*Journal of the São Paulo Institute of Tropical Medicine*] 25(1): 1–54. https://patua.iec.gov.br/handle/iec/2804.

Paxson, Heather. 2013. *The Life of Cheese: Crafting Food and Value in America*. Berkeley: University of California Press.

Paxson, Heather, and Stefan Helmreich. 2014. "The Perils and Promises of Microbial Abundance: Novel Natures and Model Ecosystems, from Artisanal Cheese to Alien Seas." *Social Studies of Science* 44(2): 165–93. https://doi.org/10.1177/0306312713505003.

Pimentel, André C., Cássia S. Cesar, Marcos Martins, and Rodrigo Cogni. 2021. "The Antiviral Effects of the Symbiont Bacteria *Wolbachia* in Insects." *Frontiers in Immunology* 11: 1–10. https://doi.org/10.3389/fimmu.2020.626329.

Pinto-García, Lina. 2022. "Military Dogs and Their Soldier Companions: The More-than-human Biopolitics of Leishmaniasis in Conflict-torn Colombia." *Medical Anthropology Quarterly* 36(2): 237–255. https://doi.org/10.1111/maq.12694.

Porter, Natalie. 2019. *Viral Economies: Bird Flu Experiments in Vietnam*. Chicago: The University of Chicago Press.

Redfield, Peter. 2018. "On Band-Aids and Magic Bullets," *Limn* (9), n.p. Accessed May 27, 2025. https://limn.it/articles/on-band-aids-and-magic-bullets/.

Reis-Castro, Luísa. 2020. "The Vector, the Viruses, and the 'Healthy World': Placing *Aedes aegypti* in Brazil." *Platypus: The CASTAC Blog.* Accessed September 2, 2020. http://blog.castac.org/2020/09/the-vector-the-viruses-and-the-healthy-world-placing-aedes-aegypti-in-brazil/.

———. 2021. "Becoming Without: Making Transgenic Mosquitoes and Disease Control in Brazil." *Environmental Humanities* 13(2): 323–47. https://doi.org/10.1215/22011919-9320178.

Reis-Castro, Luísa, and Jia Hui Lee. 2024. "Bites, Blood, Boundaries: Rats, Mosquitoes, and Domestication Across Disciplines." *The Journal of Interdisciplinary History* 54(3): 351–70. https://doi.org/10.1162/jinh_a_02002.

Reis-Castro, Luísa, and Carolina De Oliveira Nogueira. 2020. "Uma Antropologia da Transmissão: Mosquitos, Mulheres e Epidemia de Zika No Brasil" [An Anthropology of Transmission: Mosquitoes, Women, and the Zika Epidemic in Brazil]. *ILHA Revista de Antropologia* [*ILHA Journal of Anthropology*] 22(2): 21–63. https://doi.org/10.5007/2175-8034.2020v22n2p21.

Ritchie, Scott. 2014. "Rear and Release: A New Paradigm for Dengue Control." *Austral Entomology* 53(4): 363–7. https://doi.org/10.1111/aen.12127.

Rocha, Marcele Neves, Myrian Morato Duarte, Simone Brutman Mansur, Bianca Daoud Mafra e Silva, et al. 2019. "Pluripotency of *Wolbachia* against Arboviruses: The Case of Yellow Fever." *Gates Open Research* 3: 1–28. https://doi.org/10.12688/gatesopenres.12903.2.

Roosth, Sophia. 2017. *Synthetic: How Life Got Made*. Chicago: University of Chicago Press.

Roosth, Sophia, and Astrid Schrader. 2012. "Feminist Theory Out of Science: Introduction." *Differences: A Journal of Feminist Cultural Studies* 23(3): 1–8. https://doi.org/10.1215/10407391-1892880.

Schroer, Sara Asu. 2021. "The Arts of Coexistence: A View From Anthropology." *Frontiers in Conservation Science* 2: 1–6. https://doi.org/10.3389/fcosc.2021.711019.

Silva Maia, Túllio Dias da. 2018. "Cada Um com Sua Luta: Uma Etnografia da Relação Entre Sertanejos e Mosquitos No Alto Sertão Sergipano" [Each One with Their Struggle: An Ethnography of the Relationship Between People from the Sertão and Mosquitoes in the Upper Sertão of Sergipe]. Master's thesis, Universidade Federal de São Carlos.

———. 2020. "The *Mosquito Struggle*: Other-than-Vector Ecologies in a 'Zika-Free' Brazilian *sertão*." *Somatosphere: Science, Medicine, and Anthropology* (blog), series "Histórias of Zika," accessed May 27, 2025. http://somatosphere.net/2020/mosquito-struggle-zika.html/.

Sims, Rosie. 2021. "Coexisting with Mosquitoes." *Fieldsights: Society for Cultural Anthropology Blog*, series "Multispecies Care in the Sixth Extinction." Accessed May 27, 2025. https://culanth.org/fieldsights/coexisting-with-mosquitoes.

Stanaway, Jeffrey D., Donald S. Shepard, Eduardo A. Undurraga, Yara A. Halasa, et al. 2016. "The Global Burden of Dengue: An Analysis from the Global Burden of Disease Study 2013." *The Lancet Infectious Diseases* 16(6): 712–23. https://doi.org/10.1016/S1473-3099(16)00026-8.

Sylvestre, Gabriel, Mariana Gandini, and Rafael Maciel-de-Freitas. 2013. "Age-Dependent Effects of Oral Infection with Dengue Virus on *Aedes aegypti* (Diptera: Culicidae) Feeding Behavior, Survival, Oviposition Success and Fecundity." *PLoS ONE* 8(3): 1–8. https://doi.org/10.1371/journal.pone.0059933.

Tanghe, Koen B. 2019. "Leave Lamarck Alone! Why the Use of the Term 'Lamarckism' and Its Cognates Must Be Shunned." *Perspectives in Biology and Medicine* 62(1): 72–94. https://doi.org/10.1353/pbm.2019.0004.

Todd, Zoe. 2016. "An Indigenous Feminist's Take on the Ontological Turn: 'Ontology' is just Another Word for Colonialism." *Journal of Historical Sociology* 29(1): 4–22. https://doi.org/10.1111/johs.12124.

Walker, T., P. H. Johnson, L. A. Moreira, I. Iturbe-Ormaetxe, et al. 2011. "The *w*Mel *Wolbachia* Strain Blocks Dengue and Invades Caged *Aedes aegypti* Populations." *Nature* 476(7361): 450–55. https://doi.org/10.1038/nature10355.

Wolf-Meyer, Matthew J. 2017. "Normal, Regular, and Standard: Scaling the Body through Fecal Microbial Transplants." *Medical Anthropology Quarterly* 31(3): 297–314. https://doi.org/10.1111/maq.12328.

World Mosquito Program. 2018. "The WMP Welcomes AUD$50m Funding from the Gates Foundation and Wellcome Trust." WMP - Latest News. Accessed June 1, 2020. http://www.eliminatedengue.com/progress/index/view/news/1088.

Yen, Pei-Shi, and Anna-Bella Failloux. 2020. “A Review: *Wolbachia*-Based Population Replacement for Mosquito Control Shares Common Points with Genetically Modified Control Approaches.” *Pathogens* 9(5): 1–14. https://doi.org/10.3390/pathogens9050404.

Zhang, Amy. 2021. “From Immunity to Collaboration: Microbes, Waste, and Antitoxic Politics.” *Current Anthropology* 62(S24): S298–S310. https://doi.org/10.1086/715542.