Between Simians and Cell Lines: Rhesus Monkeys, Polio Research, and the Geopolitics of Tissue Culture (1934–1954)

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Abstract

This essay argues that the racialized geopolitics of the rhesus monkey trade conditioned the trajectory of tissue culture in polio research. Rhesus monkeys from north India were important experimental organisms in the American “war against polio” between the 1930s and 1950s. During this period, the National Foundation for Infantile Paralysis (NFIP) expended considerable effort to secure the nonhuman primate for researchers’ changing experimental agendas. The NFIP drew on transnational networks to export hundreds of thousands of rhesus monkeys from colonial and later postcolonial India amid the geopolitical upheavals of World War II, the 1947 Partition, and the Cold War. In this essay, I trace how NFIP officials’ anxieties about the geopolitics of the monkey trade configured research imperatives in the war against polio. I show how their anxieties more specifically shaped investment in tissue culture techniques as a possible means of obviating dependence on the market in monkeys. I do so by offering a genealogy of the contingent convergence between the use of rhesus monkeys and HeLa cell cultures in the 1954 Salk vaccine trial evaluation. Through this genealogy, I emphasize the geopolitical dimensions of the search for the “right” experimental organisms, tissues, and cells for the “job” of scientific research. The technical transformation of polio research, I argue, relied on the convergence of disparate, racialized biomedical economies.

Keywords Polio research · Nonhuman primates · Tissue culture · Empire · South Asia · Geopolitics

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Introduction

In January 1954, a headline in the *Minneapolis Sunday Tribune* declared, “In Polio Tests at ‘U,’ Human Cancer Cells Now SPARE THE MONKEY.” The feature highlighted Jerome Syvertson and William Scherer’s work culturing poliovirus in HeLa cells through several photographs. Front-and-center was an image of the researchers with eight test tubes of cell culture and eight monkeys; the staging sharpened the contrast between a beatific Syvertson presiding over the rack of human cell culture and the junior scientists immobilizing the simians. In case the reader missed the imagery, the caption was explicit about its significance for the National Foundation for Infantile Paralysis’ upcoming polio vaccine field trial: “In the new polio detection method discovered at the University of Minnesota, the eight culture tubes of cancer cells in foreground have replaced eight (or more) monkeys of the type being held in background (Fig. 1).”¹

This essay considers the triumphant substitution of experimental organism with experimental cell line as a racialized question of geopolitics. Academic and popular writers have drawn attention to the structurally racist and sexist conditions in which cervical cancer biopsy tissue was taken from Henrietta Lacks, an African American patient at Johns Hopkins University Hospital, and developed without her knowledge or permission into the “immortal” HeLa cell line in 1951 (Landecker 2007; Skloot 2010). Scholars have insightfully analyzed the changing racialized representations of the cell line and the bioethical problematics attending its commodification and personification (Landecker 1999, 2000; Holloway 2011; Wald 2012; M’charek 2014; Harvey 2016). In this essay, I draw on these analyses as I explore how an intersecting history—that of the export of experimental nonhuman primates from South Asia—shaped use of the cell line in the 1954 human field trial evaluation of the Salk polio vaccine. Many accounts detail that the field trial evaluation was one of the earliest, highly publicized uses of HeLa cells as an emergent “standard” in tissue culture (Landecker 2000, p. 64). In the lead-up to the trial, the National Foundation for Infantile Paralysis sponsored a HeLa cell production project at Tuskegee Institute so that laboratories could use the cell line instead of monkey tissues to assess the Salk vaccine (Turner 2012; Chandler and Powell 2018).

What was at stake in this substitution? More specifically, what was at stake in the *Minneapolis Tribune*’s precisely staged juxtaposition of simians and “culture tubes of cancer cells”? This essay situates the effort to replace monkeys with HeLa cell cultures in relation to the longer history of rhesus monkey export from colonial and postcolonial India. Historical accounts of the production of HeLa cells for the field trial often note that laboratories had originally intended to use cell cultures from rhesus monkey tissues to evaluate children’s antibody response to the vaccine. Yet explanations for the substitution of HeLa cell cultures are limited to brief references

¹ The article did not specify the species of juvenile monkey in the photograph. I am grateful to the ethologist Caralyn Kemp for reviewing the photograph and indicating that the monkeys are likely cynomolgus macaques. This detail exemplifies the slippage between species in media representations of polio research. While cynomolgus monkeys were utilized in polio research, the production of HeLa cells for Salk vaccine evaluation, as we shall see, was primarily framed as a replacement of rhesus monkeys from India.

to researchers' concerns about the supply of rhesus monkeys.² I offer an extended genealogy of those concerns about the monkey supply to place the vaccine trial's contingent deployment of the cell line in a transnational historical frame. In so doing, I examine the relationship between the racialized political economies of the biomedical monkey trade and of tissue culture. Attentive to historically entwined dynamics of racialization and animalization, I also examine the public representations of this relationship. Unspooling the substitution of experimental organism with cell line shows how geopolitical anxieties about securing rhesus monkeys from India shaped the interplay of human and nonhuman bodies and tissues in polio research.

Scholars have certainly emphasized geopolitical dynamics in their examinations of the ethics and politics of polio care, research, and vaccine trials and distribution (Benison 1982; Addlakha 2000; Guerrini 2003; Obadare 2005; Rogers 2007; Abraham 2018; Vargha 2018). Highlighting hierarchies of race and region, their accounts have shown the untenability of narratives that frame the development of the polio vaccine as a distinctly American innovation. Consideration of the importation of nonhuman primates—and, in particular, rhesus monkeys from north India—for American polio research has further unsettled the parameters of this history. In the field-transforming *Primate Visions*, Donna Haraway foregrounded the “extractive colonialism and neo-colonialism” shaping vaccine development in her historicization of Western governments' preoccupations with the biomedical monkey supply (1989, pp. 115–121). In various articles and *Bioinsecurities*, Neel Ahuja has more recently engaged American cultural representations of polio to examine the making of the rhesus monkey into a model organism at midcentury (2013a, 2016; b). By following primatologist Clarence Ray Carpenter's efforts to establish a rhesus monkey colony in Puerto Rico's Cayo Santiago, Ahuja contrasts the history of this model organism with the standardization of organisms like fruit flies and rats. He argues that the rhesus monkey had to be conceptually excised from orientalist imaginings of the Indian jungle and “domesticated” into the American laboratory (2013a, pp. 72–73). Ahuja shows how concerns about securing standardized monkeys from India amid decolonization and the Cold War galvanized the development of the US regional primate centers.

In this essay, I build on Ahuja's interventions to show how the American quest for rhesus monkeys from decolonizing South Asia shaped the changing scientific practice of polio research. I focus on the routine work of the National Foundation for Infantile Paralysis (NFIP) in supplying researchers with monkeys from India.³ Historians have commented on the institutionally transformative role of the NFIP,

² Describing the decision to produce HeLa for the field trial in *Culturing Life*, for example, Hannah Landecker writes that “the scale and rapidity of this testing, which was originally done on monkey cells, was threatened by the insufficient supply of rhesus monkeys” (2007, p. 35). My aim in this essay is to offer an extended genealogy of how vaccine development and testing came to be understood as “threatened” by the question of the rhesus monkey supply. For similar references to the relationship between HeLa cell use and the monkey supply, see also Skloot (2010, pp. 94–95); Chandler and Powell (2018, p. 102). As I note later, these accounts directly or indirectly rely on Brown and Henderson's 1983 account.

³ In so doing, I tell a story that supplements the historiographic focus on Clarence Ray Carpenter's translocation of rhesus monkeys from Calcutta to Cayo Santiago. See Haraway (1989); Ahuja (2013a; 2013b; 2016).

Fig. 1 “Cancer cell research, University of Minnesota, December 1953.” Photo by Powell Krueger, Minneapolis Tribune. Powell Krueger/Star Tribune via Getty Images. Image published with permission of ProQuest LLC. Further reproduction is prohibited without permission

founded by President Franklin Delano Roosevelt and now known as the March of Dimes, in the “war against polio” (Benison 1972; Creager 2002; Wilson 2015). Ensuring that scientists had sufficient monkeys was a crucial part of the organization’s efforts. From the early twentieth century, polio researchers utilized rhesus monkeys as living nonhuman hosts for the experimental production of virus. While also utilizing cynomolgus monkeys from the Philippines and other species of non-human primates, they primarily relied on rhesus monkeys.⁴ Researchers used rhesus monkeys’ susceptibility to polio to model the course of human disease, detect the presence of virus in clinical studies, and differentiate between strains. With changing knowledge and techniques, they also cultivated poliovirus in monkeys in order to formulate and test vaccines prior to human trials.⁵

Between the 1930s and the 1950s, the NFIP played a key role in procuring monkeys from colonial and later postcolonial India for these expanding experimental uses. Demand increased substantially alongside research during this period; whereas approximately eight thousand monkeys were imported in 1934, over a hundred

⁴ The use of other species of nonhuman primates points to how polio research was embedded in multiple imperial contexts and requires further exploration. While Flexner’s use of the rhesus macaque shaped the field (and, as will be noted, contributed to understanding of polio as neurotropic), the cynomolgus macaque, for instance, later came to be figured as comparatively more “delicate,” and therefore preferable to the rhesus macaque – but also less available. See Oshinsky (2005, p. 119); Smith (1990, p. 121). On green monkeys see Benison (1967, p. 269).

⁵ Guerrini outlines a number of these experimental uses in “Polio and Primates” (2003, pp. 114–136). On the broader experimental use of animal and human bodies in vaccine development, see, along with Guerrini (2003), also Löwy (1992); Lederer (1997).

thousand were being imported per year by the time of Jonas Salk's vaccine.⁶ To coordinate importation, NFIP officials drew on their connections to research institutions, the US State Department, shipping companies, and the White House. At the same time, they begrudgingly relied on a web of monkey dealers who moved between New York and Calcutta. A network of distrusted business transactions thus underpinned the NFIP's network of scientific authority, blurring the borders between lab, field, and market.⁷ This network also crossed territorial borders in a moment when the world was being restructured by anticolonial movements and war. In other words, the use of rhesus monkeys as experimental organisms necessarily embedded questions of shifting sovereignties within the seeming "placelessness" of polio laboratory research (Kohler 2002, p. 7). The NFIP's negotiation of such questions has left traces in archives across continents.

To draw out the implications of the NFIP's negotiations for the science of polio, I engage historiographical theorizations of imperial anxiety. Scholars of race and empire have long explored how "an indefinite and pervasive anxiety" about the "unknowability" of the colony subtended colonial rule (Guha 1997, p. 484). Historians of colonial science have shown how anxiety conditioned projects that sought at once to prove the civilizing effects of empire and to maintain the boundary between colonizer and colonized (Prakash 1999; Beattie 2011; Peckham 2015). Many such projects grounded the racial superiority of the colonizer in assertions of the proximity between the colonized and the nonhuman animal (Schiebinger 1993; Radhakrishna 2006; Chakrabarti 2010; Saha 2015; Sivasundaram 2015; Jackson 2020). Scholars have equally shown how ranging human and nonhuman actors destabilized and remade colonial claims—in turn fomenting unease about the foundations of rule (Prakash 1999, p. 47; Deb Roy 2019). In the American context, Ahuja has linked the "biopolitics of empire" to cultural "anxiety about the dependence of the human body on forces that appear inhuman," including the bodies of nonhuman primates from the non-West (2016, p. xii).

These analyses help shed light on the amorphous sense of uncertainty that permeated the NFIP's efforts to import monkeys from India as colonial rule unraveled. In the context of ideologies of slavery and colonialism that designated racial otherness through idioms of animality and incapacity, it was not lost on NFIP officials that a nonhuman primate from a colonized region had become essential to securing Western human capacity. Even as they managed to secure successively larger shipments year after year, NFIP officials warily assessed geopolitical shifts in the region as potential threats to polio researchers' access to monkeys. Along with monkey dealers and US government bureaucrats, they interpreted increasing colonial state regulation of the trade as a foreboding sign of a postcolonial Indian future. Their monolithic understanding of monkeys as sacred in India converged with, but also

⁶ My estimates are based on the United States Bureau of Biological Survey (1934, p. 28); Conway (1965).

⁷ Historians of science have foregrounded these blurred borders in other contexts. See, for example, Star and Griesemer (1989).

often diverged from, colonial anxieties about the governance of religious sentiment.⁸ NFIP officials viewed the Second World War, the postcolonial transition and Partition of India and Pakistan, and the emerging Cold War through the narrow prism of their anxieties about the supply of experimental organisms. In the process, their efforts to secure nonhuman primates for American research entrenched human hierarchies of religion and race.

The NFIP's anxieties about securing rhesus monkeys from India over the end of empire, I argue, were not merely incidental to the material scientific practice of polio research. Rather, the organization's racialized geopolitical anxieties configured research imperatives in the American war against polio. More specifically, I connect the politics of monkey export between the 1930s and 1950s to the history of tissue culture in polio research. The difficulties associated with procuring monkeys meant that from the organization's beginnings, NFIP officials sought alternative living forms and methods for the experimental production of poliovirus. In addition to funding research with other organisms, they were particularly invested in tissue culture. They hoped that the development of techniques for culturing poliovirus in test tubes would obviate researchers' dependence on rhesus monkey bodies—and on the transnational monkey market. Paradoxically, however, the very advent of such techniques in the late 1940s reshaped that dependence around cultures of rhesus monkey tissues; indeed, Salk developed his vaccine in monkey kidney cell cultures (Guerrini 2003; Piper 2018). As I show, tissue culture techniques consequently created a new field for the NFIP's concerns about the rhesus monkey supply to play out in polio research: through decision-making about the use of human and nonhuman cells. The subsequent production of HeLa cell cultures for polio vaccine testing occurred in response to the NFIP's longstanding anxieties about the monkey trade. Presented as a presumptively white “generalized human or cellular subject” at the time, the cell line was publicly hailed for reducing the need for monkeys in the Salk field trial (Landecker 2007, p. 165). Nevertheless, for all the investment in the cell line as a technoscientific replacement, the NFIP would ultimately continue to rely on monkey exports from India.

In offering a genealogy of this relationship, I demonstrate how geopolitical considerations can shape the changing selection of the “right” experimental organisms, tissues, and cells for the “job” of scientific research (Clarke and Fujimura 1992; Lederman and Burian 1993). Yet the relationship between the use of rhesus monkeys and HeLa cell cultures in polio research illustrates not only how changes in material scientific practice may be propelled by geopolitics. It also illustrates how such material changes may simultaneously produce “entanglements” across multiple geographies and nonequivalent formations of power (Murphy 2012, p. 12; Ahuja 2016, p. 4). Foregrounding nonequivalence is especially important in response to

⁸ Anthropologists like Radhika Govindrajan have sensitively examined how regard for Hanuman, companion to Lord Rama, can shape “knotty relatedness” with different monkeys in different contexts in contemporary India (2018, p. 177). In contrast, the actors in this history collapsed heterogeneous beliefs and practices into a monolithic conception of monkeys as uniformly sacred to all Hindus. See also Lutgen-dorf (2007) and Banu Subramaniam's examination of how Hanuman “has emerged as a potent site of a militant Hindu nationalism” (2019, p. 117). Finally on how the “secular logic of colonial politics” shaped the broader colonial governance of religious sentiments, see, among others, Adcock (2010 p. 306).

analyses that would equate humans and nonhumans – and the enrollment of their bodies and tissues in research – in ways that risk eliding and reinscribing the histories of racial abjection that differentially value lives as human.⁹ Refusing such approaches, this essay historicizes the entangled geopolitical dynamics that made possible the juxtaposition in the *Minneapolis Tribune* photograph. The advent of tissue culture techniques reconfigured the geographies of living forms that scientists could exploit in polio research. It was in this context that the colonial and postcolonial politics of procuring experimental organisms intersected with the institutionally racist American medical system through which HeLa became available to researchers as an experimental cell line. In this sense, tracing the historical relationship between experimental organism and cell line shows how the technical development of polio research relied on the convergence of disparate extractive economies.

Monkeys and the Making of the NFIP

In November 1935, members of the Advisory Medical Committee of the President's Birthday Ball Commission for Infantile Paralysis Research gathered for a luncheon with President Franklin Delano Roosevelt. Established the year before to allocate research funds raised through the President's Birthday Balls, the Commission – a precursor of the NFIP – had convened to assess the progress of its first grantees. Paul de Kruif, the bacteriologist and science writer serving as the Commission's secretary, emphasized the unique role of the new coordinating body. "This is the first time in the history of the experimental attack upon infantile paralysis," his statement concluded, "that money has been at hand for all competent investigators, for a genuinely adequate supply of monkeys." But his praise was equally a warning about the resulting technical constraints on research: "And without monkeys, no experimental attack upon the affliction is at present possible."¹⁰

The monkey – and, more specifically, the rhesus monkey – had emerged as an essential experimental organism for polio research in the first decades of the twentieth century. In 1908, following experiments with mice and guinea pigs, the Austrian

⁹ I am grateful to interventions spanning postcolonial and Black feminist studies that have profoundly critiqued scholarship that would frame the human/nonhuman divide as foundationally prior to racialization. This scholarship includes, among others, Prakash's critique of Latour (1999, pp. 12–13); Weheliye (2014); Sivasundaram (2015); Ahuja (2016); Jackson (2020). I particularly appreciate Ahuja's methodological insight, in his analysis of the history of translocated monkeys in Cayo Santiago, that "a critical monkey history must pay attention to the divisions of humanity through which monkeys emerge into humanist discourse ... recognizing the human differences through which monkey history emerges also forces us to think through the radical conjunctions and segmentations of human and monkey bodies in biological and social assemblages" (2013b, p. 200).

¹⁰ "Outline followed by Dr. DeKruif in describing progress to the President at the luncheon, November 19, 1935," p. 28, President's Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 1, Box 1, Sect. 7–11. Franklin Delano Roosevelt Presidential Library (hereafter: **FDR Library**). In a different report, de Kruif indicated that the International Committee for the Study of Infantile Paralysis provided the precedent for such funding of monkeys: "Progress Report to the President's Birthday Ball Commission for Infantile Paralysis Research," March 28, 1937, p. 9, President's Birthday Ball Commission for Infantile Paralysis Research Records, 1934–1937, Series 1, Box 1, Sect. 12–17. FDR Library. On de Kruif and the Commission, see Wilson (2015).

scientists Karl Landsteiner and Erwin Popper had famously shown that monkeys could model human susceptibility to the disease (Paul 1971, pp. 99–101; Guerrini 2003, pp. 117–118). They transmitted polio to a rhesus monkey and a baboon by injecting each with spinal cord material from a child who had died from infantile paralysis (Landsteiner and Popper 1909; Paul 1971, pp. 98–100).¹¹ The following year, Simon Flexner of New York's Rockefeller Institute for Medical Research added to their work. He showed that polio was an infectious disease by transmitting it between monkeys and determined that its cause was a virus (Benison 1974, pp. 75–76).¹²

In subsequent decades, researchers would lament how Flexner's selection of the rhesus monkey shaped polio as a research problem. His reliance on a species not orally susceptible to poliovirus contributed to a misleading understanding of the disease as neurological (Benison 1967, p. 193; Paul 1971, p. 108; Rogers 1992, p. 24; Guerrini 2003, p. 119). Flexner's experiments transmitting the virus between monkeys also created a laboratory strain that was neurotropic and would not replicate in non-nervous tissue. Scientists who used the strain in turn generated confirmation bias (Oshinsky 2005, pp. 18–19). While some researchers presented evidence – including from other species like the cynomolgus monkey – that questioned Flexner's picture and suggested that polio was an intestinal disease, understanding of the disease as neurological continued (Paul 1971, pp. 245–248; Benison 1972, pp. 316–317).

So did use of rhesus monkeys as research animals.¹³ As researchers conducted clinical investigations of polio, they too utilized the species. Attempting to detect the virus in mildly symptomatic cases in the early 1930s, John Rodman Paul and James Trask at Yale tested oral washings from patients by injecting samples into monkeys to see if paralysis developed (Paul and Trask, 1932; Horstmann 1985, pp. 81–82; Grimshaw 1996, pp. 145–147). During the Los Angeles epidemic of 1934, Paul conveyed some twenty monkeys to the city to try to isolate the virus from human specimens (Paul et al. 1935; Paul 1971, pp. 213–214; Grimshaw 1996, p. 154). Paul was intensely aware of the complexities of procuring monkeys for these investigations. In their efforts to secure sufficient experimental organisms, researchers had to negotiate with dealers who sometimes resold monkeys previously used in other laboratories (Benison 1967, p. 255). “Monkeys and their care,” he wrote in 1931, “is a hellishly expensive problem” (quoted in Grimshaw 1996, p. 111).

De Kruif's remarks during that November 1935 luncheon with President Roosevelt, then, signaled an institutional intervention into the problem of the

¹¹ The scarcity of monkeys in Vienna later prompted Landsteiner to go work with Constantin Levaditi at the Pasteur Institute in Paris (Rous 1947, p. 297). Haraway (1989) has indicated how the Pasteur Institute's access to nonhuman primates drew on French colonial networks. I thank Simon Pickstone for translating the relevant parts of Landsteiner and Popper's paper for me.

¹² See Creager (2002, p. 40 n. 98) on the question of assigning Flexner priority in establishing polio as a virus.

¹³ The rhesus monkey had also become a significant experimental animal in other fields of research over this period. Hanson (2004) and Wilson (2012) have shown how the development of a breeding colony of rhesus macaques for reproductive research at the Carnegie Institution of Washington Department of Embryology consolidated broader scientific investment in the rhesus macaque as an experimental animal.

experimental animal supply. In his report, de Kruif noted how a “scarcity of monkeys” had hindered various grantees’ ability to pursue polio research. The Birthday Ball Commission, he argued, ought to “do everything in its power to expedite the grantees’ supply of healthy animals, at as low a price as possible.”¹⁴ He had previously outlined to grantees how the Commission might help by coordinating between animal dealers and institutions.¹⁵ To this end, after grantees had expressed concern that importation duties might raise the price of monkeys from India, Commission officials immediately involved Roosevelt in resolving the matter.¹⁶ The organization thus sought to provide grantees with both financial and logistical support in acquiring experimental animals.

In its first year, the Commission provided particular support in this regard to William Hallock Park and Maurice Brodie of New York University. Park and Brodie had developed a killed-virus vaccine from rhesus monkey spinal cords that played to hopes for a solution. But the researchers’ use of nervous tissue in vaccine production would soon become controversial (Oshinsky 2005, pp. 56–58; Paul 1971, p. 259). Their vaccine trials with several thousand children in 1935 generated unclear data, allergic reactions, and potential infection with polio. Park and Brodie’s vaccine trials also became associated with those of John Kolmer, a researcher at Temple University who was not a Commission grantee. During the same period, Kolmer was testing a live-virus vaccine from monkey nervous tissue that resulted in several deaths and polio cases. The Kolmer and Park-Brodie vaccine trials would end in ignominy later that year (Smith 1990, p. 72; Halpern 2004, pp. 41–65; Wilson 2015, pp. 403–404). De Kruif would come to express regret about the Commission’s involvement (1962, p. 198).

In the months before the fallout, however, Commission members like de Kruif rushed to support Park and Brodie – and, more specifically, the grantees’ requests for monkeys from India. In a memorandum detailing the procedure whereby they killed infected monkeys and then “squeezed out” their spinal cords to make the vaccine, Park had indicated that a single monkey “yields about enough for ten doses.”¹⁷ Acquiring sufficient monkeys to provide children with two doses, he elaborated, required strategizing and alternating between dealers to ensure healthy shipments.¹⁸ De Kruif responded enthusiastically to Park’s requests, sanctioning “as many

¹⁴ “Outline followed by Dr. DeKruif in describing progress to the President at the luncheon, November 19 1935,” p. 26, President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 1, Box 1, Sect. 7–11. FDR Library.

¹⁵ De Kruif to grantees, June 21, 1935, President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 2, Box 2, Sect. 16–18. FDR Library.

¹⁶ It turned out that the duties levied on imported animals were lower than the grantees, William Hallock Park and Maurice Brodie, had thought. “Sect. 18 (Appendix): Custom Duties on Monkeys [sic] for Experimental Purposes,” President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 2, Box 2, Sect. 16–18. FDR Library.

¹⁷ “Infecting the Monkeys,” President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 2, Box 2, Sect. 9. FDR Library.

¹⁸ Park to Milbank, May 21, 1935, President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 2, Box 2, Sect. 9. FDR Library.

monkeys as he deems necessary.”¹⁹ Over the spring of 1935, Commission officials arranged for the construction of an animal house at Park and Brodie’s New York University laboratory.²⁰

Hope for a vaccine transmuted into public fascination with the thousands of monkeys transported into the city that summer and fall. “Pedestrians passing the building at the foot of E. 15th street and the East River in New York have recently been puzzled by the chattering of monkeys that assailed their ears,” wrote one journalist. “That building houses the laboratory where Dr. Brodie, the young benefactor of childhood, converts screeching monkeys from the jungles of India into a potent weapon against infantile paralysis” (Bertram 1935, p. 8).

De Kruif similarly dramatized the role of non-Western animality in securing an able-bodied (white) humanity in the West. Publicizing the trials in the *Ladies Home Journal*, he anthropomorphized monkeys as undisciplined soldiers in the war on polio. “In India’s jungles,” he explained to readers, “there’s the chattering of monkey myriads trying to evade service in the new scientific army fighting for strong-limbed childhood free from this paralysis and death.” The accompanying images specified his racial vision of healthy American childhood, juxtaposing a photograph of huddling rhesus monkeys with an illustration of burbling white infants (De Kruif 1935, p. 22).

If de Kruif implicitly acknowledged nonhuman primates as actors in his anthropomorphic depiction, journalists focused on the animal dealers who attempted to bring these actors into the service of the American laboratory. “Dr. Brodie’s vaccine,” noted a journalist in the *New York Herald Tribune*, “has created a business boom for Henry Trefflich, twenty-six-year-old animal merchant of Fulton Street, who has supplied Dr. Brodie with more than 2,000 Rhesus monkeys since the experiments began” (*New York Herald Tribune* 1935a, p. 12). Trefflich, a German immigrant who had established himself by supplying monkeys to zoos and circuses, fast became an important dealer for the Commission.²¹ Some articles about the self-avowed “monkey king” offered light-hearted accounts of animal escapes (*New York Herald Tribune* 1935b). Others provided readers with a window into the chain of transactions that brought monkeys by train, ship, and truck from trapping sites near Lucknow to the port of Calcutta to the city of Boston to the Lower East Side (*New York Herald Tribune* 1935c; *Daily Boston Globe* 1935). Throughout, the focus on Trefflich’s heroics eclipsed the non-white trappers and caretakers whose labor was critical to the business (*Toronto Daily Star* 1935).

An anxious, orientalist imagination of Indian religiosity suffused these accounts of the monkey trade. Since the late nineteenth century, the Darwinian turn had intensified colonial fixation on the complex relationships between humans and simians as

¹⁹ Telegram, April 1, 1935, President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 2, Box 2, Sect. 9. FDR Library.

²⁰ “Grant to New York University,” May 23, 1935, President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 2, Box 2, Sect. 9. FDR Library.

²¹ See *Los Angeles Times* 1928. Many of the dealers in this period were German immigrants with similar backgrounds; Elizabeth Hanson has noted that the preexisting trade for zoos and circuses shaped the comparative availability of the species (2002, p. 79; 2004, p. 69).

evidence of Indian hierarchies of race and caste (Radhakrishna 2006; Lutgendorf 2007; Sivasundaram 2015). Playing on these themes, journalists covering importation for the Park-Brodie trials described the sacredness of monkeys to irrational “Hindoo princes” whose cities were “plagued with monkeys” (*Toronto Daily Star* 1935, p. 5). Other writers explicitly connected depictions of religious irrationality to the question of the monkey supply. Explaining how the cost of the vaccine depended on the availability of monkeys, a *New York Times* journalist slipped between region and religion to speculate that “maybe the religious Bengalis will object” to exports (Kaempffert 1935, p. XX5). Persistent framings of “native backwardness” as a potential barrier to Western science reveal how racialized concerns about the political economy of research subtended the public fascination with the influx of monkeys into New York City.

For polio researchers, these concerns incentivized the search for alternatives. Park and Brodie, for example, mentioned experimenting with mice as a cheaper organism.²² De Kruif, too, was invested in alternatives. At the same November luncheon where he commended the Commission for helping researchers acquire monkeys, he also expressed particular hope for the “extremely new science of cultivating viruses outside the bodies of living animals.” Noting the University of California researcher Karl Meyer’s plan to attempt growing the virus in artificial culture media, he made clear the significance of such research for the monkey supply problem. Tissue culture techniques, he predicted, could render “the serious and expensive ‘monkey business’ which now inhibits progress ... a thing of the past.”²³

De Kruif’s comment shows how polio researchers envisioned tissue culture as a solution to the reliance on rhesus monkeys well before the production of the HeLa cell line. As de Kruif knew, a viable alternative to cultivating virus in monkey bodies would not only reduce costs but also eliminate reliance on exports from colonial India. The “monkey business,” however, was far from over. While Albert Sabin and Peter Olitsky managed to cultivate poliovirus in human embryonic nervous tissue – acquired from a surgeon who had likely performed therapeutic abortions at Bellevue Hospital – in 1936, concerns about the use of nervous tissue limited the utility of their findings (Sabin and Olitsky 1936; Guerrini 2003, p. 120; Oshinsky 2005, pp. 121–122).²⁴ Nor were researchers successful in identifying an alternative experimental organism in which they could induce polio. De Kruif thus continued to express disappointment that in contrast to use of “inexpensive guinea-pig[s]” in diphtheria research or of “countless mice” in pneumonia studies, reliance on monkeys from India had resulted in the “unparalleled costliness of infantile paralysis

²² Park to Milbank, May 21, 1935, President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 2, Box 2, Sect. 9. FDR Library.

²³ “Outline followed by Dr. DeKruif in describing progress to the President at the luncheon, November 19, 1935,” p. 27, President’s Birthday Ball Commission For Infantile Paralysis Research Records, 1934–1937, Series 1, Box 1, Sect. 7–11. FDR Library.

²⁴ Sabin and Olitsky thanked Dr. Lance Monroe of Bellevue Hospital for providing them with the “3- to 4-months-old human embryos, obtained aseptically by Cesarean section” (1936, p. 358). No further information was provided about the patients from whom the embryos were “obtained.” See also Smith (1990, p. 130) and Landecker (2007, pp. 124–125) on the individualized and unregulated norms surrounding the procurement of human embryonic tissue for polio research.

research.”²⁵ As the Commission morphed into the National Foundation for Infantile Paralysis in 1938, the problem persisted.²⁶ With Roosevelt’s former law partner Basil O’Connor at the helm, the organization would become even more involved in the geopolitics of the rhesus monkey supply.

Simian Economies and Shifting Sovereignties

On May 4, 1937, Basil O’Connor wrote with urgency to the White House. “The attached copy of a telegram from Paul de Kruif may sound funny to you but it isn’t funny at all,” he prefaced wryly. The day before de Kruif had telegraphed:

In the matter of removal of restrictions on experimental monkeys Henry Trefflich our principal dealer 215 Fulton St New York City has 2000 monkeys in Calcutta now ready for shipment he was notified before the restriction went into effect and I wonder if you could do anything through the White House to urge the State Department to facilitate the release of this shipment so important to research.²⁷

The previous month, the Government of India had issued a customs notification prohibiting monkey exports during the “hot weather” months of March through October. De Kruif had learned of the restriction from the New York City dealer Henry Trefflich, who had in turn been informed by his Calcutta agent. By the time O’Connor had written the White House, an indignant Trefflich had circulated the news to his customers at scientific institutions across the country. Letters from researchers had quickly poured into the offices of the President, the Surgeon General, and the Secretary of State, among others, urging the American government to intervene.

Stressing the “indispensable” role of rhesus monkeys in a range of scientific research, the treasurer of the University of Chicago declared the situation an “emergency.” The emergency was magnified by the overlap of the restricted period with the summer months, he added, when polio outbreaks were most likely and monkeys most necessary. Scientists at other institutions strove to explain the dependence on rhesus monkeys to American officials. The University of Wisconsin bacteriologist Paul Clark, for example, specified that while monkeys from South America were

²⁵ “Progress Report to the President’s Birthday Ball Commission for Infantile Paralysis Research,” p. 9, March 28, 1937, President’s Birthday Ball Commission for Infantile Paralysis Research Records, 1934–37, Series 1, Box 1, Sect. 12–17. FDR Library.

²⁶ See Wilson (2015) on this organizational transformation.

²⁷ The original telegram was written in all caps. O’Connor to Early, May 4, 1937, box 3198, 611.459/289, 1930–39 Central Decimal File, RG 59: General Records of the Department of State (hereafter: **RG 59**). US National Archives and Records Administration (hereafter: **US NARA**).

useful in certain fields of research, “in the work on Infantile Paralysis and in much of the work on Yellow Fever only the Indian monkeys are susceptible.”²⁸

Their pleas propelled official action. Scrambling to resolve the situation in advance of summer epidemics, officials in Washington telegraphed the American Consulate in Calcutta. The American Consul General had already been approached by Trefflich’s Calcutta agent and began lobbying the Indian government’s External Affairs Department about the urgency of the situation.²⁹ Over the same period, de Kruif lobbied India’s Home Department by telegraph. By the end of May, their efforts paid off. The Government of India granted Trefflich special permission to ship his existing consignment of two thousand monkeys.³⁰

A restriction, nevertheless, remained. In this sense, the 1937 “emergency” was a preview of the negotiations for exemptions that would occur in summers to come. The National Foundation for Infantile Paralysis (NFIP) was increasingly at the center of these efforts to secure export exemptions from what Trefflich referred to as the “India Home Rule Government.”³¹ Underpinned by an orientalist imagination, Trefflich’s adoption of the term signaled a hazy awareness of how anticolonial nationalisms were remaking India in the 1930s. Conducting business in the subcontinent over the decade, the animal dealer would have encountered the Gandhian civil disobedience movement and contests over political representation at the Round Table Conferences. Following the constitutional reforms of 1935 that restructured center/province governance and expanded the electorate, the Indian National Congress had just proved victorious in the 1937 provincial elections. Even as nationalists critiqued the reforms for maintaining imperial control, the victory bolstered the Congress’s challenge to British rule.³² Trefflich’s frequent warnings to scientists about impending restrictions from the “India Home Rule Government,” then, indexed an anxiety about how shifting configurations of sovereignty might reconfigure American access to experimental organisms. The Second World War and the Partition of India and Pakistan in 1947 would compound the sense of uncertainty for this network of scientific actors, further incentivizing their search for research alternatives to the rhesus monkey.

²⁸ Treasurer (University of Chicago) to Secretary of State, May 5, 1937; Clark to Roosevelt, April 13, 1937. Clark’s letters were further circulated, citing the distinction between Old and New World macaques. There are examples of the voluminous correspondence in box 3198, 611.459/285–611.459/290, 1930–39 Central Decimal File, RG 59. US NARA.

²⁹ American Consul General J.C. White to Secretary to the Government of India in the External Affairs Department, April 20, 1937, box 19, 1937, file 650, U.S. Consulate and Consulate General, Calcutta [UD 2720], General Records, RG 84: Records of Foreign Service Posts of the Department of State (hereafter: **RG 84**). US NARA.

³⁰ De Kruif to Home Department, March 14, 1937; Home Department to American Consul, May 22, 1937. Home Department, Police, 1936, 119/2/36, National Archives of India (hereafter: **NAI**).

³¹ Trefflich to Dunn, June 10, 1937. Trefflich appears to have adopted the term as Congress was negotiating over forming ministries in the provinces; previously he referred to the “Indian government” (see, for example, Trefflich to McIntyre, Secretary to President Roosevelt, April 12, 1937). Scientists proceeded to follow Trefflich’s lead. Box 3198, files 611.459/287 – 611.459/296, 1930–39 Central Decimal File, RG 59. US NARA.

³² For an overview of the 1935 Government of India Act and nationalist politics in late colonial India, see Muldoon (2009).

The late colonial state's increasing regulation of the monkey trade was itself a response to a transimperial network of actors.³³ From the mid-1920s, sensational news reports of a trade in monkeys had incited protest from Indian legislative assemblymen, British Members of Parliament, Hindu and Jain organizations, Societies for the Prevention of Cruelty to Animals, and antivivisectionist groups across the empire.³⁴ Playing into wider imperial preoccupations with the governance of religious sentiments, the protests had alarmed colonial bureaucrats.³⁵ Officials in the Home Department ultimately deemed the matter overblown but recommended monitoring export conditions to mitigate future controversy.³⁶ It was in response to ongoing concerns about animal welfare in transit that in 1937 the central colonial government restricted the export of monkeys during "hot weather" months.³⁷

Yet while apprehension about Hindu sentiments informed colonial officials' attention to the monkey trade, they did not approach the restriction as a blanket ban on export. Once they understood that the monkeys were for "bona fide medical research," colonial officials were not unsympathetic to the overtures of their American counterparts. In the weeks after issuing permission for Henry Trefflich's shipment in 1937, for example, they also shortened the duration of the restricted period to April through August.³⁸ Pratik Chakrabarti's analysis of the politics of animal experimentation in colonial India helps situate the officials' regulatory outlook. Chakrabarti argues that the civilizing promise of science stanching antivivisectionist protest against laboratory experimentation in the colony, compounding the pathologization of "native custom" as the real source of animal cruelty (2010).³⁹ In a similar vein, while colonial officials had variously expressed unease about how the export of monkeys might be interpreted, they were not specifically opposed to export for research.⁴⁰ The 1937 negotiations reassured the American Consul General to this end, namely, that the colonial government would consider future requests for export exemptions. The Consul General further reported that a conversation with a Home Department official had reassured him that "Hindu feeling" was opposed to the "maltreatment of exported monkeys as sacred or quasi-sacred animals" rather

³³ For the purposes of my argument, I sketch these dynamics here to highlight the disjuncture between colonial and American understandings.

³⁴ There was particular concern about exports for gland grafting, a history I explore elsewhere. Home Department, Police, 1925, Progs. Nos. 11/V. NAI.

³⁵ There is an expansive literature on how the colonial state's claim to religious neutrality and non-interference – producing bounded oppositions between religion and economy – shaped the field of colonial politics. See, for example, Adcock (2010).

³⁶ Home Department, Police, 1925, Progs. Nos. 11/V. NAI.

³⁷ 'Principal Information Officer's Summary.' Home Department, Police, 1938, 119/2/38. NAI.

³⁸ Notes, A.S. Hands, May 19, 1937; Finance Department (Central Revenues) Notification 36, June 5, 1937. Home Department, Police, 1936, 119/2/36, NAI.

³⁹ He further disaggregates antivivisectionist agendas from the ascendant Hindu cow protection movement; as he points out, a number of Indian proponents of cow protection also supported the establishment of Pasteur Institutes. Chakrabarti argues that these dynamics explain why the institutionalization of laboratory science in colonial India was not accompanied by the passage of legislation regulating animal experimentation.

⁴⁰ Notes, A.S. Hands, May 19, 1937. Home Department, Police, 1936, 119/2/36, NAI.

than to export itself. In fact, it appeared that “the Indian complaints” had been “far fewer than appeals from American anti-vivisection societies to the Indian government to stop the export.”⁴¹

State Department officials in Washington would nonetheless point to “Hindu feeling” to advocate a cautious approach to requesting exemptions over the following years.⁴² Their emphasis on religiosity marked a disjuncture between American and colonial state interpretations of the politics of export, even as both relied on stabilized imaginations of native belief. For American officials, a sense of the situation’s religious volatility melded with a sense of logistical unpredictability. Officials found that convincing the colonial government of the urgency of requests remained difficult because Britain was not a major importer.⁴³

In their wariness, Washington officials began demanding evidence of a monkey shortage before approaching the Government of India during the restricted period. The demand for evidence translated into a suspicion of animal dealers like Treflich. In the summer of 1940, for instance, officials concluded that Trefflich’s claims of a shortage were overstated and possibly linked to a separate business interest in importing pythons.⁴⁴ But after informing Trefflich that they would not intervene, they were inundated yet again with letters from scientists who insisted that the “situation constitutes a danger to public health.”⁴⁵ Coupled with the involvement of the NFIP, the lobbying prompted reassessment. When Basil O’Connor wrote to confirm the seriousness of the shortage, diplomats in Washington and Calcutta moved quickly to request an exemption.⁴⁶ The episode reflected the dynamics of expertise and authority shaping the trade. If NFIP officials and researchers relied on Trefflich’s knowledge of the monkey market, the animal dealer equally depended on their scientific legitimacy to pursue business across continents.

O’Connor’s letter in support of Trefflich alluded to how World War II was creating new challenges for supplying American scientists with experimental organisms. Shipping had been disrupted across the globe as war touched center and periphery. The imperial mobilization of India for the war effort was remaking port cities like Calcutta, where requisitioning and shipping irregularities would exacerbate famine in 1943 (Khan 2015, p. 211). Meanwhile, seamen across the empire were striking (Balachandran 2012, pp. 258–264). NFIP officials on America’s Eastern Seaboard were ever attentive to the implications of these developments for polio research.

⁴¹ Calcutta to State, Despatch 797, Enclosure No. 1, October 11, 1938, box 3198, 611.459/313, 1930–39 Central Decimal File, RG 59. US NARA.

⁴² Allen (Middle Eastern Affairs) to Trefflich, March 7, 1944, box 1678, 611.459/492, 1940–44 Central Decimal File, RG 59. US NARA.

⁴³ Memorandum of Conversation, Division of Near Eastern Affairs (Copy), July 3, 1941, box 82, 1941, file 650, U.S. Consulate and Consulate General, Calcutta [UD 2720], General Records, RG 84. US NARA.

⁴⁴ Memorandum of Conversation, June 7 and 10, 1940, box 1677, 611.459/394, 1940–44 Central Decimal File, RG 59. US NARA.

⁴⁵ Howard Howe (Johns Hopkins University) to State, May 22, 1940, box 1677, Folder 611.459/376, 1940–44 Central Decimal File, RG 59. US NARA.

⁴⁶ O’Connor to State, June 11, 1940; State to O’Connor, July 8, 1940, box 1677, 611.459/395, 1940–44 Central Decimal File, RG 59. US NARA.

Limited shipping opportunities had increased the unwillingness of shipmasters to transport monkeys from Calcutta.⁴⁷ As the war continued, the NFIP's Richard Charlock visited the State Department to lobby for shipping space. When officials inquired whether the Foundation might instead utilize the primatologist Clarence Ray Carpenter's translocated colony of rhesus monkeys in Puerto Rico, Charlock explained the problem. Monkeys from Carpenter's Cayo Santiago colony cost approximately \$75, while monkeys from India cost \$10.⁴⁸ Despite disruptions and sunken consignments, there was still a financial imperative to import monkeys from India.⁴⁹

NFIP officials framed their negotiation of these wartime challenges as both an achievement and a research problem necessitating a search for alternatives. Annual reports trumpeted their efforts to ship monkeys "in spite of the difficulties and hazards of war" as having "far-reaching benefits" (NFIP 1943, p. 15). Yet those reports simultaneously indicated the benefits of eliminating research dependence on the rhesus monkey. One report directly linked the urgency of "the search for an experimental animal to replace or supplement the use of the *Macacus rhesus*" to "world conditions" (NFIP 1941, p. 21). The chairman of the Foundation's Virus Research Committee, Thomas Rivers, later declared that he "could swear that at one time or another almost every animal that we could get our hands on had polio stuck into it" during this period. He particularly noted Charles Armstrong's cultivation of the Lansing strain of poliomyelitis virus in rodents, which were not susceptible to other types of poliovirus, and research with gerbils from the Sahara. Gesturing towards the wider imperial fields that the NFIP drew on in seeking an alternative, Rivers indicated that "animals all over the world" were tested. Nevertheless, the "search was unsuccessful and the monkey remained a problem for the Foundation" (Benison 1967, p. 269).

While polio researchers continued to seek an answer to this problem, other arrangements of trade shifted. To further regulate wartime shipping, the Government of India began requiring additional permissions to export monkeys during the unrestricted period.⁵⁰ News of the regulations immediately set off alarm in the NFIP. Diplomatic back-and-forth over the fall of 1941, however, resulted in a permit for the organization to ship twelve thousand monkeys during the "open season" and an

⁴⁷ Schnare (Calcutta) to Merrell (New Delhi), July 28, 1942, box 105, 1942, file 650, U.S. Consulate and Consulate General, Calcutta [UD 2720], General Records, RG 84. US NARA.

⁴⁸ "The only consumers who can afford to pay \$75," he elaborated, were "the relative few who, in their work, require animals whose life histories are known and a matter of record." Memorandum of Conversation, March 12, 1941, box 1677, 611.459/423, 1940–44 Central Decimal File, RG 59. US NARA. For more on Cayo Santiago, see Ahuja (2013b).

⁴⁹ A consignment of 500 monkeys sank in 1942. American Consulate Calcutta to State, Telegram 372, May 16, 1942, box 105, 1942, file 650, U.S. Consulate and Consulate General, Calcutta [UD 2720], General Records, RG 84. US NARA.

⁵⁰ Finance Department (Central Revenues) Notification, July 26, 1941, Home Department, Police, 119/11, 1941. NAI.

exemption to ship two thousand during the “closed season.”⁵¹ The annual renewal of permits and exemptions involved similar negotiations for the remainder of the war.

As the end of the war heralded the end of imperial rule in South Asia, American officials articulated new concerns about the monkey supply. The war had indebted Britain and energized anticolonial demands. The rapid exit of the British from the subcontinent was followed by the mass migrations and bloodshed of the 1947 Partition.⁵² The NFIP now considered how the violent transformation of the British colony into independent India and Pakistan might shape the trade in monkeys. After Foundation representatives heard rumors of an impending shortage in late 1947, State Department inquiries with Trefflich’s Calcutta agent led to the determination that:

There is a possibility of an interruption in the supply of monkeys from the United Provinces because the trappers are all Moslems and there has been a large movement of Moslems out of the province in consequence of the communal riots in and around Delhi. The influx of Hindus into the area from Pakistan has contributed to the confusion and has served to make the Moslem trappers nervous about the continuation of their activities because of the Hindu veneration for the monkey.⁵³

Exemplifying the racialized prioritization of nonhuman exports for American medical welfare over human welfare in South Asia, the US official invoked the risks experienced by Muslim trappers primarily to frame the violence of Partition as a threat to the monkey supply. The attention to violence between Hindus and Muslims further consolidated an understanding of the labor and politics of the trade as an issue of essential religious difference. If in previous years officials had assessed religious sentiments more tentatively, they now recast the matter in a singular frame. As they discussed how to continue securing export exemptions, for example, State Department officials proclaimed “that the Hindu’s veneration of the monkey was largely responsible for the establishment of the export embargo during the hot summer months.”⁵⁴

Behind such definitive assessments was a sense of uncertainty about how India’s independence would shape future negotiations. Despite the NFIP’s efforts to locate an alternative over the 1940s, polio researchers nonetheless remained dependent on rhesus monkeys from India. In the following years, anxiety about the monkey trade converged with the development of tissue culture techniques that rapidly reshaped the use of living bodies and cells in polio research.

⁵¹ Memorandum of Conversation, Division of Near Eastern Affairs, September 9, 1941; New Delhi to State, November 19, 1941, box 1677, 611.459/439 – 611.459/458, 1940–44 Central Decimal File, RG 59. US NARA.

⁵² For overviews of war, violence, and the making of Partition in an expansive literature, see Bayly and Harper (2007); Gilmartin (2015); Khan (2015).

⁵³ Beale to Kingdon (NFIP), December 18, 1947, box 2738, 611.459/10–2747, 1945–49 Central Decimal File, RG 59. US NARA.

⁵⁴ Department of State Memorandum of Conversation, January 9, 1948, box 2738, 611.459/1–948, 1945–49 Central Decimal File, RG 59. US NARA.

“A Flask for a Monkey”: Between Standardization and Substitution

In October 1948, the NFIP’s Director of Research, H. M. Weaver, sent a letter to India’s Minister of Finance, John Matthai, requesting permission to export four thousand monkeys during the upcoming restricted season. The “greater need for *Macacus rhesus* monkeys from India,” he explained, “is related to the development of a vaccine which we believe has considerable possibilities of becoming an effective agent for combating infantile paralysis.”⁵⁵

Weaver was referring to the NFIP’s massive new project to determine the different types of poliovirus, which was crucial to developing a vaccine. Typing the many strains of poliovirus was to be an elaborate process utilizing some twenty thousand monkeys (Jacobs 2015, p. 89). The process entailed first injecting different human virus samples – stool specimens, throat swabs, or postmortem nervous tissue – into the central nervous system of monkeys and killing those monkeys after they developed infection to collect the strains (Oshinsky 2005, pp. 118–120). Researchers proceeded to infect other monkeys with a virus strain known to be of one type. After a monkey recovered and was presumed to have antibodies to the known strain, researchers mixed antiserum from that monkey with an unknown virus strain to then inject into additional monkeys. If the antiserum protected those additional monkeys from infection, the virus strains were of the same type (Salk 1952; Jacobs 2015, pp. 78–82).⁵⁶ Dependent on monkey bodies, these methods for cultivating and testing strains would ultimately lead researchers to determine that there were three types of poliovirus (Carter 1965, p. 78–79; Guerrini 2003, p. 122).

Weaver later lauded researchers for “cop[ing] with the struggles, the dodges, and the antics of this horde of primates” throughout the typing process (1953, p. 673; Jacobs 2015, p. 89). But his racialized figuration of monkeys as a horde – as an overwhelming foreign obstacle to research – belied anxieties about a shortage of rhesus monkeys from newly postcolonial India over those years. Initially stimulated by the typing project’s need for large numbers of standardized monkey bodies, these anxieties were exacerbated by technical developments that paradoxically reoriented research around monkey tissues. The NFIP’s consideration of the HeLa cell line as an alternative would occur in the context of these dynamics of standardization and substitution.

In 1948, the Foundation’s requirements of a “constant flow of nearly *identical* monkeys” for the virus typing project spurred efforts to standardize importation.⁵⁷ Researchers had long complained about the health of the rhesus monkeys they received from dealers and often blamed colonial conditions of trapping and transport. In 1940, Don Gudakunst, then the NFIP’s Medical Director, had written

⁵⁵ Weaver to John Matthai [sic], October 13, 1948, box 243, 1948, file 862.3, U.S. Consulate and Consulate General, Calcutta [UD 2720], General Records, RG 84. US NARA.

⁵⁶ Another method, as Jacobs notes, involved testing monkeys known to have recovered from one strain with an unknown strain; if the macaques did not become infected, the strains were of the same type. See also Oshinsky (2005, pp. 119–120).

⁵⁷ Weaver, cited in Department of State Memorandum of Conversation, July 27, 1949, box 2738, 611.459/7–2749, 1945–49 Central Decimal File, RG 59. US NARA.

disparagingly of “the conditions under which these animals have to be handled – the most ignorant natives in India and completely untrained persons on board ship.”⁵⁸ Gudakunst positioned the non-white laborers who made the trade possible as a veritable barrier to the quality of experimental organisms necessary for polio research – a barrier that the Foundation needed to surmount by standardizing animal care.

It was with this aim that the Foundation established a monkey-conditioning center in South Carolina just before the launch of the typing program.⁵⁹ The center, Okatie Farms, was designed to house newly imported monkeys for three weeks before reshipping them out to laboratories (Kerkmann 1954). By subjecting monkeys to standardized diet and tuberculin testing regimens, NFIP officials aspired for Okatie to achieve what Ahuja has described as the integration of the monkey into the American nation (Ahuja 2013a, 2016). But polio researchers were often unimpressed with the results of such aspirations. Frustrated by irregular shipments, tuberculosis, and higher costs, they continued to make private arrangements with dealers like Trefflich.⁶⁰

NFIP officials now clearly saw the middlemen they relied on as jeopardizing diplomatic negotiations with the postcolonial Indian state. When reports of tuberculosis among monkeys resulted in a temporary suspension of export permissions in the summer of 1949, the NFIP blamed the animal dealers. In an emergency meeting between dealers, the NFIP, the Department of Commerce, and the State Department, Basil O'Connor warned that “unless the American dealers control themselves the Government of India will intervene and control them.”⁶¹

O'Connor's fear of “control” mapped onto broader anxieties about India's alignment in the global Cold War. In 1949, Prime Minister Jawaharlal Nehru was reiterating his refusal to choose sides and would soon recognize the People's Republic of China (Raghavan 2018, pp. 153–154; Slate 2019, pp. 171–175). The possibility of communism's spread in Asia hung over the meeting. The Foundation's research director, Weaver, drew on colonial tropes of Indian gullibility as he reported rumors that “the natives were being needled from one side by religious leaders and on the other by communist agitators who stated that the Americans were using monkeys for experiments in bacteriological warfare [sic] for future war against the Indians.”⁶² For Foundation officials, the monkey trade was becoming a site of Cold War conflict.

⁵⁸ Correspondence – 1940–43 – Animals, NFIP – letter, 1940–12-05. Letter from Gudakunst, Don W. to Sabin, Albert B. dated 1940–12-05. University of Cincinnati. Hauck Center for the Albert B. Sabin Archives. Accessed online: <https://drc.libraries.uc.edu/handle/2374.UC/691513>

⁵⁹ Department of State Memorandum of Conversation, July 27, 1949, box 2738, 611.459/7–2749, 1945–49 Central Decimal File, RG 59. US NARA.

⁶⁰ The NFIP's consequent inability “to operate the center on anything approaching a business like basis” led Weaver to “insist” that Foundation grantees first order from Okatie. Weaver to Francis, May 9, 1949. Thomas Francis Papers, Box 5, Monkeys: Okatie Farms Suppliers. Bentley Historical Library, University of Michigan.

⁶¹ O'Connor cited in Department of State Memorandum of Conversation, August 2, 1949, box 2737, 611.455/8–249, 1945–49 Central Decimal File, RG 59. US NARA.

⁶² Weaver cited in Department of State Memorandum of Conversation, August 2, 1949, box 2737, 611.455/8–249, 1945–49 Central Decimal File, RG 59. US NARA.

But as Weaver worried how the Cold War would affect the availability of monkeys for the typing project, developments in tissue culture were remaking the need for the animal in question. Earlier that year, John Enders's team at the Children's Hospital of Boston had successfully cultivated poliovirus in non-nervous tissue outside the bodies of monkeys. They had shown they could propagate the virus in cultures of human non-nervous tissue acquired from hospitals – namely, foreskin tissue removed in circumcision procedures and embryonic tissue from stillbirths and miscarriages (Smith 1990, p. 130; Landecker 2007, pp. 124–125). They further demonstrated that the presence of the virus in cell culture exhibited a detectable “cytopathogenic effect” under the microscope (Horstmann 1985, pp. 83–84). Upending the earlier belief that poliovirus was primarily neurotropic and could only be grown in nervous tissue, the findings would prove essential to vaccine development (Benison 1972, p. 327). More broadly, as Hannah Landecker has argued, Enders's work marked “the relocation of the event of infection from the experimental animal to the cell” (2007, p. 123).

Enders's method of detecting the virus in cell culture through microscopic examination was of immediate import in this regard for the scientists working on the NFIP typing project. Rather than monitoring multiple monkeys for weeks, researchers could combine different strains and antisera in test tubes of cell culture and then use a microscope to look for virus (Benison 1967, pp. 449–450; Carter 1965, pp. 105–106; Landecker 2007, p. 130). Jonas Salk at the University of Pittsburgh began to experiment with Enders's techniques in typing the virus and would soon apply them to vaccine development (Smith 1990, p. 127; Guerrini 2003, pp. 122–123). Salk and his colleagues explained the potential of such techniques for typing in relation to “the question of ease and economy” – in other words, a reduction in total monkeys required (Salk et al. 1951, p. 266).

NFIP officials and researchers celebrated these new research possibilities as the “end of ‘the monkey era’” (NFIP 1951, p. 23). Laudatory accounts conjured up the technoscientific future through imagery of “the substitution of a flask for a monkey” (NFIP 1953, p. 8). Sharing the significance of Enders's work with the physician readers of *The Merck Report*, John Rodman Paul explained:

the way is now open for many laboratories to engage in certain clinical and epidemiologic investigations on poliomyelitis which have been denied to them in the past because of the expense and other difficulties inherent in the establishment and maintenance of private primate colonies. (1952, p. 4)

Paul's reference to the “other difficulties inherent” in primate research might be read as alluding to the geopolitical implications of Enders's achievement. Foundation reports explicitly stated that tissue culture techniques could now obviate “the burden of obtaining, shipping, processing, and maintaining great numbers of primates” (NFIP 1951, p. 24). When Foundation officials declared that Enders's research “broke the monkey bottleneck,” then, they were in a sense expressing enthusiasm for what Paul de Kruif had hoped for nearly two decades earlier (NFIP 1953, p. 8). Tissue culture techniques seemed poised to break polio researchers' dependence on the transnational supply chain of rhesus monkeys.

The break, however, would remain a fantasy. Rather than eliminating dependence on monkey bodies, these developments reconfigured that dependence around monkey tissues (Guerrini 2003, p. 122; Piper 2018). As the virus typing project came to an end in the early 1950s, Salk contributed to the shift. Salk recognized the complexity of obtaining large quantities of the human foreskin and embryonic tissue used by Enders. At the time, and with limited regulatory oversight, researchers haphazardly procured such human tissues through their connections to physicians who performed circumcisions, therapeutic abortions, and other surgical procedures (Benison 1967, p. 447; Landecker 2007, pp. 124–125). In contrast, Salk advocated utilizing monkeys as a “more reliably constant source of tissue than human material” (Youngner et al. 1952, p. 291). Salk’s team began propagating the virus in cultures of rhesus monkey testes and then found they could do so even more efficiently in monkey kidneys, which could yield over two hundred cell culture tubes per monkey (Smith 1990, p. 130; Oshinsky 2005, p. 154). Liza Piper has consequently argued that the rise of tissue culture in polio research “simply marked a shift from dealing with whole monkeys to monkey parts” (2018, p. 60). While tissue culture techniques had expanded the living forms that researchers could work with, the drive to maximize virus production in cell culture ultimately served to increase demand for rhesus monkeys.

Scientific demand increased further still as Salk began to develop a vaccine using poliovirus grown in monkey kidney tissue. In late 1951, Salk demonstrated the effectiveness of his killed-virus vaccine in immunizing monkeys. With the support of Foundation leaders, he began secret vaccination trials at the D. T. Watson Home for Crippled Children and the Polk State School in Pennsylvania (Jacobs 2015, pp. 101–111). John Rodman Paul later described “the kind of patients Salk used” in these preliminary trials as “a minimal risk” (1971, p. 417). Paul’s statement reveals the hierarchies of animality and ability at play in trialing the vaccine.⁶³ The transition from experiments with imported nonhuman primates to trials with “normal” American children was conceptually bridged via the testing of institutionalized, disabled humans deemed non-normal. Indeed, the results from Salk’s trials with these children led the NFIP to start planning a large-scale field trial that would involve just under two million Americans (Paul 1971, pp. 426–430; Oshinsky 2005, pp. 166–167).

Planning for the field trial in turn required planning for more monkeys from India. Monkey kidney tissue was necessary for cultivating the large quantities of virus that would be inactivated to produce the vaccine. The NFIP’s H. M. Weaver enlisted the University of Toronto’s Connaught Laboratories in this project of virus cultivation.⁶⁴ As production scaled up, the facility began receiving shipments of several hundred monkeys a week (Rutty 1995, pp. 302–326; Piper 2018, p. 62). But monkeys were

⁶³ See Ahuja’s compelling framing of the role of carceral “dispensing” of risk in vaccine development (2016, p. 108). See also Oshinsky’s discussion of how Salk’s secret trials were ethically and legally justified by the NFIP and how Sabin justified the use of prisoners in testing his own vaccine (2005, pp. 157, p. 245). See also Smith (1990, pp. 135–144).

⁶⁴ Connaught Laboratories had previously developed Medium 199, the synthetic medium for tissue culture used by Salk in formulating the vaccine. See Rutty (1995); Piper (2018).

not just considered necessary to prepare vaccine for the field trial. Cultures of monkey kidney were also required by the laboratories involved in evaluating children's sera for antibody response to the vaccine (Brown and Henderson 1983, p. 417). To this end, Salk's team had improved on earlier methods by developing a "color test" wherein changes in color resulting from the addition of phenol red to monkey kidney cell culture could be used to assess the presence of virus (Francis 1957, p. 116; Jacobs 2015, pp. 102–103).

It was in the context of these anticipated uses of monkey tissue that the history of the NFIP's anxious negotiation of the rhesus monkey trade intersected with the history of the HeLa cell line. Jerome Syverton, in fact, presented research on growing poliovirus in HeLa cell cultures at the same 1953 NFIP meeting where Salk presented results from his secret vaccine trials (Jacobs 2015, p. 111). Two years earlier, as is now well known, Syverton's collaborator George Gey had derived the cell line utilizing cervical tissue taken from Henrietta Lacks. Lacks had come to a segregated ward of Johns Hopkins University Hospital seeking treatment for what proved to be fatal cervical cancer, and a sample of the biopsy material taken to diagnose her cancer was provided to Gey's tissue culture laboratory without her knowledge (Landecker 2007; Wald 2012). Conditioned by the structural racism of an American medical system in which postprocedural use of patients' tissue was unregulated, Gey's access to the biopsy material implicated the "long and troubled history of human experimentation" (Landecker 2000, p. 69).

After Gey found that cells from the sample divided continuously in culture, he quickly considered the implications of the cell line – soon named HeLa – for polio research. With Syverton and William Scherer, Gey began cultivating poliovirus in test tubes of HeLa cells. The scientists understood that use of the replicating, "immortal" cell line could reshape the living materials required by polio researchers (Landecker 2007, pp. 128–135). They well recognized that utilizing such a cell line in virus cultivation could eliminate the need to acquire human embryonic tissues or to harvest monkey tissues for the creation of primary cell cultures. They explained the benefits of this replacement via an oblique reference to the monkey trade. Utilizing a strain like HeLa that "can be maintained in perpetuity," they argued, could eliminate "the cost of a large monkey colony" (Scherer et al. 1953, p. 707).

At the 1953 NFIP meeting, Scherer, Syverton, and Gey's success propagating poliovirus in HeLa cell culture attracted interest. But their research also incited debate about the risks of producing a vaccine with virus that had been cultivated in cancer cells (Benison 1967, p. 489). The debate about HeLa cell cultures was, however, overshadowed by Salk's presentation and the ensuing deliberations over the field trial of his monkey-tissue-based vaccine (Jacobs 2015, p. 111). While some scientists also expressed concern about using monkey tissue as the basis of a vaccine, NFIP officials ultimately considered the potential of Salk's formulation to outweigh the risks and they went ahead with planning the field trial (Benison 1967, pp. 496–498).

The research with HeLa cells was nevertheless redeployed in evaluating the Salk field trial and soon hailed for reducing researchers' reliance on monkeys. As has been well recounted, the NFIP funded a project at the Tuskegee Institute to produce HeLa cell cultures for the laboratories conducting serological assessments of the

trial. The selection of Tuskegee – where the US Public Health Service was concurrently conducting the infamous Tuskegee Syphilis Study – drew on the institution's history of running an NFIP-sponsored polio treatment center for Black patients in the context of medical segregation and de-emphasis on Black susceptibility to the disease (Rogers 2007). Over the course of 1953, Syverton and Scherer collaborated with Tuskegee scientists Russell Brown and James Henderson to work towards the production of ten thousand cultures per week (Chandler and Powell 2018, p. 109). As Landecker notes, the scientists relied on paid blood donors from the Institute and surrounding area to obtain the blood serum necessary for the medium in which they grew the cells (2007, p. 136). Their work producing HeLa cell cultures would be commended as an example of “racial cooperation” in a moment when addressing racial discrimination had become a Cold War issue for the US government (Rogers 2007, pp. 791–793).

As the field trial launched, the production project also drew public attention to the origins of the cell line in ways that were decontextualized from the institutional medical racism that had conditioned its possibility. At the time, Gey's efforts not to disclose information about Lacks contributed to circulating origin stories that framed the cells as the sacrificial offering of a racially unmarked white woman to the cause of science (Landecker 2000, p. 58; Harvey 2016, pp. 5–6). In the following decade – as Sandra Harvey, Priscilla Wald, and Hannah Landecker have analyzed – the narrative would shift again. In 1966, concerns about the contamination of other cell lines would merge with the racial identification of Lacks and shape racist and sexist personifications of HeLa as a hypersexualized Black woman (Landecker 2000; Wald 2012; Harvey 2016). At the time of the polio vaccine trial, in contrast, media coverage anthropomorphically celebrated HeLa as an “angelic,” implicitly white Baltimore housewife (Landecker 2000, p. 64).⁶⁵

The racialization of the cell line as white flowed into narratives of the field trial that presented HeLa as “universal human cells” marking the progress of the war on polio – often via reference to research on monkeys (Landecker 2000, p. 58). As the trial commenced, a physician correspondent for the *New York Herald Tribune* rehearsed this story of the cell line and lauded the NFIP's production project for eliminating the “expensive and very time-consuming” testing on monkeys that was necessary in “the old days.” The physician proceeded to wonder “how interested the woman in Baltimore would have been if ... she could have known that her cancer cells were going to contribute so enormously” (Alvarez 1955). The *Minneapolis Sunday Tribune* feature (cited in the introduction) – which in contrast offered no origin story – similarly presented the new test as an advance over the earlier assessment methods that used monkeys.⁶⁶ The “new method of testing for polio,” the author explained, “is taking the place of the monkey method in laboratories throughout the world” (*Minneapolis Sunday Tribune* 1954, p. 14). Neglecting to mention the

⁶⁵ As Keith Wailoo (2010, p. 87) points out, this narrative contributed to framings of cancer as a white disease.

⁶⁶ The article notably did not contrast the use of HeLa cell culture with the use of primary monkey kidney cell culture, as in Salk's “color test.”

continued use of monkeys in vaccine production, the author framed the use of the cell line in vaccine evaluation as an additional triumph over the monkey era.⁶⁷ The production of HeLa cells for the field trial exemplified the technoscientific possibility of a world in which researchers could now substitute “a flask for a monkey.”

But while newspapers publicly narrated the replacement of monkeys with HeLa cells as evidence of the steady advance of polio science, the scientists involved saw the substitution as a much more contingent response to uncertainty about the monkey supply. Tuskegee Institute scientists Russell Brown and James Henderson later gestured at how a sense of anxiety led to the project. Their published account mentions that most laboratories planned to use cultures of monkey tissue in the field trial evaluation. NFIP leaders O'Connor and Weaver only approached Tuskegee about HeLa after “the required supply of Rhesus monkeys became doubtful and a host-cell alternative became necessary.” In Brown and Henderson’s account, the NFIP’s decision to fund the production of HeLa cells “as an alternative” was fueled by doubts about the availability of rhesus monkeys (1983, p. 417).⁶⁸

As in previous years, nevertheless, the NFIP’s doubts about the monkey supply did not materialize. NFIP communications with the State Department over this period provide a window into the interpretive disjuncture that shaped the production of HeLa cells as an alternative. In the spring of 1954, an NFIP representative had written that recent media coverage had made “the situation in India ... so delicate that it would be catastrophic to attempt to interfere or to make overtures to the Government of India.” Yet when the American Consul General made enquiries with Trefflich’s agent in Calcutta, he found that there seemed to be “no reason” for concern.⁶⁹ The Assistant Attaché at Delhi followed up by interviewing Indian officials at the Finance Ministry and reported back similarly that “there was no indication that they considered the subject a ‘delicate’ one,” notwithstanding “the obvious religious considerations.”⁷⁰ Rehearsing the history of export negotiations, State Department officials concluded that the NFIP’s alarm about exporting monkeys from India was misplaced.

In reflecting on the production of HeLa cells for the field trial, Brown and Henderson also suggested that the NFIP’s alarm had been misplaced. “When the Salk vaccine evaluation was started,” they noted, “the shortage of Rhesus monkeys was not as acute as had been anticipated” (1983, p. 431). In fact, only six of the twenty-seven laboratories participating in the evaluation regularly utilized HeLa cell cultures. The other laboratories managed to acquire sufficient monkey cell culture to perform the color test developed by Salk’s team (Francis 1957, pp. 116–117).

⁶⁷ This narrative would resurface when a University of Louisville laboratory developed a version of Salk’s color test for the HeLa cell line in 1955 (Francis 1957, p. 119). While the Louisville laboratory was the only one to use it, the test received considerable news coverage for obviating the need for a supply of monkeys in vaccine assessment. See *New York Herald Tribune* (1955a).

⁶⁸ Much of the secondary literature on HeLa cell production for polio vaccine evaluation draws on Brown and Henderson’s important account; in this essay, I have attempted to place their account of a “doubtful” monkey supply in a longer genealogy.

⁶⁹ Calcutta to State, Despatch 612, June 16, 1954, box 1857, 411.915/6–1654, 1950–54 Central Decimal File, RG 59. US NARA.

⁷⁰ New Delhi to State, Despatch 1980, June 22, 1954, box 1857, 411.915/6–2254, 1950–54 Central Decimal File, RG 59. US NARA.

The comparatively limited actual use of the cell line in vaccine evaluation underscores how the NFIP's HeLa cell culture production project was configured by long-standing anxiety about the geopolitics of the monkey supply. Marked by NFIP officials' paternalistic understandings of Indians, such anxiety was often indefinite in cause. Indeed, despite expressing alarm to the State Department, the NFIP began importing more monkeys from India than ever before. One estimate puts the number of rhesus monkeys imported for polio research between 1954 and 1960 at 1.5 million (Hartley 1972, p. 482).

Conclusion: A Cellular Harvest?

The lack of a rhesus monkey shortage during the 1954 field trial did not quell NFIP officials' anxieties over the following years. To the contrary, just before the positive results of the Salk trial were announced in 1955, reports of the deaths of several hundred monkeys in transit led the Government of India to announce a temporary ban on all exports. The ensuing diplomatic quest by pharmaceutical manufacturers, US government offices, and the NFIP to have the ban lifted resulted in an agreement requiring the authorization of future exports through "certificates of need." The changed regulatory environment again heightened American uncertainty about the future of the rhesus monkey trade and would shape the tenor of diplomatic negotiations until the Government of India permanently banned export in 1978 (*New York Herald Tribune* 1955b; Wade 1978; Haraway 1989, pp. 258–260).

The uncertainty also reenergized the quest for an alternative cell line with which to make the now-approved Salk vaccine.⁷¹ NFIP reports from the mid-1950s parlayed the promise of HeLa cells into a search for a non-cancerous "strain of human or animal cell which can be made to multiply indefinitely in the laboratory" that could replace "shipments of monkeys to the United States from abroad" (NFIP 1955, p. 50).⁷² The "annual importation of thousands of rhesus monkeys from India," proclaimed another, would be unnecessary if scientists found "a kind of cell that can be grown in the laboratory and harvested over and over again as one might harvest wheat" (NFIP 1957, p. 27).⁷³ This agrarian vision of cell production for virus cultivation was, to be sure, premature; American polio vaccine manufacture continued to

⁷¹ Animal welfare advocates subsequently also pointed to the possibility of an alternative strain to critique ongoing use of nonhuman primates in research (LeCornu and Rowan 1978, p. 241).

⁷² Exemplifying this optimism, for a brief moment in 1955 – in the midst of the uncertainty surrounding the Government of India's export ban – there was a flurry of news reports about the potential replacement of monkey exports from India with human placental tissues following researchers' success cultivating poliovirus in amnion cells. University of California researchers emphasized the availability of such tissue from "the many deliveries in clinics and hospitals." See Zitcer, Fogh, and Dunnebacke (1955, p. 30); Associated Press (1955).

⁷³ See also Landecker's reading of Jane Smith's use of metaphors of agricultural industrialization (Landecker 2007, p. 130).

require rhesus monkeys into the 1960s.⁷⁴ However, the agricultural imagery of cellular bounty encapsulated the NFIP's persistent hope that tissue culture would somehow usher in a self-reliant future for polio science – a future no longer dependent on the transnational market in experimental monkeys.

In examining how the NFIP sought to negotiate polio researchers' dependence on monkeys from India, this essay has situated the history of tissue culture within a transnational history of geopolitical upheaval.⁷⁵ “Events in world history and commerce,” Angela Creager and Hannah Landecker have noted, “alter the range of possibilities for the manipulation and investigation of matter” (2009, pp. 701–702). To NFIP officials between the 1930s and 1950s, “world conditions” were a cause for concern about the range of possible organisms available for polio research (NFIP 1941, p. 21). An orientalist understanding of Indian difference fed their growing alarm about those possibilities over the colonial to postcolonial transition. Their anxious efforts to procure monkeys for American scientists during this period consolidated global hierarchies of race and welfare. Further underscoring the resilience of these hierarchies, India was only “certified polio-free” in 2014 (Addlakha 2000; Park 2014; Abraham 2018).

Yet, as I have shown, midcentury American efforts to secure rhesus monkeys simultaneously incentivized a search for alternative living organisms and materials for the “job” of poliovirus research. From the NFIP's early days, the promise of tissue culture for polio science was thus not simply a matter of cost or speed. It was also the promise of extricating American scientific practice from a web of transactions that spanned a world of shifting sovereignties and alignments. However, while expanding experimental possibilities, the advent of tissue culture techniques ultimately increased polio researchers' reliance on rhesus monkeys. In the process, tissue culture techniques transmuted the NFIP's anxieties about importing monkeys from India into decision-making about the use of different human and nonhuman cells in vaccine production and evaluation. It was in this context that the HeLa cell line became a celebrated technoscientific substitute for monkey kidney cells in vaccine evaluation – a substitute that was heralded as the achievement of a presumptively white scientific modernity. As its narrativization shifted dramatically over subsequent decades, the HeLa cell line would raise important, unresolved questions about the ethical use of human biomaterials amid the persistence of racialized health inequities and exploitation (Wald 2012; Harvey 2016).

Considering how the NFIP's anxieties about the monkey supply led to the production of HeLa cells for the 1954 polio vaccine field trial foregrounds the role of geopolitics in shaping material scientific practice. Tracing the relationship between South Asian monkey export and HeLa cell production shows, to this end, how

⁷⁴ For a discussion of the emergence of anxieties about Simian Virus 40 in the polio vaccine, research on federal prisoners, and questions of medical ethics, see Stark and Campbell (2014). On the continued use and conditioning of rhesus monkeys as the “right” organism for polio vaccine manufacture in the 1960s Norwegian context, see Druglitrø (2016).

⁷⁵ In this, I am influenced by reading Landecker's work alongside Wald's insightful reading of the period as a moment “when scientific research and geopolitical transformation underscore[d] the fundamental instability of the concept of ‘human being’” (Wald 2012, p. 249).

racialized geopolitical anxieties about securing rhesus monkeys over the end of colonial rule conditioned the longer trajectory of tissue culture in polio research. At the same time, it re-emphasizes how the advent of tissue culture techniques generated new biomedical economies that capitalized on the institutional racism of American health care. The entanglement between simians and cell lines, in other words, is a story of how divergent extractive economies sustained a technical transformation in biomedical science.

Archival Collections

National Archives of India (NAI), New Delhi

Home Department

US National Archives and Records Administration (US NARA), College Park, Maryland

Department of State Central Files (RG 59)

Records of Foreign Service Posts of the Department of State (RG 84)

Albert B. Sabin Archives, Digital Resource Commons, University of Cincinnati, Cincinnati, Ohio, <https://digital.libraries.uc.edu/collections/sabin/>

Franklin Delano Roosevelt Presidential Library (FDR Library) President's Birthday Ball Commission for Infantile Paralysis Research Records

Thomas Francis Papers, Bentley Historical Archive, University of Michigan, Ann Arbor, Michigan.

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References

- Abraham, Thomas. 2018. *Polio: The Odyssey of Eradication*. Chennai: Westland Publications Private Ltd.
- Adcock, Cassie. 2010. Sacred Cows and Secular History: Cow Protection Debates in Colonial North India. *Comparative Studies of South Asia, Africa and the Middle East* 30 (2): 297–311.
- Addlakha, Renu. 2000. Global-Local Dialectic in Medico-Administrative Practice: Case Study of Poliomyelitis. *Economic and Political Weekly* 35 (8): 676–683.
- Ahuja, Neel. 2013a. Macaques and Biomedicine: Notes on Decolonization, Polio, and Changing Representations of Indian Rhesus in the United States, 1930–1960. In *The Macaque Connection: Cooperation and Conflict Between Humans and Macaques*, eds. Sindhu Radhakrishna, Michael Huffman, and Anindya Sinha, 71–91. New York: Springer.
- Ahuja, Neel. 2013b. Notes on Medicine, Culture, and the History of Imported Monkeys in Puerto Rico. In *Centering Animals in Latin American History*, eds. Martha Few and Zeb Tortorici, 180–206. Durham, NC: Duke University Press.
- Ahuja, Neel. 2016. *Bioinsecurities: Disease Interventions, Empire, and the Government of Species*. Durham, NC: Duke University Press.
- Alvarez, Walter. 1955. Cultured Cancer Cells Speed Polio Research. *New York Herald Tribune*, ProQuest Historical Newspapers: New York Tribune/Herald Tribune (February 7): 10.
- Associated Press. 1955. New Polio Virus Discovery Uses Human Instead of Monkey Tissue. *New York Times*, ProQuest Historical Newspapers: The New York Times (July 1): 1.
- Balachandran, Gopalan. 2012. *Globalizing Labour? Indian Seafarers and World Shipping, c. 1870–1945*. Oxford and New Delhi: Oxford University Press.
- Bayly, Christopher Alan, and Timothy Norman Harper. 2007. *Forgotten Wars: Freedom and Revolution in Southeast Asia*. Cambridge, MA: Harvard University Press.
- Beattie, James. 2011. *Empire and Environmental Anxiety: Health, Science, Art and Conservation in South Asia and Australasia, 1800–1920*. London: Palgrave Macmillan.
- Benison, Saul. 1967. *Tom Rivers: Reflections on a Life in Medicine and Science*. Cambridge, MA: MIT Press.
- Benison, Saul. 1972. The History of Polio Research in the United States: Appraisal and Lessons. In *The Twentieth Century Sciences: Studies in the Biography of Ideas*, ed. Gerald Holton, 308–343. New York: Norton.
- Benison, Saul. 1974. Poliomyelitis and the Rockefeller Institute: Social Effects and Institutional Response. *Journal of the History of Medicine*. 29 (1): 74–92.
- Benison, Saul. 1982. International Medical Cooperation: Dr. Albert Sabin, Live Poliovirus Vaccine and the Soviets. *Bulletin of the History of Medicine* 56 (4): 460–483.
- Bertram, Jonas. 1935. Young Doctor's Research is Acclaimed by Science. *The American Israelite*, ProQuest Historical Newspapers: The American Israelite (October 10): 8.
- Brown, Russell, and James Henderson. 1983. The Mass Production and Distribution of HeLa Cells at Tuskegee Institute, 1953–55. *Journal of the History of Medicine and Allied Sciences* 38 (4): 415–431.
- Carter, Richard. 1965. *Breakthrough: The Saga of Jonas Salk*. New York: Trident Press.
- Chakrabarti, Pratik. 2010. Beasts of Burden: Animals and Laboratory Research in Colonial India. *History of Science* 48 (2): 125–151.
- Chandler, Dana, and Edith Powell. 2018. *To Raise Up the Man Farthest down: Tuskegee University's Advancements in Human Health, 1881–1987*. Tuscaloosa: University of Alabama Press.
- Clarke, Adele, and Joan Fujimura. 1992. *The Right Tools for the Job: At Work in the Twentieth-Century Life Sciences*. NJ Princeton University Press: Princeton.
- Conway, William. 1965. Conference Reports: The Availability and Long Term Supply of Primates for Medical Research. *Laboratory Primate Newsletter*. 4 (4): 1–8.
- Creager, Angela. 2002. *The Life of a Virus: Tobacco Mosaic Virus as an Experimental Model, 1930–1965*. Chicago, IL: University of Chicago Press.
- Creager, Angela, and Hannah Landecker. 2009. Technical Matters: Method, Knowledge and Infrastructure in Twentieth-Century Life Science. *Nature Methods* 6 (10): 701–705.
- Daily Boston Globe*. 1935. 448 Monkeys Arrive for Use in Serum Experiments. ProQuest Historical Newspapers: The Boston Globe (August 24): 3.

- De Kruif, Paul. 1935. Polio Must Go! Victory in the Long Fight Against the Midget Microbe Dealer of Worse than Death Seems Ever Nearer." *Ladies' Home Journal*, ProQuest: Women's Magazine Archive, July 52 (7): 22, 84–89.
- Druglitrø, Tone. 2016. Care and Tinkering in the Animal House. In *Animal Housing and Human Animal Relations: Politics, Practices and Infrastructures*, eds. Kristian Bjørkdahl and Tone Druglitrø, 151–166. London: Routledge.
- De Kruif, Paul. 1962. *The Sweeping Wind: A Memoir*. New York: Harcourt, Brace & World.
- Deb Roy, Rohan. 2019. White Ants, Empire, and Entomo-politics in South Asia. *The Historical Journal*. 63 (2): 411–436.
- Francis, Thomas, Jr. 1957. *Evaluation of the 1954 Field Trial of Poliomyelitis Vaccine: Final Report*. Ann Arbor: University of Michigan, Poliomyelitis Vaccine Evaluation Center.
- Gilmartin, David. 2015. The Historiography of India's Partition: Between Civilization and Modernity. *The Journal of Asian Studies* 74 (1): 23–41.
- Govindrajana, Radhika. 2018. *Animal Intimacies: Interspecies Relatedness in India's Central Himalayas*. Chicago, IL: University of Chicago Press.
- Grimshaw, Margaret L. 1996. The Poliovirus Controversy in the Years before World War II: Shaping America's Medical Science Approach to Human Disease. PhD Dissertation, University of California Los Angeles.
- Guerrini, Anita. 2003. *Experimenting with Humans and Animals: From Galen to Animal Rights*. Baltimore, MD: Johns Hopkins University Press.
- Guha, Ranajit. 1997. Not at Home in Empire. *Critical Inquiry* 23 (3): 482–493.
- Halpern, Sydney. 2004. *Lesser Harms: The Morality of Risk in Medical Research*. Chicago, IL: University of Chicago Press.
- Hanson, Elizabeth. 2002. *Animal Attractions: Nature on Display in American Zoos*. Princeton, NJ: Princeton University Press.
- Hanson, Elizabeth. 2004. How Rhesus Monkeys Became Laboratory Animals. In *Centennial History of the Carnegie Institution of Washington, Vol. 5: The Department of Embryology*, eds. Jane Maienschein, Marie Glitz, and Garland E. Washington, 63–81. Cambridge: Cambridge University Press.
- Haraway, Donna. 1989. *Primate Visions: Gender, Race, and Nature in the World of Modern Science*. New York: Routledge.
- Hartley, E. G. 1972. The Use of Primates in Research and its Effect on Conservation. *British Veterinary Journal* 128 (10): 481–487.
- Harvey, Sandra. 2016. The HeLa Bomb and the Science of Unveiling. *Catalyst: Feminism, Theory, Technoscience* 2 (2): 1–30.
- Holloway, Karla. 2011. *Private Bodies, Public Texts: Race, Gender, and a Cultural Bioethics*. Durham, NC: Duke University Press.
- Horstmann, Dorothy. 1985. The Poliomyelitis Story: A Scientific Hegira. *The Yale Journal of Biology and Medicine* 58 (2): 79–90.
- Jackson, Zakiyyah Iman. 2020. *Becoming Human: Matter and Meaning in an Antiracist World*. New York: NYU Press.
- Jacobs, Charlotte DeCros. 2015. *Jonas Salk: A Life*. New York: Oxford University Press.
- Kaempffert, Waldemar. 1935. This Week in Science: Fighting Infantile Paralysis: Two New Vaccines Produced – Waterspout Lore – Aluminum Hats for the Tropics. *New York Times*, ProQuest Historical Newspapers: The New York Times (September 1): XX5.
- Kerkmann, Otto. 1954. Operation of the Monkey Colony at Okatie Farms. In *Proceedings of the Animal Care Panel: Fifth Annual Meeting, December 1–2, 1954*, ed. N.R. Brewer, 22–26. Lemont, IL: Animal Care Panel.
- Khan, Yasmin. 2015. *India at War: The Subcontinent and the Second World War*. New York: Oxford University Press.
- Kohler, Robert. 2002. *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology*. Chicago, IL: University of Chicago Press.
- Landecker, Hannah. 1999. Between Beneficence and Chattel: The Human Biological in Law and Science. *Science in Context* 12 (1): 203–225.
- Landecker, Hannah. 2000. Immortality, in Vitro: A History of the HeLa Cell Line. In *Biotechnology and Culture: Bodies, Anxieties, Ethics*, ed. Paul Brodwin, 53–72. Bloomington, IN: Indiana University Press.
- Landecker, Hannah. 2007. *Culturing Life: How Cells Became Technologies*. Cambridge, MA: Harvard University Press.

- Landsteiner, Karl, and Erwin Popper. 1909. Übertragung der Poliomyelitis Acuta auf Affen. *Zeitschrift für Immunitätsforschung und Experimentelle Therapie* 2: 377–390.
- LeCornu, Ann, and A.N. Rowan. 1978. Trends in the Use of Nonhuman Primates in Biomedical Programmes. *Laboratory Animals* 12 (4): 235–242.
- Lederer, Susan. 1997. *Subjected to Science: Human Experimentation in America Before the Second World War*. Baltimore, MD: Johns Hopkins University.
- Lederman, Muriel, and Richard Burian. 1993. Special Section: The Right Organism for the Job. *Journal of the History of Biology* 26(2): 233–367.
- Los Angeles Times. 1928. Trapper Lands Cargo of Beasts in New England. ProQuest Historical Newspapers (July 1): 12.
- Löwy, Ilana. 1992. From Guinea Pigs to Man: The Development of Haffkine's Anticholera Vaccine. *Journal of the History of Medicine and Allied Sciences* 47(3): 270–309.
- Lutgendorf, Philip. 2007. *Hanuman's Tale: The Messages of a Divine Monkey*. New York: Oxford University Press.
- M'charek, Amade. 2014. Race, Time and Folded Objects: The HeLa Error. *Theory, Culture & Society* 31(6): 29–56.
- Minneapolis Sunday Tribune. 1954. In Polio Tests at 'U,' Human Cancer Cells Now SPARE THE MONKEY. ProQuest Historical Newspapers: Minneapolis Star Tribune (January 17): 14.
- Muldoon, Andrew. 2009. *Empire, Politics and the Creation of the 1935 India Act: Last Act of the Raj*. Burlington, VT: Ashgate.
- Murphy, Michelle. 2012. *Seizing the Means of Reproduction: Entanglements of Feminism, Health, and Technoscience*. Durham, NC: Duke University Press.
- National Foundation for Infantile Paralysis (NFIP). 1941. *Fourth Annual Report*. New York: NFIP.
- National Foundation for Infantile Paralysis (NFIP). 1943. *Sixth Annual Report*. New York: NFIP.
- National Foundation for Infantile Paralysis (NFIP). 1951. *Fourteenth Annual Report*. New York: NFIP.
- National Foundation for Infantile Paralysis (NFIP). 1953. *Sixteenth Annual Report*. New York: NFIP.
- National Foundation for Infantile Paralysis (NFIP). 1954. *Seventeenth Annual Report*. New York: NFIP.
- National Foundation for Infantile Paralysis (NFIP). 1955. *Annual Report 1955*. New York: NFIP.
- National Foundation for Infantile Paralysis (NFIP). 1957. *Annual Report 1957*. New York: NFIP.
- New York Herald Tribune. 1935a. Monkeys Here to Aid War on Poliomyelitis: 400 Arrive to Be Injected with Dr. Brodie's Anti-Infantile Paralysis Serum. ProQuest Historical Newspapers: New York Tribune/ Herald Tribune (August 25): 12.
- New York Herald Tribune. 1935b. Monkey Turns Fulton St into a Pesky Jungle. ProQuest Historical Newspapers: New York Tribune/Herald Tribune (July 23): 17.
- New York Herald Tribune. 1935c. City Must Have Monkeys, Stray Cargo Reveals. ProQuest Historical Newspapers: New York Tribune/Herald Tribune (November 30): 17.
- New York Herald Tribune. 1955a. Faster Test is Devised to Check Polio Immunity. ProQuest Historical Newspapers: New York Tribune/Herald Tribune (February 20): 13.
- New York Herald Tribune. 1955b. 3 From U.S. in India to Seek End of Monkey-Export Ban. ProQuest Historical Newspapers: New York Tribune/ Herald Tribune (April 5): 19.
- Obadare, Ebenezer. 2005. A Crisis of Trust: History, Politics, Religion and the Polio Controversy in Northern Nigeria. *Patterns of Prejudice* 39 (3): 265–284.
- Oshinsky, David M. 2005. *Polio: An American Story*. New York: Oxford University Press.
- Park, Madison. 2014. Global Health Success: India Certified Free of Polio. *CNN*. March 27. <http://edition.cnn.com/2014/03/27/health/india-polio-3-years/>
- Paul, J.R., and J.D. Trask. 1932. The Detection of Poliomyelitis Virus in So Called Abortive Types of the Disease. *The Journal of Experimental Medicine* 56 (3): 319–343.
- Paul, J.R., J.D. Trask, and L.T. Webster. 1935. Isolation of Poliomyelitis Virus from the Nasopharynx. *The Journal of Experimental Medicine* 62 (2): 245–257.
- Paul, John Rodman. 1952. Current Knowledge and Trends in Poliomyelitis. *The Merck Report* 61: 2–8.
- Paul, John Rodman. 1971. *A History of Poliomyelitis*. New Haven, CT: Yale University Press.
- Peckham, Robert (ed.). 2015. *Empires of Panic: Epidemics and Colonial Anxieties*. Hong Kong: Hong Kong University Press.
- Piper, Liza. 2018. Chapter 6: Domesticating Poliovirus: Laboratory Monkeys and Vaccine Production. In *Landscapes of Science, Toronto, Network in Canadian History and Environment*, ed. Tina Adcock, 55–67. Toronto: Network in Canadian History and Environment.
- Prakash, Gyan. 1999. *Another Reason: Science and the Imagination of Modern India*. Princeton, NJ: Princeton University Press.

- Radhakrishna, Meena. 2006. Of Apes and Ancestors: Evolutionary Science and Colonial Ethnography. *Indian Historical Review* 33(1): 1–23.
- Raghavan, Srinath. 2018. *Fierce Enigmas: A History of the United States in South Asia*. New York: Basic Books.
- Rogers, Naomi. 1992. *Dirt and Disease: Polio before FDR*. New Brunswick, NJ: Rutgers University Press.
- Rogers, Naomi. 2007. Race and the Politics of Polio: Warm Springs, Tuskegee, and the March of Dimes. *Public Health Then and Now: American Journal of Public Health*. 97 (5): 784–795.
- Rous, Peyton. 1947. “Karl Landsteiner, 1868–1943.” *Obituary Notices of Fellows of the Royal Society*. 5 (15): 295–324.
- Rutty, Christopher James. 1995. “Do Something!... Do Anything!” Poliomyelitis in Canada, 1927–1967. PhD Dissertation, University of Toronto.
- Sabin, Albert, and Peter Olitsky. 1936. Cultivation of Poliomyelitis Virus in vitro in Human Embryonic Nervous Tissue. *Proceedings of the Society for Experimental Biology and Medicine* 34(3): 357–359.
- Saha, Jonathan. 2015. Among the Beasts of Burma: Animals and the Politics of Colonial Sensibilities, c. 1840–1940. *Journal of Social History* 48 (4): 910–932.
- Salk, Jonas. 1952. Immunologic Classification of the Poliomyelitis Virus. In *Poliomyelitis: Papers and Discussions Presented at the Second International Poliomyelitis Conference*, ed. International Poliomyelitis Conference, 188–193. Montreal: JB Lippincott Company.
- Salk, Jonas E., J. S. Youngner, L. James Lewis, and Byron Bennett. 1951. Immunologic Classification of Poliomyelitis Viruses: IV. Results of Typing By Neutralization of Prototype Viruses with Antiserum Produced by Vaccinating Monkeys with Unknown Strain and an Adjuvant. *American Journal of Epidemiology* 54 (2): 255–267.
- Scherer, William F., Jerome T. Syverton, and George O. Gey. 1953. Studies on the Propagation in Vitro of Poliomyelitis Viruses: IV. Viral Multiplication in a Stable Strain of Human Malignant Epithelial Cells (Strain HeLa) Derived from an Epidermoid Carcinoma of the Cervix. *Journal of Experimental Medicine* 97 (5): 695–708.
- Schiebinger, Londa. 1993. *Nature's Body: Gender in the Making of Modern Science*. Boston, MA: Beacon Press.
- Sivasundaram, Sujit. 2015. Imperial Transgressions: The Animal and Human in the Idea of Race. *Comparative Studies of South Asia, Africa and the Middle East* 35 (1): 156–172.
- Slate, Nico. 2019. *Lord Cornwallis is Dead: The Struggle for Democracy in the United States and India*. Cambridge, MA: Harvard University Press.
- Skloot, Rebecca. 2010. *The Immortal Life of Henrietta Lacks*. New York: Crown Publishers.
- Smith, Jane S. 1990. *Patenting the Sun: Polio and the Salk Vaccine*. New York: W. Morrow.
- Star, Susan Leigh, and James R. Griesemer. 1989. Institutional Ecology, “Translations” and Boundary Objects: Amateurs and Professionals in Berkeley’s Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*. 19(3): 387–420.
- Stark, Laura, and Nancy D. Campbell. 2014. Stowaways in the History of Science: The Case of Simian Virus 40 and Clinical Research on Federal Prisoners at the US National Institutes of Health, 1960. *Studies in History and Philosophy of Science, Part C: Studies in History and Philosophy of Biological and Biomedical Sciences*. 48(Part B): 218–230.
- Subramaniam, Banu. 2019. *Holy Science: The Biopolitics of Hindu Nationalism*. Seattle, WA: University of Washington Press.
- Toronto Daily Star. 1935. “I’m King of the Monkeys” Boasts Young New Yorker. ProQuest Historical Newspapers: Toronto Star. (August 23): 1, 5.
- Turner, Timothy. 2012. Development of the Polio Vaccine: A Historical Perspective of Tuskegee University’s Role in Mass Production and Distribution of HeLa Cells. *Journal of Health Care for the Poor and Underserved* 23 (4): 5–10.
- United States Bureau of Biological Survey. 1934. *Report of the Chief of the Bureau of Biological Survey*. Washington, DC: United States Government Printing Office.
- Vargha, Dóra. 2018. *Polio across the Iron Curtain: Hungary’s Cold War with an Epidemic*. Cambridge: Cambridge University Press.
- Wade, Nicholas. 1978. India Bans Monkey Export: U.S. May Have Breached Accord. *Science* 199 (4326): 280–281.
- Wailoo, Keith. 2010. *How Cancer Crossed The Color Line*. New York: Oxford University Press.

- Wald, Priscilla. 2012. Cells, Genes, and Stories: HeLa's Journey from Labs to Literature. In *Genetics and the Unsettled Past: The Collision of DNA, Race, and History*. eds. Keith. Wailoo, Alondra Nelson, and Catherine Lee. 247–265. New Brunswick, NJ: Rutgers University Press.
- Weaver, Harry M. 1953. Progress in Research on Poliomyelitis. *Public Health Reports* 68 (7): 669–677.
- Weheliye, Alexander. 2014. *Habeas Viscus: Racializing Assemblages, Biopolitics, and Black Feminist Theories of the Human*. Durham, NC: Duke University Press.
- Wilson, Emily K. 2012. Modeling Man: The Monkey Colony at the Carnegie Institution of Washington's Department of Embryology, 1925–1971. *Journal of the History of Biology* 45 (2): 213–251.
- Wilson, Daniel J. 2015. Basil O'Connor, the National Foundation for Infantile Paralysis and the Reorganization of Polio Research in the United States, 1935–41. *Journal of the History of Medicine and Allied Sciences* 70 (3): 394–424.
- Youngner, J. S., Elsie N. Ward, and Jonas E. Salk. 1952. Studies on Poliomyelitis Viruses in Cultures of Monkey Testicular Tissue. I. Propagation of Virus in Roller Tubes. *American Journal of Hygiene* 55 (2): 291–300.
- Zitcer, Elsa M., Jørgen Fogh, and Thelma H. Dunnebacke. 1955. Human Amnion Cells for Large-Scale Production of Polio Virus. *Science* 122 (3157): 30.

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