



Once Zeldovich moves into the present, her account begins to flourish. At the outset, she recounts her experiences assisting researchers to measure nitrogen accumulation around Cape Cod, from septic-tank leakage in the area. This has had devastating effects on surrounding marshlands, impacting on these delicate ecosystems and affecting everything from water quality to the breeding cycles of aquatic organisms. Through further encounters with researchers and entrepreneurs who are seeking variously to extend our ability to harness the power of waste and to profit commercially from such ventures, Zeldovich truly embraces her role as ethnographer and explorer. She marvels at the creativity and imagination on display, but equally uses these episodes to reflect on how humans can become better connected to this aspect of our biological reality, for the betterment of the global ecology. Touring diverse locations and experiences, from visiting an enormous sewage treatment plant in Washington, DC to testing out a 'biotoilet', Zeldovich documents her experiences as both participant and potential beneficiary.

The final section, ostensibly focused on the future potential of other innovations in the use of waste, also reflects back on the past. The maverick British surgeon William Arbuthnot Lane (1856–1943) and freewheeling Russian zoologist Ilya (Elie) Metchnikoff (1845–1916) make cameo appearances in Chapter 15, which focuses on the human bowel. Their presence reinforces Zeldovich's central argument about effluence, affirmed in her closing paragraph: 'let's not just sit there and watch this versatile, renewable power go to waste' (p. 241).

For historians of science, technology and medicine, there is much in *The Other Dark Matter* to commend. The contemporary case study chapters in particular offer a window into current practices and attitudes towards the management and impact of human waste, and its potential, though they do at times feel more rooted in the North American context than the earlier, more geographically adventurous chapters might lead the reader to expect. Setting aside the lack of connection to recent historical scholarship, Zeldovich provides a fascinating window into current attitudes towards waste and reflects on the wide-ranging meanings and practices associated with excreta. In doing so, she has written a book which picks up wider trends in present research: the porosity of the human body and its leakiness, the incomplete nature of transitions across explanatory frameworks of disease, and the rehabilitation of historic practices that might have transformative potential in the future.

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Neeraja Sankaran, *A Tale of Two Viruses: Parallels in the Research Trajectories of Tumor and Bacterial Viruses*

Pittsburgh: University of Pittsburgh Press, 2021. Pp. 312. ISBN: 978-0-8229-4630-4. \$55.00 (hardcover).

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What is a virus? This seemingly simple question, as historians and biologists alike know, is rife with controversy. Facets have been debated in scientific and philosophical journals nearly as often as at the pub or the dinner table. Are viruses alive? What relationships do they form with the living organisms they infect? These are murky, difficult and

challenging issues, as Sankaran captures in this ambitious and challenging work. Attempts to answer these questions, both through studies in individual pathogens and in the broader conceptual history of the virus, have been highly contingent on the cross-pollination of scientists and their methods. In keeping with the book's Dickensian theme, we might summarize its plot with reference to *A Tale of Two Cities*: 'A wonderful fact to reflect upon, that every [scientific approach] is constituted to be that profound secret and mystery to every other' (Borders Classics edn, 2006, p. 14).

A Tale of Two Viruses tells the story of two key viruses with alternate chapters focused on RSV research and bacteriophage research, drawing out the structure and progression of controversy around the biology and aetiology of the two viruses, both of which were subject to a high degree of uncertainty throughout the twentieth century, and, as Sankaran argues, 'represent the specific entities that scientists worked with, and over which they discussed and debated the broader issues of viral identity and definition' (p. 6). It follows the stories of a few key scientists who conducted research on these organisms between 1920 and 1960, tracing the evolution of different theories surrounding each pathogenic agent and the incremental experimental developments that bound each camp. In the case of the Rous sarcoma virus, key controversies surrounding the mechanisms of how malignancy was conferred were instigated when French bacteriologist Peyton Rous isolated a 'live causative agent' that allowed for the transmission of sarcoma between chickens. The bacteriophage, first discovered by Frederick Twort in 1915 and the function of which was described by Félix d'Hérelle in 1917, was the subject of controversy over the nature of the organism and its mechanisms for causing bacterial lysis. Although the two scientific communities remained fairly distinct and the scientific development of hypotheses around each did not overlap, Sankaran argues that the trajectory of these two viral tales challenged and created tension with existing scientific concepts. Both presented the possibility of "infective agents" of some extrinsic or exogenous origin, which caused their effects by entering, or infecting, the host cells, and somehow disrupting normal functions within' (p. 32). However, existing epistemic and technological frameworks made these claims tenuous at best, and for the following forty years allowed contested spaces to develop in which scientific actors used varied experimental methods to propose varied forms, functions and mechanisms for each agent. Eschewing teleological readings of these experiments, Sankaran embraces these controversies, delineating the stakes, claims, origins and groundings of each theory.

The first three chapters present the context of the twin scientific controversies. The first two tell the story of the discovery of each virus and delineate early hypotheses of their form and function, and why and how they presented specific problems for existing bacteriological epistemologies. The third chapter then presents the context of viral conception and discovery, bringing the reader through the history of the virus as a concept and outlining its epistemic boundaries preceding the discovery of RSV and the bacteriophage.

The following chapters alternate between the histories of these two microbes, first tracing the history of bacteriophages in the 1920s and 1930s and then moving to research on tumour viruses (and RSV in particular) which accelerated in the 1930s, and a broader contextual section on the history of virology, viral technologies and the virus. Finally, Sankaran brings these threads together in the final chapter to bear on the topic of bacterial lysis, the resolution of which (by novel technologies, focused on research on both bacteriophages and the RSV virus) settled major controversies in both research communities and expanded both the scope and the scale of viral research in the mid-twentieth century.

Sankaran draws on the specificities of these two cases, the theorization of which preoccupied a tight-knit set of bacteriologists in the first half of the twentieth century, to explicate the sticky and tenuous nature of laboratory research at a moment of scientific tumult. The organization of the text suggests to the reader that the disputed categories and disparate

theories were very much the story of how science operates in the space 'between'. At the beginning of the described period, the mechanisms of each virus (and, indeed, whether each could be considered a virus) were heavily disputed, and the dispute was fuelled by unreliability and inconsistencies in laboratory technologies that could capture and describe the mechanisms of infection presented by each virus. By the end, technological developments, including the electron microscope, the ultracentrifuge and advances in virus cultivation allowed for Antoine Lwoff's revolutionary 'prophage' theory of bacterial lysis to elucidate the mechanisms of both bacteriophages and RSV transmission.

Sankaran's work develops a number of well-established themes in the history of science, capturing well the thorny, plural and often contentious nature of research into the fundamental components of life and infection that characterized the development of microbiology and the life sciences in the twentieth century. Sankaran does not shy away from the complexity of knowledge making, and presents the stakes, structure and contexts that constitute scientific inquiry in a manner that reflects its nuances. The major difficulty with this book is not, as Sankaran describes, that it is an 'internalist' account of the history of science (described as an account focused on science in action, the scientists who conduct their research and their communications and decisions without a teleological focus on the eventual consensus), but rather that the organization of this 'inside' account is challenging to follow. Although Sankaran focuses on a few key scientists for each virus, the individual experiments, exchanges and intellectual lineages that define research in each area are discussed in such detail that it becomes easy to lose the thread. Much like science itself, it becomes difficult to discern which are the important actors and discoveries until the end, when the eventual consensus clarifies the important through-lines. Somewhat fittingly, a phylogeny of the two research communities and their discoveries to which the reader could refer between chapters and context shifts would go a long way towards mitigating this particular difficulty.

Overall, Sankaran's work is a challenging but useful contribution to the under-represented topic of history of virology, and a worthwhile read for historians of medicine and biology (particularly advanced graduate students or professionals) seeking to engage with the mechanics and evolution of microbiological research in the twentieth century. For readers willing to wade into the murky depths of scientific uncertainty with Sankaran as a guide, their efforts will be well rewarded.

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Eglė Rindzevičiūtė, *The Will to Predict: Orchestrating the Future through Science*

Ithaca, NY: Cornell University Press, 2023. Pp. 306. ISBN 978-1-5017-6977-1. \$56.95 (hardcover).

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Eglė Rindzevičiūtė's study focuses on prediction of the future as a form of power situated across two distinct, but intertwined, domains – governmentality and science. From the