

THE VIRUS IN THE RIVERS: HISTORIES AND ANTIBIOTIC AFTERLIVES OF  
THE BACTERIOPHAGE AT THE SANGAM IN ALLAHABAD

by

RIJUL KOCHHAR\*

*Massachusetts Institute of Technology, Doctoral Program in History, Anthropology,  
Science, Technology, and Society (HASTS), 77 Massachusetts Avenue, E51-163,  
Cambridge, MA 02139, USA*

The confluence (*sangam*) of India's two major rivers, the Ganges and the Yamuna, is located in the city of Allahabad. Ritualistic dips in these river waters are revered for their believed curative power against infections, and salvation from the karmic cycles of birth and rebirth. The sacred and geographic propensities of the rivers have mythic valences in Hinduism and other religious traditions. Yet the connection of these river waters with curativeness also has a base in historical microbiology: near here, the British bacteriologist Ernest Hanbury Hankin, in 1896, first described the 'bactericidal action of the waters of the Jamuna and Ganges rivers on Cholera microbes', predating the discovery of bacterial viruses (now known as bacteriophages) by at least two decades. Pursuing the record of these purificatory waters in sacred writings and folklore, and later elaboration in the work of Hankin, this paper traces an epistemology of time that connects the mythic to the post-Hankin modern scientific, asking how imaginations of the waters' antibacterial properties are articulated through idioms of faith, filth and the phage. The paper explores how the bacteriophage virus comes to be spoken about within secular and sacred epistemes of infection and riverine pollution, among contemporary historians, biologists and doctors, and in the city's museums. At the same time, it traces the phage in histories arcing from the ancient religious literature, to colonial disease control efforts, to today, where bacteriophages are being conceived as a potential response to the crisis of planetary antimicrobial resistance (AMR). Allahabad presents a 'cosmotronics' where faith, filth and phage are inextricably intertwined, generating complex triangulations between natural ecologies, cultural practices and scientific imaginations. Cosmotronics therefore opens up novel avenues to reimagine the phage as a protean object, one that occupies partial and multiple spaces in the historico-mytho-scientific arena of Allahabad today.

**Keywords:** Ernest Hanbury Hankin; *sangam* in Allahabad; bacteriophage discovery; cosmotronics; faith and pollution; antimicrobial resistance

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\*rijul@mit.edu

## BACTERIOPHAGES: TRACES IN TIME

*The miniscule, a narrow gate, opens up an entire world.*<sup>1</sup>

The Indian city of Allahabad is located at the confluence (*sangam*) of India's largest rivers, the Ganges and the Yamuna. At the *sangam*, ritualistic dips in the sacred river waters are revered by many for their believed curative power against sin and infections, as well as salvation from the *karmic* cycles of birth and rebirth. The *sangam* in Allahabad is one of the sites of the Kumbh Mela, a pilgrimage held every 12 years (with smaller versions held annually in the winter months).<sup>2</sup> During the month-long event, a veritable 'tent city' is erected in the middle of the riverine channels; and massive state resources are mobilized to organize the security and stay of a vast multitude of people visiting the city and the *sangam* for the bathing festival.<sup>3</sup> Considered to be one of the largest human gatherings on the planet,<sup>4</sup> the Kumbh Mela is simultaneously a *mélange* of service, commerce, politics, asceticism and technology.<sup>5</sup> At the same time, it is a contemporary spectacle at the crossroads of the traditional, the transcendental and the televised that is directed at both Indian and global audiences.<sup>6</sup>

The sacred and geographic propensities of the *sangam* have many mythic valences in Hindu, Buddhist, and other local religious and lived traditions, yet these river waters also feature in some histories of microbial physiology. It is near here that the British bacteriologist Ernest Hanbury Hankin, in 1896, described the putative actions of the bacteriophage (literally, bacteria-devouring viruses), titling his work the 'bactericidal action of the waters of the Jamuna and Ganges rivers on Cholera microbes'.<sup>7</sup> Hankin's paper predates the discovery of bacterial viruses by two decades or so.<sup>8</sup> Pursuing the record of the purificatory waters of the *sangam* in the sacred writings of mythology and folklore, and its later discussion in the work of Hankin, this paper traces an epistemology of time<sup>9</sup> that connects the mythic to the post-Hankin scientific, asking how imaginations of the waters' antibacterial properties are articulated through idioms of faith, filth and the phage.

1 Gaston Bachelard, *The poetics of space* (Beacon Press, Boston, 1994), p. 155.

2 The Kumbh Mela is regarded by some scholars as the intensification of an ancient pilgrimage that, since the modern colonial period, has acquired sustained prominence and patronage from the state. Other adherents link the pilgrimage and the site to the myth of the *samudra manthan*—the collaborative churning of the oceans between the *devas* and the *asuras* for the nectar of immortality. This culminated in war, flight and splattering of the nectar from its pot onto earthly places that ultimately became the Kumbh Mela's pilgrimage sites, including at Allahabad. For a discussion of these interpretations, see Giorgio Bonazzoli, 'Prayaga and its Kumbha Mela', *Purāna* 19, 81–179 (1977); D. P. Dubey, *Prayāga: the site of Kumbha Mela* (Aryan Publishers, Delhi, 2001); and Kama MacLean, 'Making the colonial state work for you: the modern beginnings of the ancient Kumbh Mela in Allahabad', *J. Asian Stud.* 62, 873–905 (2003) (<https://doi.org/10.2307/3591863>).

3 R. Mehrotra, D. Eck *et al.*, *Kumbh Mela: mapping the ephemeral city* (Harvard University Press, Cambridge, MA, 2015).

4 James G. Lochtefeld, 'The construction of the Kumbh Mela', *S. Asian Pop. Cult.* 2, 103–126 (2004), at p. 103 (<https://doi.org/10.1080/1474668042000275707>).

5 P. Thacker, 'From Waze for crowds to Uber for street food: MIT innovations at Kumbh Mela', *Guardian*, 1 July 2015, <https://www.theguardian.com/cities/2015/jul/01/waze-crowds-uber-street-food-mit-kumbh-mela> (accessed 14 March 2020).

6 K. Maclean, 'Seeing, being seen, and not being seen: pilgrimage, tourism and layers of looking at the Kumbh Mela', *Cross Currents* 59, 319–341 (2009) (<https://doi.org/10.1111/j.1939-3881.2009.00082.x>), at p. 321.

7 E. Hankin, 'The bactericidal action of the waters of the Jamuna and Ganges rivers on Cholera microbes', *Bacteriophage* 1, 117–126 (2011) (<https://doi.org/10.4161/bact.1.3.16736>) (repr. from *Ann. Inst. Pasteur* 10, 511–523 (1896)).

8 The two competing claimants for phage discovery are F. W. Twort, 'An investigation on the nature of ultra-microscopic viruses', *Lancet* 186, 1241–1243 (1915); and F. d'Herelle, 'Sur un microbe invisible antagoniste des bacilles dysentériques', *C. R. Acad. Sci.* 145, 373–375 (1917).

9 The role of an 'epistemology of time' in dynamic experimental–scientific systems is discussed as the unpredictable and constantly deferred movement of a trace in H.-J. Rheinberger, 'Experimental systems: historicity, narration, and deconstruction', *Sci. Context* 7, 65–81 (1994), at p. 65. For a more general treatment of the 'epistemology of time', which regards modern time as one of many possibilities of social time, see Laura Bear, 'Doubt, conflict, mediation: the anthropology of modern time', *J. R. Anthropol. Inst.* 20:S1, 3–30 (2014) (<https://doi.org/10.1111/1467-9655.12091>), at p. 15.

The first part of the paper introduces Hankin's 1896 observations of antiseptics in the Indian rivers, its acknowledged influence on d'Herelle, and its ongoing claims and contested invocations in popular culture and scientific literatures as putative phage activity. Reverberating between a secular-scientific modernity and a time encased in eternal sacrality, Allahabad's riverine *sangam* remains, in that sense, ground zero for the bacteriophage: Félix d'Herelle and Frederick Twort hypothesized on the idea of bacterial lysis following Hankin's publication in 1896, and before the phage-therapy collaboration between d'Herelle and Giorgi Eliava materialized in Soviet Georgia.<sup>10</sup> Given their common research interests in cholera and plague, Hankin and d'Herelle moved in overlapping bacteriological circles and both came to be affiliated with the Pasteur Institute at the turn of the twentieth century.<sup>11</sup> Hankin's pre-discovery of the phage, therefore, has both short-term and long-term scientific legacies. As such, this section interrogates the role of influence and discovery in scientific enterprise, exploring when and under what conditions something might come into being as a particular kind of thing (in this case, a bacteriophage).

The second part of the paper is based on ethnographic material collected in Allahabad, and explores Hankin's integration and contemporary legacy in the geographic locale of his 1896 work. It traces how his ambiguity in phage discovery becomes usable history. In asking what is the phage and for whom, today, I examine the work of biomedical and Ayurvedic specialists dealing with the burdens of antibiotic-resistant infections and illnesses, local biologists pursuing the nascent promises of bacteriophage therapy, and local museums and historians dedicated to serving as repositories of popular belief and memory regarding this unique riverine confluence. Through them, I explore how the phage came to be spoken about within secular and sacred epistemes of infection and pollution, and in histories arcing from the ancient religious literature to colonial disease control efforts, to today, where bacteriophages are being conceived as a potential response to the crisis of planetary antimicrobial resistance (AMR).<sup>12</sup> Starting with contemporary Allahabad as a 'geography of knowledge', I use the travelling story of the bacteriophage to trace the tension between 'transcendentalist conceptions of truth and emerging localist perspectives on the making, meaning and evaluation of scientific knowledge'.<sup>13</sup> Implicit here is an enquiry into the 'different modes of being right/reasonable/rational'.<sup>14</sup> Constituted by the traffic between myth and science, memory and infection, purity and pollution, what forms of 'nontrivial'

10 N. Chanishvili, 'Phage therapy: history from Twort and d'Herelle through Soviet experience to current approaches', *Adv. Virus Res.* **83**, 3–40 (2012).

11 Hankin's position at the Pasteur Institute in August 1892 is confirmed by his own recollections of volunteering for Waldemar Haffkine's cholera vaccine while there and writing favourably, if guardedly, of its efficacy in conferring immunity. See E. H. Hankin, 'Remarks on Haffkine's method of protective inoculation against cholera', *Br. Med. J.* **2**, 569–571 (1892), at p. 570. D'Herelle's long, if troubled, association with the Pasteur Institute in Paris, beginning in 1911, is recorded in detail in W. C. Summers, *Félix d'Herelle and the origins of molecular biology* (Yale University Press, New Haven, 1999), p. 48.

12 For recent reviews of this century-long quest, see K. E. Kortright, B. K. Chan, J. L. Koff and P. E. Turner, 'Phage therapy: a renewed approach to combat antibiotic-resistant bacteria', *Cell Host Microbe* **25**, 219–232 (2019) (<https://doi.org/10.1016/j.chom.2019.01.014>); and S. T. Abedon, S. J. Kuhl, B. G. Blasdel and E. M. Kutter, 'Phage treatment of human infections', *Bacteriophage* **1**, 66–85 (2011) (<https://doi.org/10.4161/bact.1.2.15845>).

13 Steven Shapin, 'Placing the view from nowhere: historical and sociological problems in the location of science', *Trans. Inst. Br. Geogr.* n.s. **23**, 5–12 (1998), at p. 5.

14 Henri Atlan, *Enlightenment to enlightenment: intercritique of science and myth* (State University of New York, Albany, 1993), p. 2.

truths and illumination<sup>15</sup> do my respondents in Allahabad offer when it comes to the multiple propensities of the Ganga *jal* (Ganges water)?

As the world around the Ganges confronts a future of catastrophic microbial and toxicological pollution, and the ravages of anthropogenic climate change, multiple rationalities regarding the water's qualities, its histories and futures emerge. This paper therefore argues that the bacteriophage is located within a 'cosmotechnics' wherein faith, filth and phage are multiply reinforcing—and sometimes conflicting—actors. Cosmotechnics, as a concept, denotes 'the unification of the cosmos and the moral through technical activities'.<sup>16</sup> It aims to achieve a double reconciliation. On the one hand, it recognizes a plurality of existences of beings that goes beyond universality of the Western human. On the other hand, it accepts their more-than-modern modes of relating to nature through a deployment of technics in attempts to configure a cosmology (i.e. systems of thought about the world as a well-ordered whole). Cosmotechnics thus triangulates natural ecologies, cultural practices and technical imaginations. It offers new ways to reimagine the phage as a protean object, one that occupies partial and multiple spaces in the scientific, medical and religious traditions of Allahabad today.

#### PHAGE BEFORE PHAGE: HANKIN (1896)

In an article published in the *Annales de l'Institut Pasteur* in 1896, Ernst Hanbury Hankin reported an 'antiseptic substance present in the waters of the Ganges and Jamuna rivers'.<sup>17</sup> Hankin was the chemical examiner to the government of the North West Provinces and Oudh in India, based at Agra. He wrote that the bacteriological examination of these sacred river waters showed a remarkable scarcity of microbes when compared to the major European rivers. Commenting on this 'bacteriological purity', Hankin offered several hypothetical reasons: the absence of polluting factories on the rivers' banks; sparsely concentrated villages alongside the river banks, which are cut across by barren ravines; the 'self-purificatory' powers of air and light to which the meandering river waters are exposed; and the source of the waters being the germ-free Himalayan snowmelt.<sup>18</sup>

Yet, if these were potential factors contributing to the waters' cleanliness, there were other factors that should have ensured pollution by cholera microbes: the Ganges and Yamuna rivers, after all, received water from the drains at Agra that did, indeed, have cholera germs. Furthermore, these rivers served as receptacles for inhabitants washing themselves,

<sup>15</sup> *Ibid.*, p. 14.

<sup>16</sup> Yuk Hui, 'Cosmotechnics as cosmopolitics', *e-flux journal* 86 (November 2017), <https://www.e-flux.com/journal/86/161887/cosmotechnics-as-cosmopolitics/> (accessed 15 March 2020). The notion of technics, Hui points out, is clarified in Martin Heidegger's theorization of technology, which includes both the Greek notion of *technē*, meaning *poiesis* or 'bringing forth' (*Hervorbringen*); and secondly modern technology, whose essence according to Heidegger is no longer *technē* but *Gestell*, in which being is understood as 'standing reserve' or 'stock' (*Bestand*) always ready for exploitation and mastery. Understanding technical activity from a cosmopolitical perspective, for Hui, involves moving past the reductive claims to universality espoused for modern technology. Against this singular and instrumental view of universal technology, Hui posits a variety of cosmotechnics that open up new ways of thinking about how humans relate to nature through a range of technical practices. *Technē*, long viewed in opposition to *epistēmē*, is nevertheless practice based on an 'account', a theoretical understanding of a body of knowledge, thereby destabilizing the distinction between technic and knowledge. For an historical–philosophical study of this destabilization, and the role of technical activities and objects (i.e. technics) in the production of human subjectivity, memory, and conceptions of time, see Bernard Stiegler, *Technics and time, 1: the fault of Epimetheus* (Stanford University Press, Palo Alto, 1994).

<sup>17</sup> Hankin, *op. cit.* (note 7), p. 121. Jamuna is Hankin's reference to the river Yamuna.

<sup>18</sup> *Ibid.*, p. 117.

their cattle and their clothes, and for ‘half burnt corpses that often have their final journey in the river’.<sup>19</sup> Finally, bathing spots at pilgrimage sites such as Allahabad (where the Ganges and Yamuna rivers meet) had always shown the presence of cholera microbes (which Hankin claims to have collected), not the least because those dying of cholera were ‘condemned beyond redemption’ and were half-cremated and tossed into the rivers without proper purification by fire.<sup>20</sup> Nevertheless, Hankin asked why it was that, if cholera is waterborne, ‘one has never seen epidemics coming downstream the Jamuna and the Ganges?’<sup>21</sup> Why, he insisted, despite the impurities from the big cities and the practice of throwing half-burnt bodies into the rivers, do microbes and organic matter not survive for long in these river waters?

Hankin offered a vivid description of himself as a microbe-hunter in the context of cremation practices in these rivers, describing the challenges he faced on his ‘unpleasant adventure’ as he jumped into a boat to collect water samples from areas of freshly submerged dead bodies, where turtles and vultures competed with him to get at ‘all the effluvium coming out of the body’.<sup>22</sup> Based on painstaking time-study experiments and analyses of the number of microbes per cubic centimetre in water samples from various points along the riverine flow, Hankin deduced the function of an antiseptic in the waters of the Ganges and Yamuna—one that ‘had a powerful bactericidal action on the cholera germ’.<sup>23</sup> He argued that this ‘bactericidal substance’ was volatile and lost its potency when the river water was heated, or when it was kept for a longer duration of time.<sup>24</sup> He declared,

It is seen that the unboiled water of the Ganges kills the cholera germ in less than 3 hours. The same water, when boiled, does not have the same effect. On the other hand, well water is a good medium for this microbe, whether boiled or filtered.<sup>25</sup>

These conclusions led Hankin to issue a call that the river water, rather than well water, be advised for use during Hindu pilgrimages such as the Kumbh Mela.<sup>26</sup>

A fellow at universities in Cambridge and Allahabad, Hankin had undergone medical training at London’s St Bartholomew’s Hospital.<sup>27</sup> Following that, he worked for Robert Koch and Louis Pasteur in Berlin and Paris.<sup>28</sup> Upon his engagements in India, he was instrumental in the turn to microbiological, rather than miasmatic, aetiologies of infectious

<sup>19</sup> *Ibid.*, p. 118.

<sup>20</sup> *Ibid.*

<sup>21</sup> *Ibid.*

<sup>22</sup> *Ibid.*, p. 121. While Hankin found the custom of such water burial ‘repulsive to our European tastes’ and dissuaded its practice ‘only from a sentimental point of view’, he found no evidence that such practices contaminated the river or the vicinity of cities.

<sup>23</sup> *Ibid.*, p. 118.

<sup>24</sup> *Ibid.*, p. 120.

<sup>25</sup> *Ibid.*, p. 118.

<sup>26</sup> *Ibid.*, p. 121. Hankin regarded his own findings as confirmation of pilgrim beliefs that these river waters were ‘sacred as well as a stimulant for digestion’ (p. 121).

<sup>27</sup> C. Hayavadana Rao, ‘Hankin, Ernest Hanbury’, in *The Indian Biographical Dictionary* (Pillar and Co., Madras, 1915), pp. 176–177.

<sup>28</sup> ‘Dr Ernest H. Hankin; British bacteriologist found source of cholera infection’, *New York Times*, 3 April 1939, <https://www.nytimes.com/1939/04/03/archives/dr-ernest-h-hankin-british-bacteriologist-found-source-of-cholera.html?> (accessed 24 September 2019).

diseases.<sup>29</sup> Early in his career, he would contribute to important scientific studies of anthrax and theories of immunity,<sup>30</sup> the knowledge of complementary blood bodies referred to at the time as 'alexins', and forays in forensic criminology and toxicology during his tenure as chemical examiner.<sup>31</sup> An important area of work that he contributed to was the transfer of immune responses in animal sera to humans to confer immunity against tetanus and diphtheria, referring to a new class of bacteria-killing proteoid bodies derived from the spleens and lymph glands of assorted animals which he called 'defensive proteids'.<sup>32</sup>

Hankin was instrumental in the establishment of early medical research in colonial India. He helped in instituting the first Pasteur Institute in the country at Kasauli in 1900,<sup>33</sup> as part of a colonial scheme to institute a network of bacteriological laboratories dedicated to investigating cholera and typhoid in food and water.<sup>34</sup> He would subsequently help the British government deal with outbreaks of the plague and cholera across the subcontinent, working closely with the pioneering bacteriologist W. M. Haffkine on the successful development and use of the first prophylactic vaccines against these diseases.<sup>35</sup> Hankin was also at the forefront of unpopular, yet ultimately triumphant, public sanitation efforts through the use of potassium permanganate in the disinfection of village wells in the Indian countryside.<sup>36</sup> An avid ornithophile, he treated sick vultures at Bombay's Tower of Silence that had consumed bodies decimated by the cholera and plague epidemics,<sup>37</sup> and subsequently authored pioneering treatises on bird flight.<sup>38</sup> Referring to himself as an 'experimental animal', he wrote about cobra poisoning, the effects of opium, vivisection and animal suffering.<sup>39</sup> These and other pursuits crafted a vast panoply of professional and extracurricular interests—an 'experimental life'—that, in the words of his obituary, enabled Hankin to 'constantly entertain himself by problems old and new'.<sup>40</sup>

29 E. H. Hankin, *Cholera in Indian cantonments and how to deal with it* (Pioneer Press, Allahabad, 1895), p. 2, invokes Gamaleia, Haffkine and Metschnikoff to assert the microbial aetiology of cholera.

30 E. H. Hankin, 'Immunity produced by an albumose isolated from anthrax cultures', *Br. Med. J.* **2**, 810–811 (1889).

31 H. H. B., 'Obituary: Ernest Hanbury Hankin', *Eagle* **51**, 181–183 (1939).

32 E. H. Hankin, 'A cure for tetanus and diphtheria', *Science* **17**, 1–3 (1891). For Hankin's pursuit of the 'bacteria-killing powers of the blood serum' in relation to the results of Nuttall, Buchner and Nissen, see E. H. Hankin, 'A bacteria-killing globulin', *Proc. R. Soc. Lond.* **48**, 93–101 (1891) (<https://doi.org/10.1098/rsp1.1890.0013>).

33 S. R. Christophers (ed.), *Souvenir: the Indian empire; being a brief description of the chief features of India and its medical and sanitary problems* (Government Press, Calcutta, 1927), p. 99. On Hankin's essential role in the establishment of bacteriological laboratories such as the Pasteur institutes in British India, and their relation to colonial, racial and paternalistic imperatives, see Pratik Chakrabarti, *Bacteriology in British India* (University of Rochester Press, Rochester, 2012), p. 22.

34 Anon., 'E. Hanbury Hankin, Sc. D.', *Br. Med. J.* **1**, 848–852 (1939), at p. 850.

35 B. J. Hawgood, 'Waldemar Mordecai Haffkine, CIE (1860–1930): prophylactic vaccination against cholera and bubonic plague in British India', *J. Med. Biogr.* **15**, 9–19 (2007), at p. 10; and D. Kumar, "'Colony' under a microscope: the medical works of W.M. Haffkine', *Sci. Tech. Soc.* **4**, 239–271 (1999), at p. 245.

36 E. H. Hankin, 'A simple method of checking cholera in Indian villages', *Br. Med. J.* **1**, 205–207 (1898). Hankin's method of well purification would later be challenged but not overturned: see M. L. Dhingra, 'The fallacy of the permanganate disinfection of wells (Hankin's method)', *Br. Med. J.* **2**, 414–415 (1901).

37 H. H. B., *op. cit.* (note 31), p. 182.

38 E. H. Hankin, *Animal flight: a record of observation* (Iliffe & Sons Ltd., London, 1913). These observations would lead Hankin to write about the military applications of insect camouflage: see E. H. Hankin 'The comparative invisibility of *Papilio demoleus* during flight', in *Report of the proceedings of the third entomological meeting held at Pusa on the 3rd to 15th February 1919* (ed. T. Fletcher Bainbrigge), vol. 3, pp. 900–903 (Government of India, Calcutta, 1920).

39 H. H. B., *op. cit.* (note 31), p. 182. On vivisection, Hankin would defer to 'good taste and good feeling' of colonial scientists and experimenters to not torture animals, even as he loudly protested legal curbs that he regarded as anathema to basic scientific research. See Pratik Chakrabarti, 'Beasts of burden: animals and laboratory research in colonial India', *Hist. Sci.* **48**, 125–151 (2010) (<https://doi.org/10.1177/007327531004800201>).

40 H. H. B., *op. cit.* (note 31), p. 181. On Hankin's anthropological interests in the workings of native 'attitudes of mind', see E. H. Hankin, *Nationalism and the communal mind* (Watts and Co., Ltd., London, 1937). Hankin's philosophical theories of expertise,

Hankin hypothesized that the Indian rivers' unknown antiseptic substance was 'formed in the river or formed in situ by the water'.<sup>41</sup> A year before, in an 1895 text published in Allahabad, he asserted that the native populations around the Ganges and Yamuna rivers never contracted cholera by drinking these waters (unlike the other cholera-causing waters of India)—even though cholera microbes were constantly introduced into these rivers through the 'cholera corpses' thrown into them.<sup>42</sup> Referencing a December 1894 presentation, titled 'The microbes of Indian rivers', which he made to the First Indian Medical Congress, he suggested that the waters of these rivers 'acts as a feeble antiseptic to the cholera microbes, while the same microbe reproduces rapidly in well water under otherwise similar conditions'.<sup>43</sup> These observations have been regarded by some as the earliest descriptions of bacteriophage activity,<sup>44</sup> years before their discovery and contested elaborations between 1915 and 1917 as bacterial viruses by Frederick Twort and Félix d'Herelle.<sup>45</sup>

Hankin's assertions generated astonishment in his time. Many commentators responded incredulously to his findings regarding the germicidal action in the Ganges, taking his 'scientific endorsement' as encouraging the rapidly increasing dumping of sewage and pollutants into the river. Others took his findings as scientific confirmations of 'Hindu belief that flowing water purified itself and that the holy Ganges was able to cleanse itself of any impurities'.<sup>46</sup> Bactericidal action, then, was tied intimately to the movement and flow of water, while the question of pollution itself was widely debated. These debates have continued to be of interest to travellers and commentators ever since. Mark Twain, in his social commentary from travels across the British empire in 1895, was fascinated by the conjunction of the mythic and the scientific when he learnt of a 'memorable scientific discovery' during his journeys in Agra, Allahabad and Banaras—that, 'in certain ways the foul and derided Ganges water *is* the most puissant purifier in the world!'<sup>47</sup> With a measure of humility, Twain continued:

For ages and ages the Hindoos have had absolute faith that the water of the Ganges was utterly pure, could not be defiled by any contact whatsoever, and infallibly made pure and clean whatsoever touched it. They still believe it, and that is why they bathe in it

intuition and judgement are elaborated in E. H. Hankin, *Common sense and its cultivation* (Kegan Paul, Trench, Trubner & Co., Ltd., London, 1926). His pioneering studies in Saracenic art and the mathematics of the Islamic geometric patterns found on many Indian monuments are available in E. H. Hankin, *The drawing of geometric patterns in Saracenic art: memoirs of the Archaeological Survey of India no. 15* (Archaeological Survey of India, New Delhi, 1998).

41 Hankin, *op. cit.* (note 7), p. 120.

42 Hankin, *op. cit.* (note 29), p. 3.

43 *Ibid.*, p. 4.

44 On various references in the scientific literature, including d'Herelle's papers, that are either sympathetic or opposed to the connection between Hankin's findings and their putative connections with bacteriophage activity, see a review in Stephen T. Abedon *et al.*, 'Bacteriophage prehistory: is or is not Hankin, 1896, a phage reference?', *Bacteriophage* **1**, 174–178 (2011) (<http://dx.doi.org/10.4161/bact.1.3.16591>), at p. 176.

45 On Twort and d'Herelle, see William C. Summers, 'In the beginning', *Bacteriophage* **1**, 50–51 (2011) (<https://doi.org/10.4161/bact.1.1.14070>), at p. 51. Other contestations over the nature of bacteriophages and of viruses, and over bacteriophages as viruses would continue after d'Herelle. See, for instance, Ton Van Helvoort, 'The construction of bacteriophage as bacterial virus: linking endogenous and exogenous thought styles', *J. Hist. Biol.* **27**, 91–139 (1994); Neeraja Sankaran, 'When viruses were not in style: parallels in the histories of chicken sarcoma viruses and bacteriophages', *Stud. Hist. Phil. Biol. Biomed. Sci.* **48**, 189–199 (2014); and Robin W. Scheffler, *A contagious cause: the American hunt for cancer viruses and the rise of molecular medicine* (University of Chicago Press, Chicago and London, 2019).

46 See D. Arnold, *Toxic histories: poison and pollution in modern India* (Cambridge University Press, Cambridge, 2016), p. 187.

47 Mark Twain, *More tramps abroad* (Chatto & Windus, London, 1895), pp. 343–344, emphasis in original.

and drink it, caring nothing for its *seeming* filthiness and the floating corpses. The Hindus have been laughed at, these many generations, but the laughter will need to modify itself a little from now on. How did they find out the water's secret in those ancient ages? Had they germ scientists then? We do not know.<sup>48</sup>

*The mystery of influence: d'Herelle hints at Hankin*

This indeterminacy of Hankin's observations regarding the antiseptics of the river waters—i.e. an inability for others to explain his observations—was Twain's conclusion. It is a theme of ambiguity that has recurred in other places and times, continuing to mystify those who invoke Hankin's scientific observations of the holy waters. A recent survey of Hankin's significance to 'bacteriophage prehistory' is therefore instructive.

Asking 'Is or is not Hankin, 1896, a phage reference?', the microbiologist Stephen Abedon and his collaborators concluded in a special 2011 issue of the journal *Bacteriophage* that 'it may be imprudent' to assume that Hankin's 1896 study of the bactericidal action 'represents an early observation of phage-mediated bactericidal activity'.<sup>49</sup> Abedon *et al.* challenged the stance of other scientists writing in journals such as the *Lancet* and *Clinical Infectious Diseases* (whom they cite), who regarded Hankin's observations as the earliest reference to phage action.<sup>50</sup> Abedon *et al.* recreated Hankin's time-series examinations of the river waters in sealed and open tubes, and raised issues regarding phage density in the river waters needed to achieve bacterial losses reported by Hankin. They concluded 'that the anti-bacterial action observed by Hankin was *not* due to bacteriophages'.<sup>51</sup>

And yet Abedon *et al.* point out that Hankin's observations had remained consistent with a very phage-like specificity where the Ganges river water was not active against certain *V. cholera* strains, whereas the Jumna [or Yamuna] river was. Similarly, the Jumna river was not active against 'typhoid bacillus'. This specificity particularly can be a phage property.<sup>52</sup>

Hankin's observations from a time-series devised in 1896 would also generate phage densities against *Vibrio cholerae* that, for Abedon *et al.*, while on the higher side, are nevertheless plausible in aquatic environments.<sup>53</sup> These factors led to Abedon *et al.* to the conclusion that,

while Hankin clearly appears to have discovered a bactericidal property associated within Indian river water, Hankin's experiments seem to be inconsistent with that property being due to the presence of phages. *Notwithstanding this skepticism, we are unable to identify an alternative hypothesis other than to speculate that some volatile bactericidal chemical agent, active against some bacterial strains but not others, must have been present in the waters Hankin tested.*<sup>54</sup>

48 *Ibid.*, p. 344, emphasis in original.

49 Abedon *et al.*, *op. cit.* (note 44), p. 174.

50 *Ibid.*, p. 176.

51 *Ibid.*, p. 174, emphasis in original.

52 *Ibid.*, p. 177.

53 *Ibid.*, p. 177. Abedon *et al.* reference recent scientific analyses (specifically Faruque 2005 (note 27) and Das 2009 (note 26)) that determined phage densities against cholera in Indian freshwater bodies to be high enough to kill bacteria but not form plaque-forming progeny. They suggest that this is an exciting avenue for phage environmental studies, especially to control *V. cholera* populations in the place of their outbreaks—a concern shared by Hankin in 1896.

54 *Ibid.*, p. 178, emphasis added.



Abedon *et al.* revealed that nearly 30 references before the 1915/1918 bacteriophage papers of Twort and d'Herelle 'hint at the existence of phage-like antibacterial activity'.<sup>55</sup> What is more, Hankin's 1896 paper is the earliest of these, and was referenced by d'Herelle himself, who at various points indicated his certainty that Hankin was really speaking of an antiseptic action that 'ought in reality to be assigned to the bacteriophage',<sup>56</sup> while at other times he was less sure.<sup>57</sup> For instance, in his well-known feud with Twort on the question of bacteriophage discovery, d'Herelle is more charitable to Hankin than he is to Twort. At a 'defence' presented before the Society of Biology in Paris in 1921, d'Herelle admitted that he had

been able to find only two references in the scientific literature that could pertain to the question of bacteriophage. The first is that of Hankin (*Ann. de l'Institut Pasteur*, 1896) who states that the water of certain rivers of India possesses a bactericidal action ... *no doubt bacteriophage has been the cause*.<sup>58</sup>

The second reference, to Twort's paper from 1915, is invoked but immediately dismissed by d'Herelle as misinterpretation (by Twort's readers, Bordet and Ciuca) and incomprehension (on Twort's part) that Twort had, indeed, 'observed transmissible lysis of bacteria'.<sup>59</sup>

Hankin may not have received enough credit in contemporary historical accounts of bacteriophage discovery, but there remains documented evidence that d'Herelle acknowledged Hankin's role in his own work. Each observed through painstaking laboratory experiments either an 'antiseptic substance' working against cholera or an 'invisible microbe' antagonistic to the Shiga bacillus. At the same time, d'Herelle attributed a later concept (the bacteriophage) to an earlier observation by Hankin (the 'bacteriological purity' of some Indian rivers).<sup>60</sup> It might be speculative to argue that d'Herelle *allowed* credit to flow to Hankin when the latter might have just as easily been ignored, perhaps because of Hankin's charismatic associations with Koch and Pasteur, or his status as an early twentieth-century researcher and colonial administrator, or because of d'Herelle's own travels in India to aid in the British effort of plague and cholera control, which in earlier decades had engaged Hankin.<sup>61</sup>

The tangled relationship between Hankin, d'Herelle and Twort presents no clear-cut solutions to the question of bacteriophage discovery. In tracing the tenuous influence of Hankin on his successors—and by elaborating the cultural milieu of the Indo-Gangetic plain from which Hankin drew inspiration while recording his experimental observations regarding the bactericidal qualities of the Ganges and Yamuna—this paper gestures at an extended process involving the large agglomeration of people and temporal traces through

<sup>55</sup> *Ibid.*, p. 174.

<sup>56</sup> F. d'Herelle, *The bacteriophage: its role in immunity* [translation by G. H. Smith] (Williams and Wilkins Co./Waverly Press, Baltimore, 1922), cited in Abedon *et al.*, *op. cit.* (note 44), p. 176.

<sup>57</sup> F. d'Herelle, *The bacteriophage and its behavior* [translation by G. H. Smith] (Williams and Wilkins Co./Waverly Press, Baltimore, 1922), p. 7.

<sup>58</sup> Donna H. Duckworth, 'Who discovered bacteriophage?', *Bacteriol. Rev.* **40**, 793–802 (1976), at p. 797, emphasis added.

<sup>59</sup> *Ibid.*, p. 798.

<sup>60</sup> On Bruno Latour's demonstration that local, material and practical networks are 'necessary to render the fact visible', see B. Latour, 'On the partial existence of existing and non-existing objects', in *Biographies of scientific objects* (ed. L. Daston), pp. 247–269 (University of Chicago Press, Chicago, 2000), at p. 250.

<sup>61</sup> For a detailed survey of d'Herelle's activities in India, starting in 1927, and his efforts as part of the Bacteriophage Inquiry in fighting plague and cholera, see Summers, *op. cit.* (note 11), pp. 125–144.

which science progresses.<sup>62</sup> As such, a lack of conclusions regarding the question of influence and discovery—witnessed in the piece by Abedon *et al.*, and in d’Herelle’s own career—opens up a zone of indeterminacy between ‘bacteriophage discovery’ and discoveries of phage action. In such a zone of indeterminacy, one finds that current cultural elaborations make a direct reference to Hankin as both a starting point and authoritative justification with regard to the purifying claims of these holy waters, reconfiguring events as usable history in the service of making differential claims to knowledge and power.

It is important to mention here that Hankin was operating in a cultural milieu that had multiple, local conceptions of diseases such as cholera. For instance, as Mridula Ramanna points out, Hankin himself noted that the locals associated the goddess Bhawani with cholera, mandating offerings to placate her but forbidding flight from her gaze by turning one’s back on her.<sup>63</sup> Many of my interlocutors from Allahabad and elsewhere therefore make knowledge and political claims by rhetorically asking whether Hankin could have similarly encountered some of the purificatory qualities of the Ganges and Yamuna recorded in local myths and folkloric literature, to which he subsequently adduced scientific confirmations through his microbiological experiments. For instance, Hankin was aware of references to the plague in the *Bhagwat Purāna*, which he referred to as the ‘ancient sacred’ text.<sup>64</sup> This question on the part of my interlocutors also implies a further interesting conundrum: that notions of ‘evidence’ and ‘science’ (themselves changing) were appellations that were denied Hankin in how subsequent generations received his work, leaving him out of the roll call of credits regarding bacteriophage discovery. Temporally and conceptually, Hankin serves as a bridging figure between indigenous conceptions of riverine purification and modern microbiological conceptions of disease and healing. A halo of evidence and rigorous experimentality surrounded him at the end of the nineteenth century, and has since eluded him. Is the claim to Hankin that many in Allahabad make today a mode by which they seek to resurrect that halo for post-antibiotic futures?

### *Zones of ambiguity*

Recent scholarship of the Ganges, and the *sangam* at Allahabad, also grapples with the waters’ believed curative powers, but few works do so by directly invoking the bacteriophage’s historical reference to Hankin.<sup>65</sup> In a masterful exploration of the conjunctions and contingencies surrounding issues of pollution and sacredness in the

62 On the role of temporality in scientific discovery, see T. Kuhn, *The structure of scientific revolutions* (University of Chicago Press, Chicago, 2012; first published 1962); S. Shapin and S. Schaffer, *Leviathan and the air-pump: Hobbes, Boyle, and the experimental life* (Princeton University Press, Princeton, 2011; first published 1985); and F. Vostal, L. Benda and T. Virtová, ‘Against reductionism: on the complexity of scientific temporality’, *Time Soc.* **28**, 783–803 (2019) (<https://doi.org/10.1177/0961463X17752281>).

63 Mridula Ramanna, *Western medicine and public health in colonial Bombay, 1845–1895* (Orient Longman, New Delhi, 2002), p. 125.

64 E. H. Hankin, *The bubonic plague* (with a preface by W. M. Haffkine) (Pioneer Press, Allahabad, 1899), p. 22.

65 A vast corpus of literature exists on the Ganges and Yamuna, and the Kumbh Mela. Some recent, selected, works on the Ganges include S. G. Darian, *The Ganga in myth and history* (Motilal Banarsidass, Delhi, 2010); A. Doron, R. Barz and B. Nelson, *An anthology of writings on the Ganga: goddess and river in history, culture, and society* (Oxford University Press, Delhi, 2017); J. Parry, *Death in Banaras* (Cambridge, 1993); S. Sen, *Ganges: the many pasts of an Indian river* (Yale University Press, New Haven, 2019). For a summary of the Yamuna’s mythical past and ecological present, see D. Haberman, *River of love in an age of pollution: the Yamuna river of northern India* (University of California Press, Berkeley and London, 2006). On the Kumbh Mela, see Dhirendra K. Jha, *Ascetic games: sadhus, akharas, and the making of the Hindu vote* (Context Books, Delhi, 2019); Dubey, *op. cit.* (note 2); and Kama Maclean, *Pilgrimage and power: the Kumbh Mela in Allahabad, 1765–1954* (Oxford University Press, Oxford, 2008).

Gangetic plain, the anthropologist Kelly Alley has argued that various ‘discursive configurations’ populate the Ganges.<sup>66</sup> These are crafted by their proximity to the river, based on people’s occupational, spiritual or cultural needs. These configurations of cultural personas, tied to the river in various ways, introduce linguistic ‘terms for purity, impurity, cleanness, uncleanness, flow, and power to give meaning to their understanding of the confluences of wastewater with this sacred river’.<sup>67</sup> Alley recounts her own experiences with viral hepatitis contracted from tea made with the waters of the Ganges, an incident that pushed her to re-examine for herself and her informants questions of pollution, public health and devotion.<sup>68</sup>

In examining the ‘power of the Ganga’, Alley discusses the discharge of human, animal and industrial waste into the river, even as the Ganges remains the largest source of water for drinking, domestic, municipal and industrial needs of the cities and towns of millions of inhabitants living on its banks. For many of these inhabitants, and others, the Ganga’s powers are eternally inscribed in sacred Hindu texts, while many of the pre-eminent Hindu and Buddhist pilgrimage centres of knowledge, healing and devotional significance have developed historically along its banks. Sacred texts, physical geography, natural ecology and spiritual cosmology are woven together here, wherein ‘interpretations of sacred space describe time–space conjunctions between divine power and the physical world’, and its material manifestations.<sup>69</sup> Alley’s is a sophisticated account of the weaving together of the sacred, the cosmological and the natural meanings of the Ganga, one that is essential to understanding how devotees put issues of pollution, absolution and healing into everyday practice in relation to the material river.

A section titled ‘Science and religion—a convergence’ is especially compelling for this paper because it seeks to explore the intersection of the material (*bhautik*) and the spiritual (*adhyatmik*) aspects of the Ganga’s power, especially in the realms of science and religion. Just as struggles over sacred spaces, such as the destruction of the Babri Masjid and the *Ramjanmabhoomi* movement in Ayodhya, have conflated a scientific insistence on empirical facts with religious ideologies to further claims to cultural hegemony,<sup>70</sup> so too have sacred ecologies such as rivers. As Alley reports:

Some Hindus living in cities in Uttar Pradesh invoke the scientific notion of water quality to support the master narrative of Ganga’s sacrality. This master narrative is embedded in the *Gangajal* story and supported even when Hindus invoke the modernist notion of microbial impurity. Many people will argue that if kept in a jar or glass at home for years and years, *Gangajal* will never ‘spoil’ or ‘develop bacteria’. It will never develop the kind of bacteria that breeds in mineral water or tap water. Extending the notion of microbes further in this trajectory, a student from Banaras-Hindu University once told me that an unidentified microbe found only in Ganga was responsible for the river’s incredible self-purifying capacity. Ganga possessed a special microbe that was able to

66 Kelly D. Alley, *On the banks of the Ganga: when wastewater meets a sacred river* (University of Michigan Press, Ann Arbor, 2002), p. 12.

67 *Ibid.*

68 *Ibid.*, p. 7.

69 *Ibid.*, p. 55.

70 On the (mis)use of science to ‘prove’ myth, see the interesting parallels in Deepak Mehta, ‘The Ayodhya dispute: the absent mosque, state of emergency and the jural deity’, *J. Mat. Cult.* 20, 397–414 (2015) (<https://doi.org/10.1177/1359183515607093>); and Nadia Abu El-Haj, *Facts on the ground: archaeological practice and territorial self-fashioning in Israeli society* (University of Chicago Press, Chicago, 2001).

eat up material pollution at a fantastic rate. But the nature of this microbe was a spiritual issue for him: why did Ganga, above all rivers, possess it?<sup>71</sup>

Recall here Hankin's insistence on the distinction between the antiseptic qualities of the river waters, and the ordinary cholera-bearing well waters that he wanted treated with potassium permanganate as a public health exercise. What Alley reports as a conflation of spiritual, mythical and scientific orders through the notion of a 'special microbe' unique to the Ganges may be reformulated to ask: what is the role played, today, by the unique historical *event* that is Hankin's 1896 descriptions of the 'unknown bactericidal substance' in the waters of the Ganges and Yamuna—an agent that d'Herelle would explicitly invoke to discuss his discovery of the bacteriophage in 1917? Natural ecology, Alley argues, is processed not by 'godless categories', but by invocations that fit science, moment and materiality within a cosmic order, an order not given to the vagaries of time or capricious history but, instead, to a 'long durée [which] brings out the true essence of Ganga's purificatory power'.<sup>72</sup> Scientific evidence, then, arrives as merely a signature—a material, *this-worldly* confirmation—of more powerful, cosmic rationalities foretold.

If contemporary writings invoke Hankin to reference the special qualities of the Ganges and Yamuna, they, too, grapple with the same inability to explain Hankin's observations that confronted Twain and Abedon.<sup>73</sup> The investigative journalist Victor Mallet, for instance, has recently written of the Ganges as a 'river of life, river of death'—a toxic, yet deeply revered, body of water intimately entwined with the subcontinent's social history, its religious practices and its political developments. Mallet's is a disturbing account of how 'Indians are killing the Ganges with pollution and that the polluted Ganges, in turn, is killing Indians'.<sup>74</sup> He offers a vivid narrative of the decades-long struggle to 'clean up' the river, and presents a wide range of political and civil society actors involved in the effort to save the Ganges from death due to 'poor sanitation', upstream damming and the uncontrolled flow of effluence. Floating in Mallet's account are the antibiotic-resistant 'superbugs', including the feared carbapenem-resistant pathogen NDM-1, that populate this river water.<sup>75</sup>

Seeking to decode what he calls the 'age old question' of Ganga *jal's* power to kill germs, Mallet invokes Hankin's 1896 findings, the 'Mysterious Factor X', and its impact on Mark Twain. But that is all. There is no attempt to explain Hankin's findings in their times, nor the impacts of those findings either on bacteriophage history or on contemporary culture. There is no linkage between Hankin and contemporary efforts to resuscitate bacteriophage therapy in a time of increasing antibiotic resistance, only a feeble hypothesis that the river's supposed bacteria-killing properties might come from its 'ability to rapidly re-oxygenate itself, or of magnesium or sulphur or something in the silica-rich silt carried down from the Himalayas'.<sup>76</sup> While it is true that bacteriophages are ecologically ubiquitous and are abundantly found in places teeming with bacteria (on which they are

71 Alley, *op. cit.* (note 66), pp. 65–69.

72 *Ibid.*, p. 67.

73 Scientific discussions of bacteriophages have recently started making the connection to Hankin explicit. Three good examples are Food and Drug Administration, *Bacteriophage Therapy: Scientific and Regulatory Issues Public Workshop, July 9–10, 2017* (Heritage Reporting Corporation, Washington, D.C., 2017), at p. 81; S. Adhya and C. Merrill, 'The road to phage therapy', *Nature* **443**, 754–755 (2006) and Abedon *et al.*, *op. cit.* (note 44), p. 176.

74 Victor Mallet, *River of life, river of death: the Ganges and India's future* (Oxford University Press, Oxford, 2019), p. xviii.

75 *Ibid.*, p. 104.

76 *Ibid.*, p. 113.

predatory), Mallet declines an opportunity to explore what it means for *this* particular river water—with its copious mythical and religious history—to be the site where a scientific prehistory of these viruses is located. That is an ambiguous zone which this paper explores.

#### FAITH, FILTH, PHAGE: TOWARDS A COSMOTECHNICS OF THE BACTERIOPHAGE IN ALLAHABAD

In Allahabad, today, Hankin's findings take on a life of their own, placing the phage at the centre of everyday cultural life, bringing out people's beliefs about the holy waters' connections to bacteriophages, to pollution and to contemporary imaginations of the past. A sociography of the rivers in Allahabad reveals that even ordinary citizens are grappling with historical memories of bacteriophage pre-discovery in the polluted rivers of their city.<sup>77</sup> For them, the ordinary is enwrapped in promissory futures of bacteriophages, in a time of pollution and widespread antibiotic resistance. The phage in Allahabad, then, merges history and anthropology by 'troubling the archive' of discovery and prominence.<sup>78</sup> It organizes cultural life along specific gradients of science and religion, scepticism and speculation, faith and veracity. At the same time, it continues to generate productive dilemmas and theories about the facts of Hankin's findings in this particular geographic location and body of water.<sup>79</sup> Allahabad and Hankin (1896), therefore, serve as chronotopes for the phage—an 'irreducible relationality of time and space as semiotic (that is to say, socially meaningful) constructs'.<sup>80</sup> In turn, these semiotically mediated spatio-temporal orders shape experience and the 'subjective feel for history and place ... [showing] how signs of (and in) time and place coalesce into orientations, narratives, and mnemonic practices that constitute historical subjectivities'.<sup>81</sup>

I have outlined three elements in the conceptual apparatus of this paper: (1) historical subjectivities emerging from a symbolic relationality of space and time ('chronotope'); (2) the quest for 'localist perspectives on the making, meaning and evaluation of scientific knowledge' ('geography of knowledge'); and (3) the weaving of the sacred, cosmological and natural meanings in the purificatory prowess of these rivers ('discursive configurations'). Yet each of these concepts only partially describes a connection between nature and culture. They can be strengthened if they incorporate questions of technic and technology in their analysis of how systems of meaning operate. At the same time, the many 'localist' views of technology and epistemology need not remain ephemeral against an always dominant (and acceptable) metropolitan one.

For the philosopher of science Yuk Hui, 'cosmotecnics' follows the order of Kantian cosmopolitics, but argues *against* the 'universalization of particular epistemologies' of

77 Patrick Geddes defined sociography as the 'philosophical study of the biosphere': see John Clark, 'Social ecology', [nothingness.org](http://nothingness.org), 2000, [http://library.nothingness.org/articles/anar/en/display\\_printable/303](http://library.nothingness.org/articles/anar/en/display_printable/303) (accessed 18 March 2020).

78 Andrew Willford and Eric Tagliacozzo (eds), *Clio/Anthropos: exploring the boundaries between history and anthropology* (Stanford University Press, Stanford, 2009), p. 2.

79 The anthropologist Stefan Helmreich has proposed that seawater operates historically as a 'theory machine' that generates insights about the human cultural condition. While Helmreich's point is that seawater has, over time, navigated the split between nature and culture (regarded sometimes as uncontainable and at others times as sustaining cultural pursuits), I argue in this paper that the virus in the river at Allahabad also generates similar questions relating to the nature-culture grid, especially on matters concerning faith, ecology, technology and rationality. See Stefan Helmreich, 'Nature, culture, seawater', *Am. Anthropol.* **113**, 132–144 (2011), at p. 132.

80 Kristina Wirtz, 'The living, the dead, and the immanent: dialogue across chronotopes', *HAU: J. Ethnogr. Theory* **6**, 343–369 (2016), at p. 344.

81 *Ibid.*

nature and reason inaugurated by what has been called modernity.<sup>82</sup> If modernity has colonized the earth and the cosmos, transforming them into a singularly ‘gigantic technological system’, Hui invites us to imagine a new cosmopolitics. In addition to a pluralistic cosmopolitanism, this new cosmopolitics engenders a ‘politics of the cosmos’ through which differing and multiple concepts of nature and technology may be brought to light. Hui’s claim is that ‘technology is not anthropologically universal; it is enabled and constrained by particular cosmologies, which go beyond mere functionality or utility. Therefore, there is no single technology, but rather multiple cosmotechnics.’<sup>83</sup>

Following Claude Lévi-Strauss’s mandate of anthropology as *entropology* (i.e. a study of the disintegration of forms of life under the transformative impetus of technology), Hui argues that ‘globalized modernization ... silently homogenizes different cosmological relations into one that is compatible with modern technology’.<sup>84</sup> Modern technology therefore ruptures the relations between cosmos and technics. It subsumes the various attempts to find order and interpretations of nature (i.e. cosmologies) within a gigantic and universalizing moral system of exploitation in which ‘machines become opaque to their users’.<sup>85</sup> Cosmotechnics, however, denotes ‘the unification of the cosmos and the moral through technical activities, whether craft-making or art-making’.<sup>86</sup> It explores ‘constellations’ of relations that ‘can be traced in technical activities such as the invention and use of tools’,<sup>87</sup> and that are *always* more expansive than what is permitted as *valid* by modern technology. The idea of cosmotechnics pluralizes ways of apprehending and intervening in the world across time and space.

Cosmotechnics foregrounds a new relationship between technology and nature.<sup>88</sup> It speaks of objects in the world such as the phage, appropriating the aura of their technological possibilities and (para)scientific apprehensions. In Allahabad, faith, filth and phage are elements of a cosmotechnics. Together, they open up key questions which triangulate natural ecologies, cultural practices and technical imaginations. They reveal a nexus of the dangers of resistant pathogens to the future of antibiotic technologies, the salvific promises of bacteriophages in an antibiotic afterlife, and the timeless purificatory essences that render the Ganga *jal* a technology of individual and collective transcendence in the face of profound pollution. Such a cosmotechnics reimagines the phage as a protean object, one that reverberates through the mythical, ecological and scientific matrix in Allahabad today.

In my ethnographic research in Allahabad, I encountered a range of local actors congregating around the bacteriophage. These include historians, local museums, biomedical and Ayurvedic doctors, phage biologists, and patients suffering from multi-drug-resistant infections who are using phages from the river for therapy. Through them, I

82 Hui, *op. cit.* (note 16). Kant’s moral philosophy of cosmopolitanism is a part of an organic whole, a universal nature whose ‘hidden plan’ and mysteries are revealed by the singular reason of modern science and technology. Only through the achievement of a universal community (*Gemeinschaft*), reciprocity (*Wechselwirkung*) and consensus—a perpetual peace—might a communion with nature be achieved, uniting the individual soul with its natural order within the cosmos (Hui cites Kant’s description as the ‘starry heavens above me and the moral law within me’).

83 *Ibid.*

84 Yuk Hui, ‘On cosmotechnics: for a renewed relation between technology and nature in the Anthropocene’, *Techné: Res. Phil. Technol.* 21, 319–341 (2017), at p. 326.

85 *Ibid.*, p. 328.

86 Hui, *op. cit.* (note 16).

87 Hui, *op. cit.* (note 84), p. 326.

88 *Ibid.*, p. 320.

examine how people in the region of Hankin's work regard his findings today. What does this pre-history of the bacteriophage mean for their differential notions of a present, a past and an imagined future? How do these actors make religious, scientific, personal, national or medical meanings out of their readings of Hankin, and the pre-discovery of the phage in the river waters that are familiar to them? How are imaginations of the water's anti-bacterial properties articulated in idioms of faith, filth and the phage? I offer four ethnographic vignettes to answer these questions.

*The Ganga Gallery: promissory mythosciences of the phage*

Consider the local museum, The Ganga Gallery. Established by the Government of India's Ministry of Culture, and operated by its National Academy of Sciences (founded in 1930 by the Allahabad physicist M. N. Saha), the Gallery aims to create 'public awareness, conservation and restoration of the holy river' Ganges.<sup>89</sup> The gallery's permanent exhibit reveals intimate connections between spiritual, hydrological and Hindu nationalist political concerns surrounding the Ganges, painting the river as 'life-line, a symbol of purity and virtue for millions of people living on its bank, representing their ethos, socio-scientific culture and identity in every forum, not just in India, but in the entire world'. In one of the exhibits, Jawaharlal Nehru's lyrical articulations of the significance of the Ganges in the historical lives of the nation's people<sup>90</sup> is set adjacent to his ideological nemesis, the Hindu nationalist Madan Mohan Malviya's 'deep reverence' for the river and his concerns at attempts to dam and channel its flow. Other exhibits speak of the myths surrounding the river's origins, the opportunities for tourism and navigation as it flows across the subcontinent, and the river's salvific and purificatory powers manifested by taking dips in it, consuming its waters and participating in its Kumbh Mela pilgrimage. Some installations elaborate on the wildlife and hydrological characteristics of the river. Others describe the kinds of livelihoods generated around it, the impact of human activities (such as the disposal of bodies and waste) on the river's ecology, and real-time monitoring capabilities to track the river's steadily degrading water quality. Efforts to conserve the river's ecosystem from climate change are situated within a broader paradigm where the care of the river is pre-eminent. Gallery items such as the 'list of actions prohibited in the river' and the 'Ganga Pledge' only aim to fortify this care for the river.<sup>91</sup>

An installation titled 'Gangajal: past & present' (figure 1) is particularly interesting because it explicitly links the river's believed healing powers to the fact of Hankin's 1896 report 'that cholera microbes died within three hours in Ganga water'.<sup>92</sup> The exhibit then labels a picture of Félix d'Herelle as 'E Hanbury Hankin', sets up a microscope diagram of 'Bacteriophage structure' next to this mislabelled image, and claims that 'a French

89 The National Academy of Sciences, Government of India, 'The Ganga Gallery' (museum brochure), n.d. <http://www.nasi.org.in/The%20Ganga-Gallery.pdf> (accessed 16 March 2020).

90 Jawaharlal Nehru, 'Will and testament, 21 June 1954', reprinted in Doron, Barz and Nelson, *op. cit.* (note 65), pp. 42–43; also available at <http://www.nehruvian.com/article/will-and-testament-jawaharlal-nehru> (accessed 12 March 2020).

91 The care of the river also reverberates in the legal domain, at times borrowing from, and at other times keeping distant from, Hindu nationalist idioms that seek to legally codify the 'personhood' of divine beings. See Kelly Alley, 'River goddesses, personhood and rights of nature: implications for spiritual ecology', *Religions* 10, 2–17 (2019); and Michael Safi, 'Ganges and Yamuna rivers granted same legal rights as human beings', *Guardian*, 21 March 2017, <https://www.theguardian.com/world/2017/mar/21/ganges-and-yamuna-rivers-granted-same-legal-rights-as-human-beings> (accessed 12 March 2020).

92 National Academy of Sciences, *op. cit.* (note 89), p. 11.



Figure 1. Gangajal: Past & Present. (Online version in colour.)

scientist, Monsieur Herelle, was amazed to find, that only a few feet below the dead bodies floating in the Ganga who had died of dysentery and cholera, where one would expect million of germs, there were no germs at all'.



These are, obviously, misreadings in the history of science and bacteriophages, and might be easy to dismiss. But this misrecognition of d'Herelle for Hankin is also generative. It presents the three actors—the phage, Hankin/d'Herelle and the Ganges—as part of a logic within which myth, science and cure meld into one another. The mystical (and now ecologically threatened) Ganges water serves as the locale of that logic, through which time and space, past and present, phage and purification, technic and myth become conflated into a semiotically meaningful construct which shapes experience and subjectivity. Such a hybrid conflation is not novel; it only serves to cement a set of ideas about the river's spiritual and scientific import in the cultural lifeworld of India.<sup>93</sup> This logic might be referred to as the promissory mythosciences of the phage in Allahabad.

*The historian: between prophecy and pollution on the Ganges*

These promissory mythosciences of the phage find further refinement in the works of a resident historian of the Kumbh Mela and the city of Allahabad.<sup>94</sup> For the historian, the story of Hankin's activities in relation to the Ganges and Yamuna waters is enmeshed in wider questions of ecological degradation and textual records that serve as prophecies of the rivers' fate. On the one hand, the historian refers to a variety of ancient *Purānic* texts and folklore which extol the virtues of these river waters.<sup>95</sup> For instance, he tells me that 'in the *Skanda Purāna's Gangaahasranaam* it is said that "the medicated water of the Ganga, in sweetness, lightness and taste, has no equal, and that the water of this river, howsoever kept long, does not stink or spoil".<sup>96</sup> Citing the epic *Mahabharata*, he declares, 'as amrita is to the gods, so Ganga water is to human beings'.<sup>97</sup> Referring to the god Krishna in the *Brahma Purāna*, the historian describes the mode through which the 'sins which are washed into the Ganges from the bodies of bathing sinners is counterbalanced by the pilgrimage of believers. Their faith will spontaneously destroy the poisonous and sinful element.'<sup>98</sup>

Against these ideal-typical veneration of the Ganges's waters,<sup>99</sup> the historian presents a dark and turbid reality of the rivers' current ecological and political fate. Overwhelmed by

93 There are innumerable references to the Ganges in Sanskrit, Pali, Prakrit and other texts, including in the *Purānas*. A survey of the treatises devoted to the 'glorification of the Ganges and the pilgrimage to it' may be found in P. V. Kane, *History of Dharmasastra*, vol. 4 (Bhandarkar Oriental Research Institute, Poona, 1953), pp. 585–617, available at <https://archive.org/details/HistoryOfDharmasastraancientAndMediaevalReligiousAndCivilLawV.4> (accessed 12 August 2019).

94 The author has sought to keep the respondent's identity anonymous. The city's name was changed from Allahabad to Prayagraj in 2017, but the former has been used to retain the nomenclatural connections with Hankin.

95 *Ibid.*, pp. 77–81. For a discussion of the multiple categories, classes and characteristics of the *Purānic* corpus, including its extra-Hindu, extra-Sanskritic and extra-antiquarian features, see Freda Matchett, 'The *Purānas*', in *The Blackwell Companion to Hinduism* (ed. Gavin Flood), pp. 129–143 (Blackwell Publishing, Oxford, 2003).

96 'Pranada prananiya ch mahoshdhsvaroopini. Mahoshdhajala chav paprogotramrita' (this, and the following, transliterations from the Sanskrit are by the author).

97 'Yatha suranamritam pitranam ch yatha svadha. Sudha yath ch naganam tatha gangajalam nrinam. Devaha somarksansthani yatha satradibhirmarkhaiha. Amritsupajivanti tatha gangajalam naraha.'

98 'Papinam tu sahastranam shavsparsheyn yattav. Manmantropasaksnanattadgh ch vinashyati.' For the entire *shloka*, the historian refers me to Rampratap Tripathi 'Shastri' (ed.), *Purānon Mein Ganga* (Hindi Sahitya Sammelan, Allahabad, 1952), p. 124, available at <https://www.44books.com/purano-me-ganga-shri-rampatap-tripathi.html> (accessed 17 April 2019).

99 For an elaboration of the references to the waters of the Ganges in ancient Indian medical treatises of Chāraaka and Chakrapānidatta, the historian points me to P. K. Gode, *Studies in Indian cultural history*, vol. 3 (Bhandarkar Oriental Research Institute, Poona, 1969), available at <https://archive.org/details/StudiesInIndianCulturalHistoryVolume3> (accessed 17 April 2019). To my surprise, the chapter in this text titled 'Use of Ganges waters by Muslim rulers from A.D. 1300 to 1800' ends with a reference to d'Herelle and Hankin (at p. 149), seeking to chart a commensurability between the 'chemical properties' of the Ganges water and its 'spiritual properties' (not restricted by religion) via the figure of the bacteriophage.

the ecological degradation that confronts the Ganges and Yamuna, he is compelled to find confirmation of this contemporary ruination of the rivers in other textual sources.<sup>100</sup> Here is an excerpt from our conversation at the Kumbh Mela:

So—did you find the bacteriophage? Is there any Ganga water in the bed of this river? In the Skanda *Purāna*, what was prophesied has now come true: ‘10,000 years after *Kaliyug*, Vishnu puja on this Earth will cease. In half that time—5,000 years—we will see the Ganga water vanish in the bed of the river, and this body of water emanating from the foot of Vishnu will leave the earth. In 2,500 years, the village deities will disappear.’<sup>101</sup> Presently, this is the 5,119th year of the *Kaliyug*. Is it not enough time that the Ganga has flown till this moment? And *you* still believe that *this* is Ganga *jal*, and you are trying to find the bacteriophage in it!

In 2013, I gave a lecture at the past Kumbh Mela where I told them all: we’re surrounded by untreated sewage water, effluent from the factories, tanneries, sugar-mills which has a whole range of harmful chemicals and bacteria in it. So, the thing you must know foremost, and I am not saying it, our religious texts (*shastras*) are prophesying this based on the observations of our thoughtful ancient seers, is that after 5,000 years of the *Kaliyug*, the Ganga water will leave the river’s channel.

Bacteriophage, as you know, is found everywhere, but its quantity must have been quite high in the Ganga. This I felt even while reading Hankin’s account. Hankin worked on cholera, but that, too, was 100–150 years ago. Where were these chemicals running off from the agricultural fields and industries into the river then? People are using all this urea and pesticides today unthinkingly. The river is on the way to extinction. Can a dying person be saved by oxygen mask?

Articulated here is a foreboding sense of the gulf between the Ganges’s current material manifestation and its essences—its scriptural and spiritual mandates—as they have been recorded and prophesied in a variety of folkloric texts. The prophetic voice of ancient texts is merely confirmatory of modern degradations. For the historian, the presence of the bacteriophage in the Ganges was foretold, and is to be located in the registers of the river’s divine and timeless essence, its *jal*, which does not spoil, which ‘spontaneously’ destroys poisonous elements and which draws millions to itself for pilgrimage, ablution and absolution.<sup>102</sup> He therefore regards Hankin’s findings in 1896 as confirmations—or scientific elaborations—of an older order of time and sacrality; the technical object of the bacteriophage confirms mythic rationalities. As he once put the formula to me, ‘myths are nothing but science being *simplified* through many observations, while science is everything about myths that are *verified* through experiments’. Hankin’s scientific experiments, for the historian, merely confirm, or ‘verify’, older popular observations

100 Two recent works which trace the pollution of the Ganges—first, to colonial sewerage techniques, and, second, to the political ecology of mega dam projects on the upstream sections of the river—are Janine Wilhelm, *Environment and pollution in colonial India: sewerage technologies along the sacred Ganges* (Routledge, London, 2016); and Georgina Drew, *River dialogues: Hindu faith and the political ecology of dams on the sacred Ganga* (University of Arizona Press, Phoenix, 2020).

101 ‘Kaley darshanam Sahastrasrantey Vishnustayjati Meydineem Tadarth Jahanvitoyam tadartham gramdevta.’ The historian tells me that references to this same prophecy that the Ganges will ‘disappear from the face of the Earth’ after 5,000 years of the *Kaliyug* is repeated in both the *Varaha Purāna* (‘Prithvi Gangya Hina Bhavishyatyantimay’) and the *Brahma Purāna* (praktiti khandā, 68) (‘Adhya Prabhriti Deveshi Kale Panchsahastrakam Varshay Sthitistay Bharatyaa Shapayn Bhuvi’). For the entire *shloka*, see ‘Shastri’, *op. cit.* (note 98), p. 123. *Kaliyug* refers to the last of the four cyclical stages of the world; it is an age that witnesses widespread strife, greed, egotism and afflictions.

102 While poison, pollution and toxicity are interchangeably deployed by my respondents, they retain a specific medical, legal and categorical schema. On the ‘social life of poisons’ in India, see Arnold, *op. cit.* (note 46), pp. 7, 17–40.

regarding the river's self-purifying properties. At the same time, the mythic records 'simplify' these observations into easily digestible and transmissible facts.<sup>103</sup>

Faith, filth and phage therefore occupy positions on a syntagmatic chain of signification. Together, they offer confirmatory signatures of the operations of an eternal time and the powers of its prophecy. The routine introduction of modern toxins and pollutants into the riverine channel—and its transformation into a 'mutant ecology' of superbugs—is *also* foretold. This logic of mutation underlies both ecologies and cosmologies that are now *en route* to destruction.<sup>104</sup> The extinction of the river, to which he is resigned by way of textual prophecy, is linked intimately with the historian's doubts regarding the contemporary fate of the bacteriophage, whose loss, after Hankin, he mourns as merely an aspect of the looming end of scriptural, social and secular time.

*The vaid: between pollution and remedy by the Ganges*

The prophecy of pollution also finds reflection in material degradations within contemporary forms of life. Between 2015 and 2019, from the months of December to March, I began spending time at the practice of an Ayurvedic doctor who ministers to a cross-section of Allahabad's rural, peri-urban and outstation visitors who seek his remedies. I will refer to him as the *vaid* (doctor).<sup>105</sup> With him, at his clinic close to the banks of the river, I sought to explore the significance of the Ganges waters to a clinician practising a non-Western form of medicine; and the links between pollution, disease and remedy in a time of burgeoning AMR. How does the figure of the bacteriophage feature in the ministrations of a contemporary Ayurvedic *vaid*? How do these ministrations, in turn, address the effects of antibiotic resistance, itself conceptualized by the *vaid* as the fruit of a poisoned way of modern living?

According to the *vaid*, one must adhere to Ayurveda's mandates of living which promote healthfulness. These include *din charya* (routines of the day), *ritu charya* (routines of the season), *aahar charya* (routines of eating), *ratri charya* (routines of the night), *brahm charya* (routines of sexuality), etc. These finely dissect and prescribe aspects of lifestyle, routines, activities, exercises, compatible foods, etc.<sup>106</sup> Time, body and season are thus

103 Lévi-Strauss regarded the role of modern science not as one of antagonism to the lost myths of humanity but as an attempt to 'reintegrate' disordered sense data into new systems of meaning and truth. See Claude Lévi-Strauss, *Myth and meaning* (London, Routledge, 2001), pp. 1–4. On the 'high spiritual ambitions' of scientists in society, see M. Midgley, *Science as salvation: a modern myth and its meaning* (London, Routledge, 1992).

104 The term 'mutant ecology' is from Joseph Masco's descriptions of the social role of mutation in the aftermath of the nuclear testing at Los Alamos, one that introduces metamorphosis simultaneously in the biophysical world and multigenerational life of the area's 'survivors'. See J. Masco, *The nuclear borderlands: the Manhattan Project in post-Cold War New Mexico* (Princeton University Press, Princeton 2006), p. 326.

105 I am using a pseudonym here to keep the identity of my respondent anonymous.

106 During our conversations, the *vaid* recommended I peruse two texts that he found useful during his Ayurvedic medical training in which these mandates are recorded: Anantram Sharma, *Ashtanghridayam, Sutra Sthana, aur Maulik Siddanth* (Chaukhamba Prakashan, Varanasi, 2018); and Ravidutt Tripathi, *Padarth Vigyan* (Chaukhamba Prakashan, Varanasi, 2016). On recent historical studies of Ayurveda, see Jean M. Langford, *Fluent bodies: Ayurvedic remedies for postcolonial imbalance* (Duke University Press, Durham, NC, 2002); Projit Bihari Mukharji, *Doctoring traditions: Ayurveda, small technologies, and braided sciences* (University of Chicago Press, Chicago, 2016); and F. Zimmermann, *Jungle and the aroma of meats: an ecological theme in Hindu medicine* (Motilal Banarsidass, New Delhi, 2011). The role of medicine in contemporary Indian life is a vast field of enquiry: for a sampling, see D. Banerjee, 'Cancer and conjugality in contemporary Delhi: mediating life between violence and care', *Med. Anthropol. Q.* 33, 579–594 (2019); R. Barrett, *Aghor medicine: pollution, death, and healing in north India* (University of California Press, Berkeley, 2008); V. Das, *Affliction: health, disease, poverty* (Fordham University Press, New York, 2014); Michael M. J. Fischer, 'Urban Mahabharata: health care, ordinary, traditional, and contemporary ethics', *Med. Anthropol. Theory* 9, 98–129 (2017);

fundamental precepts of the *vaid's* Ayurvedic practice. Their transgression and profanation is the generation of pollution, a poisoned mode of living that has reached its nadir with our modern times.<sup>107</sup> The *vaid* witnesses their transgressions as part of his practice, which he seeks to manage and remedy through his prescriptions. The antibiotic is an exemplar of this modern mode of living—a poisonous entity that is promoted for its perceived benefits but which, nevertheless, has widespread consequences (*dikkat*) and side effects (*dushparinams*). For the *vaid*, antibiotics may treat conditions, but they never offer a permanent cure (*chutti*).

Within an overburdened medical setting, surrounded by various levels of deprivation, the *vaid* operates as a community therapist. He is a man available for prescribing, speaking, listening, learning from, and dwelling in the anxieties and symptoms of his many clients. He is also a refuge for people struggling against aspects of everyday life—joblessness, anomie, ageing, sickness, marital discord, sexual anxieties—who arrive at his practice bearing apprehensions of their *dis*-ease. They regard the *vaid* as a fount of diagnostic surety in a time of existential doubt.

The *vaid* claims to be witness to widespread popular alienation produced by changes in the modes of production and everyday consumption in contemporary Indian life. A resulting psychic anxiety emerges from a perceived absence of any element of grounding experience. This lack of authentic experience is supplemented with a pharmacological prosthetic like antibiotics, which are deemed to be 'strong and effective' medicines offering psychic and physical surety. Doctors trade off on this search for authenticity on the patient's part, but they also remain hostage to their own habits and pre-formatted prescriptions where generic symptoms elicit generic (antibiotic) drugs as automated response.

The *vaid* sees misuse and mismanagement of antibiotics fuelling growing antibiotic resistance in his area. Drugs being prescribed for months on end without proper diagnostics stop working for many. And poor-quality drugs continue being given without concern. Both practices forego the question of 'effectiveness' and foster pollution in the body; they secure transient, as opposed to lasting, relief. A good practitioner is able to think through an 'ineffective' medicine or bodily response; he must be willing to try and experiment both in the registers of the medicine and in the body's constitution.<sup>108</sup> For the *vaid*, a rampant culture of prescribing and accessing care through antibiotic quick-fixes in an overburdened biomedical system only generates poison.

In the *vaid's* imagination, the pollution in the rivers running adjacent to his clinic is merely an aspect of the transgressions of lifeways prescribed in Ayurvedic texts. The pollution in the river and the pollution of ill-being coalesce. Given this context of remedy, relief and pollution, I was interested in his views on the waters of the Ganges and the potential, as he sees it, of bacteriophages in a time where he is witnessing the increasing ineffectiveness of modern antibiotics and, concomitantly, deep social and medical anxieties. The *vaid* claims that

S. Pinto, 'Development without institutions: ersatz medicine and the politics of everyday life in rural north India', *Cult. Anthropol.* **19**, 337–364 (2004).

<sup>107</sup> In a similar vein, the anthropologist Lawrence Cohen has described how Indian gerontology is constructed around 'a narrative of inevitable decline' in family and cultural life, listing the vectors of this material and moral collapse as the 'four horsemen of contemporary apocalypse: modernization, industrialization, urbanization, and Westernization': see L. Cohen, *No aging in India: Alzheimer's, the bad family, and other modern things* (University of California Press, Berkeley, 1998), p. 18.

<sup>108</sup> Poisons (*bish*) feature as both remedy and cure in Ayurvedic and Unani medicine. The role of the *vaid* is in the management of poisons through a knowledge of their properties, symptoms and antidotes. See Arnold, *op. cit.* (note 46), p. 24.

people come to him in desperation (*majboori*) and suffering. To him, the phage in the waters of the Ganges could offer an experimental reprieve:

One could use Ganga *jal* on a patient (*mareez*), and then conduct a culture on a sample of their stool. We'll then be able to see whether, through the medium of the Ganga's water, the bacteriophage has any impact on the gastro-intestinal system or not. If it has a beneficial impact, I'm thinking that it can be deployed in a number of areas. It can serve as a therapeutic option (*vikalp*). One can see whether a person can be administered the water once or twice a month. The durations can then be adjusted or stopped, as needed. One must conduct research to see how long these viruses last in the body. If the body eliminates them after they kill the bacteria, it might be the case that Ganga's waters might be consumed daily in tiny amounts, say 10 ml, as an inoculum. More, and the water will make you sick!

I find it fascinating that the Ganga's waters are given to the dying person in their mouth for liberation (*moksha*). I wonder if that act has a connection to bacteriophages. Perhaps, upon death, what starts as the body's process of disintegration by rotting (*saran*)—which we call 'categoric lividity'—can be slowed down? Perhaps, because the body can then be kept appropriately for the last rites (*antim sanskaar*), there will be no issue with the soul's onward journey. Who knows? There are so many explanations! Whether you burn or bury a body, it is desirable to control its bacterial content before its disposal. Perhaps, with bacteriophages, you are serving the community by not allowing that polluting bacteria (*pradushan*) to spread in the environment? That is why, perhaps, when people drown in Ganga ji, or take dips, it is considered that they have been purified (*swacch ho gaye*).

The practical lesson here is that we can only dream of *moksha* if we can purify the community (*samaj ko swacch*), if we can give society something even in our death, if we don't spread polluting practices on Earth. *Moksha* means we will go to heaven only when we stop spreading filth in our life and our rivers. This is also the lesson of Ayurvedic remedy—keep a healthful person healthy (*swastha se swasthya rakshanam*). Ayurveda speaks about *general* health—health is at once mental, physical, social and spiritual wellbeing, not only the absence of disease (*san bhushan samarey sam dhatu bal kriya/ Prasann*). This is why the Ganga ji's bacteriophages raise the question of social health. That, even in the time of our death, we don't spread the causes of ill-health in society.

This contemporary manifestation of the phage's memory in the geographic locale of Hankin's nineteenth-century experiments deploys his 'antiseptic element' in the Ganges waters but, through it, imagines a more wholesome, collective future. Conflating the ecological with embodied pollution, the Ganga *jal* with the phage, and antisepsis with liberation, the *vaid* offers an experimental imagination.<sup>109</sup> On one level, this imagination uses the phage to pursue salvation for the material body plagued by modern pollutants and poisons. At another level, the *vaid*'s experimental imagination deploys the prospect of the phage in the river to simultaneously pursue individual, community and ecological transcendence. Within both levels of that imagination, the phage remains a technic—an object which offers not only therapy, purification and healthfulness, but also a reconfigured relationship with natural ecologies and cultural practices.

109 Experimental systems, by their nature of manipulation, make possible a transition from epistemic things—perpetually generated reactions, structures and processes—to stabilized and restricted technical objects. See Hans-Jörg Rheinberger, 'The "epistemic thing" and its technical conditions: from bio-chemistry to molecular biology', in *The interaction between technology and science* (ed. Bart Gremmen), pp. 281–291 (Wageningen Agricultural University, Wageningen, 1991).

*The patient and the biologist: between remedy and futures*

For residents of Allahabad like Prakash, bacteriophages make the future possible.<sup>110</sup> Prakash was introduced to me by a mutual friend in Delhi, whom he had encountered while searching for a cure for his multi-drug-resistant urinary tract infection. This infection is one that he continues to live with as a legacy of six surgeries and the many associated bodily ‘complications’ following multiple renal transplants since 2000: the removal of his failing native kidneys, their replacement with kidneys transplanted from his kin-members, and the associated surgeries to address complications in his heart and bladder. In one way, this is a good summary of Prakash’s body. But it is an inadequate one. For Prakash is also a teacher, a father, a husband and an avid lover of road trips.

Prakash learnt about phage therapy while searching online for alternative therapies to his infection—ways of improvising a future when the standard modes of operation and endurance (here with antibiotics) were exhausted. Through that effort, he encountered the work of a leading phage biologist at Banaras Hindu University, Professor Gopal Nath.

For Prakash, these local phages serve as a lifeline—a prosthetic to lead as ordinary a life as possible with a multi-drug-resistant infection.<sup>111</sup> His is a case where antibiotics and phages present ‘ethical plateaus’—a complex *mélange* of peoples, promises and institutions that must endure as a tentative system to address challenges emanating from a future filled with crisis and potentiality.<sup>112</sup> On the one hand, Prakash cannot do without the last-line antibiotics for treating his urinary tract infection. On the other hand, these same antibiotics—colistin, tigecycline and fosfomycin—are highly toxic for his kidneys, threatening the integrity of his renal transplants. At the same time, to prevent an immune rejection of his transplanted kidneys, Prakash is routinely administered immunosuppressant drugs—entities that make him even more prone to bacterial infections. In this fatal circle involving the recalcitrant microbe, the vulnerable body and the poisonous drug, phages offer a welcome break.

Prakash claims that phages alter the antibiogram of his infection by changing the sensitivities of his infection to antibiotics. Once given, they allow him the option of more antibiotics that he can deploy when, for a very long time, he could only use nephrotoxic antibiotics, or none at all. As such, in removing him from the fate of *total* resistance, phages serve as an experimental prosthetic—entities that make a future possible for Prakash so that he can ‘live way past the mid-40s’. Phages do not produce the total eradication of his infection. But they allow the infection, and its myriad symptoms (such as pain and burning), to be effectively managed. When I ask Prakash if he believes in the curative powers of the waters of the Ganges, from which some of his phages have been sourced, he claims that he takes ritualistic dips in the *sangam* during the Kumbh Mela only because of his faith and the force of habit. On the suggestion that the phages of the Ganges are unique, he smiles knowingly, citing evidence that they can be found in *any* dirty or polluted body of water.

The conflation of the Ganges waters with the phage—the Ganga *jal*—is symbolically and historically important, even if scientifically it can be demonstrated that phages are universally

110 I am using a pseudonym here to keep the identity of my respondent anonymous.

111 On the relationship of cures to time—i.e. whether cures produce horizons marked by endings, finality, transience, relapse or some other promissory modality—and what it takes in the realm of evidence production to apprehend the ‘truth of cure’, see Bharat Venkat, ‘Cures’, *Public Culture* 28, 475–497 (2016).

112 Michael M. J. Fischer, *Anthropological futures* (Duke University Press, Durham, NC, 2004), p. 51.

ubiquitous. The link with Hankin and, through his experiments on these waters, with an older sacral and temporal order is productive in the present—as my interactions with Professor Nath alerted me. For instance, at a conference he organized in 2017, titled the ‘1st international conference on bacteriophages in “River Ganga”’, Professor Nath explicitly invoked the 1896 reference to Hankin, linking it both to the sacred and to more terrestrial ethics. The former emerged from his childhood and from devout connections that members of his family and extended kin have had with the river. The terrestrial ethics pertain to his pursuit of phages from the river as alternatives to antibiotics in the face of drug resistance, for instance, in practically helping individuals like Prakash who have run out of antibiotic options.<sup>113</sup>

Professor Nath’s formulation of bacteriophage therapy as an ‘indigenous technology’ remains oriented both to a historicity linked to the river’s connection with Hankin and to a viable future.<sup>114</sup> With bacteriophage therapy, a ‘looking back into the future’ now includes Professor Nath’s stewardship of the ‘Ganga Bacteriophage Research and Therapy Centre’ in Banaras.<sup>115</sup> The centre plans to run the gamut of phage isolation and characterization, experimental animal model studies and human trials,<sup>116</sup> and aims to deploy phages as part of a One Health paradigm in animal husbandry, poultry and fishery, and human health care systems.<sup>117</sup> The invocation of the river as one of the many local sources—or ‘natural niches’—for phage isolation in an imagined post-antibiotic world,<sup>118</sup> is a tacit and tactical move: a mode to create awareness in government and regulatory circles, and invite more public belief in his bacteriophage research.

#### CONCLUSION: THE SIGNIFICANCES OF BACTERIOPHAGES

Bacteriophages have a robust future. In the twenty-first century, these ecologically ubiquitous viral predators of bacteria have multiple lives in the modern biosciences. They are foundational to the unfolding story of CRISPR genome-editing tools—based on the

113 Félix d’Herelle’s biographer, William C. Summers, was a participant at this conference. In Summers’s view, the conference sought to recognize ‘the ancient historical and cultural aspects of the Ganga while at the same time exploring the river in the up-to-date ways of biological sciences ... This international conference brings together scientists who are dedicated to understanding the microbiology of the Ganga river, especially as it relates to her bacteriophages, but in the background, we all know the importance of understanding and respecting the important role of Ganga as India’. See Gopal Nath, *Phage in Ganga conference souvenir* (Banaras Hindu University, Varanasi, 2017), emphasis added.

114 Gopal Nath, ‘Editorial: bacteriophage therapy: an answer to superbugs’, *Indian J. Preventive Soc. Med.* **44**, 1–2 (2013).

115 Gopal Nath *et al.*, ‘Bacteriophage therapy: looking back in to the future’, in *The battle against microbial pathogens: basic science, technological advances and educational programs* (ed. A. Méndez-Vilas), pp. 284–294 (Formatex Research Center, Spain, 2015). Gopal Nath, ‘RFP: National Ganga Bacteriophage Research and Therapy Centre, Centre for Advance Research’ (Banaras Hindu University, Varanasi, 2018).

116 Gopal Nath *et al.*, ‘Bacteriophage therapy: an alternative to antibiotics—an experimental study in mice’, *Ann. Nat. Acad. Med. Sci. (India)* **55**, 151–158 (2019) (<https://doi.org/10.1055/s-0039-1698545>); and Gopal Nath *et al.*, ‘Phage therapy of staphylococcal chronic osteomyelitis in experimental animal model’, *Indian J. Med. Res.* **143**, 87–94 (2016). D. R. Patel, S. K. Bhartiya, R. Kumar, V. K. Shukla and G. Nath, ‘Use of customized bacteriophages in the treatment of chronic nonhealing wounds: a prospective study’, *Int. J. Lower Extremity Wounds*, 1–10 (2019) (<https://doi.org/10.1177/1534734619881076>); Deepak Kumar, Pooja Gupta, Akanksha Srivastava and Gopal Nath, ‘Phage therapy of MRSA infected wound: a case report’, poster presented at the ‘International conference on bacteriophage research and antimicrobial resistance (ICBRAMR ’19), Vellore’, December 2019.

117 P. Gupta, H. S. Singh, V. K. Shukla, G. Nath and S. K. Bhartiya, ‘Bacteriophage therapy of chronic nonhealing wound: clinical study’, *Int. J. Lower Extremity Wounds* **18**, 171–175 (2019) (<https://doi.org/10.1177/1534734619835115>).

118 See Gopal Nath, ‘Pattern of multidrug resistance and phage types in *Salmonella enterica* subspecies enterica serotype typhi in Varanasi during 1979–1997’, *Indian J. Med. Microbiol.* **17**, 97–98 (1999).

adaptive immune systems of bacteria infected by bacteriophages—now being deployed, potentially, for human germline transformations.<sup>119</sup> Simultaneously, bacteriophages retain a crucial role as workhorses of modern molecular biology and genetics, continuing their twentieth-century history as experimental organisms for basic scientific experimentation and epistemology.<sup>120</sup> At the same time, bacteriophages are being (re)invoked—following their Soviet deployment—as contemporary antibacterial agents in a time where the slower contagion of AMR is proliferating across the planet.<sup>121</sup> Further, phages are increasingly instrumental to our evolving understanding of biochemical processes at the level of the individual microbiome and the planetary carbon and nitrogen cycles, given their role in the infection, elimination and recycling of nearly 40% of the planet’s marine bacterial cells on a daily basis.<sup>122</sup> Yet, if bacteriophages have been ‘machines for making the future’,<sup>123</sup> they arrive, conceptually, from a knotted history of myth and indigenous-scientific epistemes of damage and recovery.<sup>124</sup>

A headline in the *New York Times* on 23 December 2019 blared: ‘The Ganges brims with dangerous bacteria’.<sup>125</sup> Part of the newspaper’s ‘Deadly germs, lost cures’ series that has been tracking the emergence of multi-drug-resistant pathogens, or ‘superbugs’, in the twenty-first century, the article reveals the ‘astronomically high’ levels of antibiotic-resistant bacteria in the river, and the environmental degradations faced by it, as it descends from its glacial Himalayan abode down the plains of northern India and into the oceanic expanse of the

119 Three pioneering records of CRISPR are P. D. Hsu, E. Lander and F. Zhang, ‘Development and applications of CRISPR-Cas9 for genome engineering’, *Cell* **157**, 1262–1278 (2014) (<https://doi.org/10.1016/j.cell.2014.05.010>); M. Jinek, K. Chylinski, I. Fonfara, M. Hauer, J. A. Doudna and E. A. Charpentier, ‘A programmable dual-RNA-guided DNA endonuclease in adaptive bacterial immunity’, *Science* **337**, 816–821 (2012) (<https://doi.org/10.1126/science.1225829>); and F. J. M. Mojica, C. Díez-Villaseñor, J. García-Martínez and C. Almendros, ‘Short motif sequences determine the targets of the prokaryotic CRISPR defence system’, *Microbiology* **155**, 733–740 (2009) (<https://doi.org/10.1099/mic.0.023960-0>). On the legal tussle surrounding CRISPR patent claims, see Jon Cohen, ‘How the battle lines over CRISPR were drawn’, *Science*, 15 February 2017, <https://www.sciencemag.org/news/2017/02/how-battle-lines-over-crispr-were-drawn> (accessed 17 March 2020). CRISPR’s (mis)use to conduct human germline genetic alterations—‘CRISPR Babies’—by He Jiankui in China was recently in the news, see J. Doudna, ‘CRISPR’s unwanted anniversary’, *Science* **366**, 777 (2019); and E. Lander *et al.*, ‘Adopt a moratorium on heritable genome editing’, *Nature* **567**, 165–168 (2019).

120 On the role of phages as experimental organisms in twentieth-century molecular biology, some historical accounts are J. Cairns *et al.* (eds), *Phage and the origins of molecular biology* (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 2007); M. Morange, *A history of molecular biology* (Harvard University Press, Cambridge, MA, 2000); A. Cambrosio, D. Jacobi and P. Keating, ‘Phages, antibodies and de-monstration’, *Hist. Phil. Life Sci.* **30**, 131–158 (2008); Helvoort, *op. cit.* (note 45); Nicholas C. Mullins, ‘The development of a scientific speciality: the phage group and the origins of molecular biology’, *Minerva* **10**, 52–82 (1972); W. C. Summers, ‘How bacteriophage came to be used by the phage group’, *J. Hist. Biol.* **26**, 255–267 (1993). Recent efforts to (re)purpose bacteriophages include their deployment in astrobiological research: see National Aeronautics and Space Administration, ‘Astrovirology’, virtual workshop, 18–19 September 2019, <https://nai.nasa.gov/seminars/featured-seminar-channels/workshops-without-walls/2019/9/18/astrovirology/> (accessed 16 June 2020).

121 Hannah Landecker has recently described AMR as a ‘biology of history’, an outgrowth that carries historical time within it: see H. Landecker, ‘Antibiotic resistance and the biology of history’, *Body Soc.* **22**, 19–52 (2016), at p. 19. On contemporary accounts of phage therapy against AMR, see S. Strathdee, *The perfect predator: a scientist’s race to save her husband from a deadly superbug: a memoir* (Hachette Books, New York, 2019); and Timothy K. Lu *et al.*, ‘Engineering phage host-range and suppressing bacterial resistance through phage tail fiber mutagenesis’, *Cell* **179**, 459–469 (2019) (<https://doi.org/10.1016/j.cell.2019.09.015>).

122 Nicola Twilley, ‘Inside the world of viral dark matter’, *New Yorker*, 6 February 2015, <https://www.newyorker.com/tech/annals-of-technology/phage-killer-viral-dark-matter> (accessed 8 March 2019).

123 Hans-Jörg Rheinberger, *Toward a history of epistemic things: synthesizing proteins in the test tube* (Stanford University Press, Stanford, 1997), p. 80.

124 Epistemes are epistemological grounds on which the ‘conditions of possibility’ of specific systems of knowledge are predicated. For a discussion of how historical epistemes change over time, generating new forms of rationality, value and objectivity, see M. Foucault, *The order of things: an archaeology of the human sciences* (Routledge, London, 1970).

125 Donald G. McNeil Jr, ‘The Ganges brims with dangerous bacteria’, *New York Times*, 23 December 2019, <https://www.nytimes.com/2019/12/23/health/ganges-drug-resistant-bacteria.html> (accessed 25 December 2019).



Bay of Bengal. Researchers from the Indian Institute of Technology, Delhi, surveyed by the article, track how

winding over 1,500 miles to the Bay of Bengal, Ma Ganga—‘Mother Ganges’—eventually becomes one of the planet’s most polluted rivers, a mélange of urban sewage, animal waste, pesticides, fertilizers, industrial metals and rivulets of ashes from cremated bodies.<sup>126</sup>

Yet, if the current fate of the Ganges offers clues to the global spread of antibiotic resistance—‘one of the world’s most daunting health problems [that render] germs impervious to common medicines’<sup>127</sup>—the river has an interesting history that is also tied up with its bacterial load. As one of the commentators to the article points out, despite over-population and the ecological devastation wrought by the introduction of pollutants into the river:

it was this river that introduced us to bacteriophages in 1896, viruses that devoured bacteria, pathogens included. One has to wonder what it is that is present in the Ganges, perhaps in the bed or even the waters, that can support an existence of so many pathogens and yet not decimate the population of pilgrims that visit in enormous throngs. This is an incomplete study at this point. But it would be immensely profitable to study the waters of the Ganges for clues on how to battle resistant bacteria.<sup>128</sup>

While I was conducting ethnographic fieldwork in Allahabad in 2019, my movements around the *sangam* and the Kumbh Mela were routinely disrupted. Politicians and VIPs regularly attended the event in SUVs with large coterie of followers and gun-toting bodyguards, impeding the ordinary flow of devotees and pilgrims. They performed religious rituals by the banks of the riverine confluence and carried out official functions beyond the pale of a secular constitutional state, including chairing ministerial meetings by the *sangam*, inaugurating religious functions and providing patronage to explicitly religious groups and individuals. While always a heavily mediated event that is broadcast globally, this version of the Mela in an election year had its name changed by bureaucratic fiat from an ‘ardh Kumbh’ (calendrically scheduled every six years) to the more prestigious ‘Kumbh’ named after the 12-yearly iteration of the event.<sup>129</sup> Before the Mela, the city’s name was altered by governmental orders with the aim of erasing the city’s intimate cultural connections with the Mughal emperor Akbar.<sup>130</sup> As such, the Mela in 2019 was specifically engineered towards achieving a politics that blended electoral triumph, state power and religious majoritarianism. Today, the phage and Kumbh Mela are increasingly hostage to a politics in which Hankin’s findings are routinely called upon to aggrandize a particular history and statecraft.<sup>131</sup> Yet, if this paper has argued anything, it is that the

126 *Ibid.*

127 *Ibid.*

128 *Ibid.*

129 Dharendra K. Jha, ‘Despite the hype, the BJP couldn’t turn an Ardh-Kumbh into a full Kumbh Mela’, *Caravan*, 6 February 2019, <https://caravanmagazine.in/politics/kumbh-mela-bjp-renaming-ardh-kumbh> (accessed 9 February 2019).

130 On the civic importance of Allahabad to Mughal governance, see N. R. Farooqi, ‘Once upon a time in Prayag: Akbar did not rename a holy site, but convinced of its sanctity, he imagined a city—for all faiths’, *Indian Express*, 28 October 2018, <https://indianexpress.com/article/express-sunday-eye/once-upon-a-time-in-prayag-5420922> (accessed 14 November 2019). For a discussion of Allahabad’s salience to Mughal and British administrative rule, see Faridah Zaman, ‘Colonizing the sacred: Allahabad and the Company state, 1797–1857’, *J. Asian Stud.* **74**, 347–367 (2015).

131 The Indian minister for water resources and river development sought to describe Hankin’s work, and the supposed self-purifying qualities of the Ganges, in terms of ‘Brahma Dravya’ or ‘divine liquid’. See Pallav Bagla, ‘Is Ganga water special because of

phage and the constellation that surrounds it is much more, and much more complex, than these reductive political machinations and their instrumentalist views of science.<sup>132</sup>

The phage is not just a virus of historical significance. It is something lost in an archive that once instigated scientific thought, and which continues to stimulate a range of conversations—encouraging *Illahabadis* to rethink their connections to history, to place and to technics. Constituted by the river, the virus and the time of pollution, Allahabad's cosmotechnical constellation generates 'particular, concrete forms of life'.<sup>133</sup> Within that context, the bacteriophage remains a protean technical object around which actors operating with their own sense of material and discursive facts, and spirits of objectivity, now coalesce.

For many of my interlocutors, the spiritually purifying and bactericidal qualities of the Ganges waters remained conflated. They regarded Hankin's findings as scientific confirmations of older orders of sacrality and cultural truths—a sacrality that holds the Ganga *jal*'s spiritual-purification and self-purification qualities as co-equal and co-present. Some respondents expressed concern regarding the spectacle of the Kumbh Mela and bathing with Ganga *jal* in the river, which they regarded as having devolved from a spiritually important pilgrimage to a vulgar display of power and prominence. The pollution of the river, further confirmation for them of this vulgarity, meant that what was spiritually purifying as well as bactericidal was no longer as *effective* as it once was. If Hankin's findings were, once upon a time, scientific elaborations of truths already foretold in other sources, the ecological and political degradations of the Ganges and the Kumbh Mela today generate scepticism for some regarding the conflation of the scientific and the mythic forms of reason. However, this scepticism, too, derives from myths and textual sources that foretell the doom of the rivers. Other respondents dealt differently with the conflation of the scientific and mythic orders in the Ganga *jal*: some were happy to make that connection for strategizing patronage from the authorities; others did not believe in any connection between the spiritual and the scientific but continue to make use of the waters out of force of habit, upbringing or the pursuit of grace. Still others, like the *vaid*, present their own unique (and speculative) perspectives about remedy, pollution and death through the Ganga *jal* and the bacteriophage. Reverberating between the sceptical and the speculative, respondents in Allahabad remind us that both the virus and the rivers remain 'good to think with'.<sup>134</sup>

As I write this paper, I witness the world confronting the perils of the COVID-19 pandemic.<sup>135</sup> Set against that alarming eukaryotic virus, the bacteriophage remains

an enigmatic X-factor?', *Economic Times*, 22 November 2015, <https://economictimes.indiatimes.com/news/politics-and-nation/is-ganga-water-special-because-of-an-enigmatic-x-factor/printarticle/49877929.cms> (accessed 16 March 2020).

132 Two prominent accounts of the hijacking of science and spiritual cosmographies to rigid rationalities of social order are Banu Subramaniam, *Holy science: the biopolitics of Hindu nationalism* (University of Washington Press, Seattle, 2019); and Meera Nanda, *Prophets facing backward: postmodern critiques of science and Hindu nationalism in India* (Rutgers University Press, New Brunswick, 2003).

133 Hans-Jörg Rheinberger, 'Gaston Bachelard and the notion of "Phenomenotechnique"', *Perspect. Sci.* **13**, 313–328 (2005), at p. 316.

134 Claude-Lévi Strauss, *Totemism* (Beacon Press, Boston, 1962), p. 89.

135 World Health Organization, 'Coronavirus disease (COVID-2019) situation reports', 21 January 2020, <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports> (accessed 17 March 2020). On the need to distinguish 'promising' phages from 'enemy' viruses like COVID-19, see H. Harris, 'In defence of viruses', *Conversation*, 22 April 2020, <https://theconversation.com/in-defence-of-viruses-136732?> (accessed 24 April 2020).

ubiquitous and humble, one of the most widely distributed entities on the planet.<sup>136</sup> The Ganges and Yamuna waters, and their relation to bacteriophage pre-discovery, also continue to provide ways of thinking through this unfolding pandemic. For instance, an Indian non-governmental organization in April 2020 called upon government authorities to examine whether bacteriophages in the Ganges—which the group termed ‘ninja viruses’—might be effective against the novel coronavirus.<sup>137</sup> Notwithstanding the ecological specificity of bacteriophages to bacteria, rather than other viruses, such creative thought-experiments illustrate how imaginaries of bacteriophages in the Ganga *jal* are summoned as technical quick-fixes to deal with contemporary cultural malaises. Such quick-fixes, nevertheless, remain enmeshed within wider questions of historical evidence, the intimate connections between politics and nature, and the imagined roles for religion and technology in dealing with crises. With Hankin’s pre-discovery in 1896 of a bactericidal substance in Indian river waters, its subsequent influence on d’Herelle in the early twentieth century, and Hankin’s erasure in contemporary bacteriophage history, we return to the river banks of the Ganges and Yamuna. There we find people on multiple quests to rethink and live with the bacteriophage. Their stories bring into sharp relief the phage’s dispersion, and its many contemporary careers, in Allahabad and the world.

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136 A ‘centennial field guide to the Earth’s most diverse inhabitants’ is F. Rohwer *et al.*, *Life in our phage world* (Wholon, San Diego, 2014). For the use of phages in vaccinology, see R. Sartorius *et al.*, ‘Arming filamentous bacteriophage, a nature-made nanoparticle, for new vaccine and immunotherapeutic strategies’, *Pharmaceutics* **11**, 1–22 (2019) (<https://doi.org/10.3390/pharmaceutics11090437>).

137 Rahul Sampal, ‘Can Gangajal treat Covid-19? Modi govt wants a study, ICMR says no’, *Print*, 5 May 2020, <https://theprint.in/health/can-gangajal-treat-covid-19-modi-govt-wants-a-study-icmr-says-no/415365/> (accessed 5 May 2020). For this NGO, the history of the phage in the Ganges waters is the source of the river’s special essence—its ‘Gangatva’—which is today speculated to treat COVID-19. The Indian government asked the country’s apex biomedical regulator to conduct further studies. I thank Abhimanyu Pandey for alerting me to this news item.