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EDICIONES COMPLUTENSE

A New Definition of the Black Death: Genetic Findings and Historical Interpretations

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Abstract. The field of infectious disease history has been transformed in the past decade in large part because of fortuitous developments in several adjacent fields, most importantly genetics. The medieval period (ca. 500 to ca. 1500) has proved particularly important for these developments, not simply because it is now the earliest period from which whole genomes of several bacterial and viral pathogens have been retrieved, but also because the narratives that can be constructed about disease emergence and dissemination are most robust for this period thanks to the amount of surviving archival evidence. This essay introduces the transformative work in molecular biology that has allowed reconstruction of the evolutionary histories of pathogens afflicting humankind. Plague, the disease caused by the bacterium *Yersinia pestis*, has been at the forefront of this new work. An extraordinarily lethal disease, plague gives a prime example of how the evolutionary narratives of genetics yield information valuable to historians, precisely because they allow us to see phenomena at a hitherto invisible microscopic level. This essay proposes a new definition of the Black Death, or more properly, the Second Plague Pandemic, which is based on a new, evolutionary understanding of the pandemic's pathogen. However, scientific approaches are not inherently more productive of unassailable truths than are traditional humanistic or archaeological methods for the study of disease history. The complementarity of material and cultural sources is especially fruitful for work employing the perspectives of global history. Although most historiography on the late medieval pandemic has focused on Europe, whose crisis with plague did not begin until 1347, I argue that such a limited geographic definition occludes not only as much as a century and a half of plague activity, but also occludes connected events in Asia and Africa. Given the urgency of understanding pandemics in a world of rapid change, the history of plague offers us the best available model for thinking about pandemics.
Keywords: Plague (Yersinia pestis); palaeogenetics; Justinianic Plague; Black Death; Mongol Empire; Global Middle Ages

[es] Una nueva definición de la Peste Negra: Hallazgos genéticos e interpretaciones históricas

Resumen. El campo de la historia de las enfermedades infecciosas se ha transformado en la última década en gran parte debido a desarrollos fortuitos en varios campos adyacentes, sobre todo, la genética. El período medieval (ca. 500 a ca. 1500) ha demostrado ser particularmente importante para estos desarrollos, no solo porque ahora es el período más antiguo del que se han recuperado genomas completos de varios patógenos bacterianos y virales, sino también porque las narrativas que se pueden construir sobre la aparición y diseminación de la enfermedad son más sólidas para este período, gracias a la cantidad de evidencias de archivo sobrevivientes. Este ensayo presenta el trabajo transformador en biología molecular que ha permitido la reconstrucción de las historias evolutivas de los patógenos que afligen a la humanidad. La peste, la enfermedad provocada por la bacteria Yersinia pestis, ha regido este nuevo trabajo. Enfermedad extraordinariamente letal, la peste brinda un excelente ejemplo de cómo las narrativas evolutivas de la genética ofrecen información valiosa para los historiadores, precisamente porque nos permiten ver fenómenos en un nivel microscópico hasta ahora invisible. Este ensayo propone una nueva definición de la Peste Negra, o, más propiamente, la Pandemia de la Segunda Peste, que se basa en una nueva comprensión evolutiva del patógeno de la pandemia. Sin embargo, los enfoques científicos no son inherentemente más productivos en verdades incuestionables que los métodos humanísticos o arqueológicos tradicionales para el estudio de

[1] Acknowledgements: The following synthesis builds on work I have been doing for two decades to bring the findings of medical history, bioarchaeology, and genetics into an interpretive alliance. An earlier form of this essay was commissioned in 2020 for a special issue on pandemics for the *Isis Critical Bibliography* and remains available on that journal's webpage. Because of editorial disagreements, I withdrew the essay after the second round of review and present a substantially rewritten form of it here. First and foremost, I wish to acknowledge the many conversations I had with bioarchaeologists Anne Grauer, Jane Buikstra, and Rachel Scott about the material record of infectious diseases. In 2013-14, I was a Visiting Scholar of the World History Center at the University of Pittsburgh, which allowed me to expand my global thinking. Tutorials from my former colleague, Lauren McArthur Harris, a specialist in History Education at Arizona State University, taught me the value of scalar thinking in world history pedagogy. In 2015, a short-term fellowship at the American Academy in Berlin allowed me to expand my network of contacts in Europe and dive more deeply into the literature on leprosy's history. In 2020-21, a COVID-19 Grant from the Lepage Center for History in the Public Interest, Villanova University, allowed my collaborators, Nükhet Varlık and Tunahan Durmaz, and I to expand yet again the network of scholars engaged with infectious disease history. Finally, my debt to conversations with Robert Hymes, Nahyan Fancy, and Susan Einbinder about the challenges of synthesizing cultural and scientific approaches to disease history is immeasurable.
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la historia de la enfermedad. La complementariedad de las fuentes materiales y culturales es especialmente fructífera para el trabajo que emplea las perspectivas de la historia global. Aunque la mayor parte de la historiografía sobre la pandemia de la Baja Edad Media se ha centrado en Europa, cuya crisis con la peste no comenzó hasta 1347, argumento que una definición geográfica tan limitada bloquea no solo un siglo y medio de actividad de la peste, sino que también bloquea otros eventos relacionados en Asia y África. Dada la urgencia de comprender las pandemias en un mundo que cambia rápidamente, la historia de la peste nos ofrece el mejor modelo disponible para considerar las pandemias.
Palabras clave: Plaga (Yersinia pestis); paleogenética; Plaga de Justiniano; Peste Negra; Imperio Mongol; Medioevo Global.

Summary. 1. The Great Mortality: Telling Stories on a Global Scale. 2. Methodological Innovations: A Reverse Archaeology of Infectious Disease History. 3. Historians Making Sense of Plague Genetics. 4. Paths Forward: Histories Informed by Science (and by the History of Science)

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1. The Great Mortality: Telling Stories on a Global Scale

The Middle Ages have always loomed large in the history of epidemics because of the outsized role the late medieval Black Death ("the Great Mortality") has held in defining what true epidemiological horrors were possible. Plague, as we understand the disease now, would have killed its victims within three to twelve days of infection. It could readily lay whole towns to waste in a matter of weeks. It repeatedly elicited morbid observations to the effect that "There weren't enough living to bury the dead". A pandemic that in many regions caused upwards of fifty per cent mortality, and that had economic and social ramifications traceable throughout the early modern period (and even up to the present day), certainly should be seen as epoch-defining.[2]

Yet the Black Death (usually dated 1346-1353) and the plague pandemic that preceded it at the beginning of the medieval period, the so-called Justinianic Plague (541-ca. 750), have perhaps been seen as too singular. In modern western historiographical traditions, and in popular thinking, there has been a tendency to cordon off the Black Death and the Middle Ages itself as a past the world outgrew. Most people are surprised to learn that plague still exists in the world today. Even most early modernists are unaware of how profoundly plague continued to affect the landscape of early modern Europe, East and North Africa, the Ottoman Empire, and China for centuries after the late medieval mass mortalities. Yet in the space of just the past decade, it has become commonplace among plague historians to see unified histories of plague that extend for centuries, with various regions of Afro-Eurasia suffering under sustained "plague regimes". The Second Plague Pandemic (thirteenth to nineteenth centuries) seems to have followed, in its routes and perhaps its causes, a "playbook" already seen in the prior major outbreak of plague, the First Plague Pandemic, whose transmission out of its rodent reservoir may have begun as early as the first or second century BCE. In both cases, both the chronologies and the maps of these pandemics have been utterly transformed in the past few years.[3] This shift in perception of plague's history has occurred for one principal reason: the advent of an evolutionary understanding of the pathogen that causes plague, *Yersinia pestis*. Plague is no longer a generic disease, undifferentiatable from one instance to another. Instead, plague can now be understood as a branching network of specific strains, each tied to specific times and places. This transformation in perception allows a new *historical* understanding of the medieval pandemics to emerge.

Plague has been in the vanguard of a new mode of understanding infectious disease history generally. Research on other major diseases of the eastern hemisphere –most importantly, tuberculosis, leprosy, paratyphoid fever, and smallpox– has been developing as well, and the whole ensemble of these Old World disease histories are now being taken into account when assessing the impacts of European colonial expansion in the fifteenth century and later when the disease *oecumene* of the Old World expanded to include that of the New (the Americas and Oceania).[4] Transformative insights have also come from molecular investigations of infectious diseases in the modern period: for example, our current understanding of the history of influenza since the early twentieth century has been based on work in modern bacteriological archives, while genomic analy-

[2] Examples of work suggesting the long-term consequences of the Black Death on the basis of massive population loss include the following: James Belich, "The Black Death and the Spread of Europe", in *The Prospect of Global History*, edited by James Belich, John Darwin, Margret Frenz, and Chris Wickham (Oxford: Oxford University Press, 2016), 93-107; Gérard Chouin and Olanrewaju Blessing Lasisi, "Crisis and Transformation in the Bight of Benin at the Dawn of the Atlantic Trade", in *Power, Political Economy, and Historical Landscapes of the Modern World: Interdisciplinary Perspectives*, edited by Christopher R. DeCorse (Albany: SUNY Press, 2019), 285-306; and Guido Alfani, "Economic Inequality in Preindustrial Times: Europe and Beyond", *Journal of Economic Literature* 59, no. 1 (2021): 3-44. On the persistence of medieval strains of plague in Asia, see Monica H. Green, "Putting Asia on the Black Death Map", *The Medieval Globe* 8, no. 1 (2022), 59-87.

[3] Up-to-date bibliographies of both pandemics can be found in Joris Roosen and Monica H. Green. "The Mother of All Pandemics: The State of Black Death Research in the Era of COVID-19 – Bibliography", 26 May 2020 (with subsequent updates), https://drive.google.com/file/d/1x0D_dwy-Awp9xi9sMCW5UvpGfEVH5J2ZA/view?usp=sharing, accessed 07 Sep 2022; and Nükhet Varlık, "Plague in the Mediterranean/Islamic World" [version 3], *IsisCB Special Issue on Pandemics*, edited by Neeraja Sankaran and Stephen P. Weldon, submitted on 2022/04/13, accepted 2022/05/25, https://drive.google.com/file/d/1fPI4PhwbNcwt6dyZkwthRzHZNoeLabSs/view, accessed 11 September 2022.

[4] Monica H. Green, "The Great Dying: The Epidemiological Implications of Old and New World Encounters, 1000-1800," *Isis Critical Bibliography*, draft submitted 10 June 2021, https://drive.google.com/file/d/1wYlHpY5l11HE5Vk2qwvxYSeiXKqEZQSo/view.

ses of archived blood samples have transformed our understanding of the twentieth-century history of HIV. But plague clearly was and is the most important of these diseases, and not simply because of its catastrophic mortality or even because of the public health interventions it eventually elicited. Rather, the history of plague adds depth of historical perspective that reveals broader landscapes and more complicated patterns in infectious disease history than historians have previously imagined. Most importantly, a *global* Middle Ages is revealed, demonstrating that plague as experienced in Europe and the western Islamicate world (which are also the regions that have contributed the most to modern Black Death narratives) constitutes only part of the story. The advent of evolutionary understandings of *Yersinia pestis*' spread helps reveal more, and more complicated, stories of how multiple plague regimes were created in the late medieval world. These patterns have a special importance now because they also reveal, as if in slow motion, processes that the world has newly witnessed at a greatly accelerated pace during the COVID-19 pandemic. The pathogens may be different, but the forces that allow pandemics to become *pan*-demic have major commonalities. As such, this essay suggests how medieval historians can reconceive and reframe prior generations' efforts at explaining the history of infectious diseases and human experiences of them.

2. Methodological Innovations: A Reverse Archaeology of Infectious Disease History

Plague, the disease caused by the bacterium *Yersinia pestis*, has been the object of medical attention since at least the first century of the Common Era.[5] At first understood in the Greco-Roman-Islamic tradition as a particular type of symptom –the bubo, a purulent swelling in the neck, underarm, groin or (in one of the earliest descriptions) behind the knee– the condition came to be seen as a particular kind of pestilential fever.[6] As such it was classed among other pestilential fevers which, as a group, could be attributed to noxious environmental conditions, most especially miasms ("bad air"). Although notions of contagion (direct person-to-person spread) were entertained at certain points in time, miasmatic thinking predominated until the advent of bacteriological investigations in the late nineteenth century. This was the great age of germ theory discoveries, as one infectious disease after another was revealed to have a microscopic organism as its cause. Plague's causative organism, now known as *Yersinia pestis*, was discovered in 1894 by Alexandre Yersin during a major plague outbreak in Hong Kong. Once rodent involvement, and then arthropod vector involvement, were demonstrated in the late 1890s, plague research, clinical interventions, and public health measures moved permanently to the new "germ theory" mode of thinking.

This transition had effects on plague's history, too. Although plague historiography can be traced back to the ninth century in the Islamic tradition, in the sense of chronicling outbreaks as historical events of note, speculations about plague's origins as a pandemic phenomenon seem to have only begun in earnest with the onset of major outbreaks of plague in the mid-fourteenth century. As it became obvious later in the fourteenth century that plague had become a recurring phenomenon, local geographies of plague became embedded in public health surveillance, as it was important for legal or economic interventions to know from which direction a new plague outbreak was arriving. Even these speculations, however, focused on human populations that seemed to be involved in disease spread, a concern that took a turn toward what Nükhet Varlık has called epidemiological orientalism in the eighteenth century as plague disappeared from Europe but continued on in the Ottoman Empire.[7] With the advent of bacteriological understandings of plague, the search for long-term *foci* –where and in which animal populations plague seemed to establish more or less permanent reservoirs– became a concern of the late nineteenth century, as bacteriologists allied with various colonial projects in Africa and Asia began to compare notes on their observations of plague in widely dispersed landscapes.[8]

Importantly, even with the transition to a bacteriological understanding of plague, it was impossible to differentiate the disease from one manifestation to another. It was all just "plague." It has only been in the past decade that a mature *evolutionary* understanding of plague's history has come into view, allowing researchers to think about specific strains being tied to specific times and places. With that new understanding, a reconceived history of plague in the Middle Ages has become possible. Before addressing the developments in genomic microbiology, however, it will be useful to review what else can be known about the physical history of plague.

2.1. The Challenges of Confirming Plague's Physical History

Even before genetics came on the scene, another field of science had already been contributing for several decades to the reconstruction of disease histories. This is paleopathology (now commonly subsumed under the umbrella term "bioarchaeology"), the field devoted to the study of physical remains (mostly skeletons, but also mummies where they are preserved)

5 John Mulhall, "Plague before the Pandemics: The Greek Medical Evidence for Bubonic Plague before the Sixth Century," *Bulletin of the History of Medicine* 93, no. 2 (Summer 2019): 151-179.

6 Nahyan Fancy, "Knowing the Signs of Disease: Plague in Arabic Medical Commentaries Between the First and Second Pandemics," in *Death and Disease in the Long Middle Ages*, edited by Lori Jones and Nükhet Varlık (York: York Medieval Press, 2022), 35-66.

7 Nükhet Varlık, "'Oriental Plague' or Epidemiological Orientalism?: Revisiting the Plague Episteme of the Early Modern Mediterranean," in: *Plague and Contagion in the Islamic Mediterranean*, edited by Nükhet Varlık (Kalamazoo, MI: Arc Humanities Press, 2017), 57-87.

8 Monica H. Green, "Putting Asia on the Black Death Map," *The Medieval Globe* 8, no. 1 (2022), 59-87; reprinted in Robert Hymes and Monica H. Green, edited by Carol Symes, *New Evidence for the Dating and Impact of the Black Death in Asia*, 57-87 (Leeds, UK: Arc Humanities Press, 2022).

and the biological evidence of past lives. Importantly, paleopathology, whose work focuses primarily on macroscopic lesions, is incapable of directly discerning the presence of plague. That is because the disease kills too quickly to leave visible lesions on the hard tissues. Even a mass grave cannot automatically be assumed to be the result of a plague outbreak, since other situations (war, famine, even other infectious diseases) may account for the sudden death of numbers of people.

Instead, paleopathology has, like history, been transformed by paleogenetics because its diagnostic capability can confirm the presence of *Yersinia pestis*. This, in turn, allows the pursuit of new research questions on that basis. For example, a recent study of remains from the time of the Justinianic Plague documented the presence of plague in England a full century earlier than it had previously been thought to have arrived.[9] Sites in and around Cambridge, from the time of the Black Death up through the sixteenth century, have yielded evidence that individuals in normal burial sites, not just mass graves, had died of plague.[10] Even beyond the specific confirmation of *Y. pestis*'s presence in a given locale, the genetics age of plague studies has infused bioarchaeology with a new confidence in its analysis; a recent study of changes in the ages and health effects of menarche in pre– and post-Black Death populations in England, for example, does not draw directly on genetics, but it brings a precision of demographic analysis not seen in work of, say, the 1990s.[11] This in turn contributes importantly to the history of women's health, which previously was constructed primarily from the evidence of medical texts, which only hinted at this biological shift.[12] Indeed, the multidisciplinary, diachronic survey based in Cambridge (which also analyzed isotopes, to assess immigration status), has yielded evidence for a variety of health issues of the English populace, including stunning results about the incidence of metastatic cancers in this premodern community.[13]

Paleopathology, therefore, holds renewed promise for reconstructing plague's history at the local level. The field also holds potential in illuminating common biological effects of plague, in terms of its effects on populations defined by common nutritional or syndemic stresses (that is, co-infection with other diseases). In terms of the larger epidemiology of plague, however –where the initial spillover events occurred that constitute the Big Bang, the forces that led to the long-distance dissemination of what would become new strains, the circumstances that allowed plague to focalize in new environments, as well as the panoply of cultural responses to the chaos and destruction the pathogen caused– all these elements will have to be reconstructed on the basis of the combined data and inferences fusing traditional historical work with new understandings coming from *Y. pestis*' evolutionary history.

2.2. From the Bacteriological Revolution to the Genetics Revolution

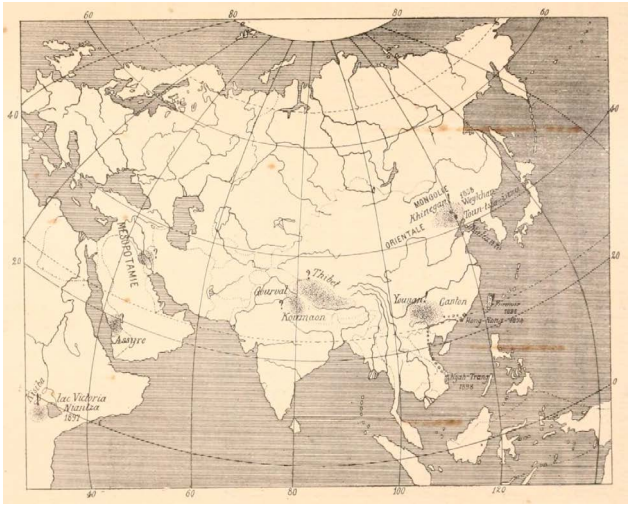

Fig. 1. "Foyers connus jusqu'ici sur le continent asiatique"; map reproduced from Danilo K. Zabolotny, "La Peste en Mongolie Orientale." *Annales de l'Institut Pasteur* 13, no. 11 (1899): 833-840, p. 839.

The map above shows the global *foyers* or "hearths" of plague as they were understood by a Ukrainian plague researcher, Danilo Zabolotny (1866–1929), in 1899. Plague had not presented itself in continental Europe for over a century and a half when he was writing, and it had not yet crossed the Pacific to reach Hawai'i or the Americas, nor been carried to Madagascar, where it continues to produce some of the highest annual numbers of human cases in the world. Plague had, however, already been reported from the Great Lakes of East Africa, including from the village of Kisiba (modern Tanzania) whence the famed German bacteriologist, Robert Koch, had obtained isolates in 1897 and confirmed

[9] See most recently Meriam Guellil, *et al.*, "An Invasive *Haemophilus influenzae* serotype b Infection in an Anglo-Saxon Plague Victim," *Genome Biology* 23 (2022), article 22.

[10] Craig Cessford, *et al.*, "Beyond Plague Pits: Using Genetics to Identify Responses to Plague in Medieval Cambridgeshire," *European Journal of Archaeology* 24, no. 4 (November 2021), 496-518. On the current state of bioarchaeological work on plague pits, see Sacha Kacki, "Black Death: Cultures in Crisis", in: *Encyclopedia of Global Archaeology*, ed. C. Smith (Cham: Springer, 2020), https://doi.org/10.1007/978-3-319-51726-1_2858-1; and Sacha Kacki, "Digging up the Victims of the Black Death: A Bioarchaeological Perspective on the Second Plague Pandemic", in *Waiting for the End of the World? New Perspectives on Natural Disasters in Medieval Europe*, ed. Christopher M. Gerrard, Paolo Forlin, and Peter J. Brown (London: Routledge, 2020), 259-279.

[11] Sharon N. DeWitte and Mary Lewis, "Medieval Menarche: Changes in Pubertal Timing in the Aftermath of the Black Death," *American Journal of Human Biology*, 33, Issue 2 (2021), Special Issue: Biocultural approaches to the plasticity of the human skeleton, https://onlinelibrary.wiley.com/doi/full/10.1002/ajhb.23439.

[12] Monica H. Green, "Flowers, Poisons, and Men: Menstruation in Medieval Western Europe," in *Menstruation: A Cultural History,* ed. Andrew Shail and Gillian Howie (New York: Palgrave, 2005), pp. 51-64.

[13] Piers D. Mitchell, *et al.*, "The Prevalence of Cancer in Britain Before Industrialization," *Cancer* 127, no. 17 (September 1, 2021), 3054-3059.

the identity of the African organisms with isolates he had studied just recently in India.[14] What none of these early bacteriologists could do, however, was explain how these different foci of plague had come to be, when they had formed, or how they related to each other. There were speculations, to be sure. But no way to test them other than by assembling scattered reports in historical accounts.

By the 1950s, a biochemical technique for differentiating different strains of plague (then called "biovars") was developed by the Belgian researcher René Devignat (also working in East Africa), and for the next sixty years scientific descriptions of plague used Devignat's historicized categories–*antiqua, medievalis,* and *orientalis*–to refer to strains that were presumed to have arisen with each of the three different historical pandemics.[15] As it happens, however, Devignat's three biovars were physiological chimeras. *Antiqua* was found in both East Africa and Central Asia. By 1998, it was realized that the lineage dubbed *orientalis* was not "modern" but was likely responsible for both the Black Death in western Europe and early modern outbreaks there. And it is now becoming likely that *medievalis* is not of medieval origin at all, but emerged in the early modern period. Most astoundingly, though, it has become clear that all the plague foci that late nineteenth-century bacteriologists were observing in both Africa and Asia arose from one single event: the Big Bang.

The Big Bang is a term that has been adopted since 2013 to refer to the sudden proliferation of a single strain of *Yersinia pestis* out of a marmot-hosted plague reservoir in the mountains of the Tian Shan, in modern Kyrgyzstan.[16] I will return to discuss the Big Bang's alleged date below; for the moment, it is important simply to understand that (as shown in fig. 2 below) it occurred before the Black Death as documented in Europe and that it is the origin of not simply the lineage that caused European outbreaks (Branch 1) but also three other main lineages (Branches 2-4), all of which are primarily associated with Asia. The marmot reservoirs of the disease in the high-altitude Tian Shan range would not come to the attention of early plague field researchers until the 1920s, even though we have reason now to believe that they have existed since the beginning of the Common Era. Both the First and Second Plague Pandemics took their origin as spillover events in this region. Whereas the lineages generated in the First Pandemic are now all extinct (so far as we know), the late medieval proliferation of *Y. pestis* lives on in four surviving lineages. There may have been more.

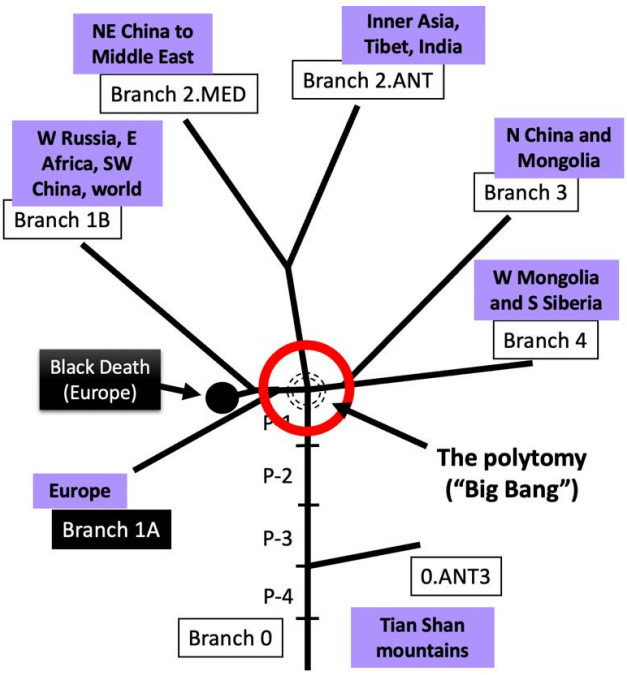

Fig. 2. The structure of the phylogenetic tree of *Yersinia pestis* from its probable late medieval proliferation in the Tian Shan mountains (at the point where Branch 0 and 0.ANT3 diverge) up through the documented geographic locations of the four extant lineages resulting from the Big Bang. Lineages documented solely from aDNA are indicated with a black box; those still living are in a white box. Source: the author.

Overturning Devignat's "historical" biovar categories and replacing them with an evolutionary understanding of *Y. pestis* has been the work of two different subfields within microbiology. Bacterial phylogenetics works primarily with modern genomes of bacterial organisms and discerns the evolutionary relationships between different strains on the basis of differences in their genomic profiles. (Note that most of the strains that have gone into making the phylogenetic tree above are modern.) Pathogen paleogenetics (aDNA or "ancient DNA") has developed techniques to retrieve the "molecular fossils" of bacterial and viral organisms from historical remains and, if the preservation has been good, reconstruct the genomic structure of these pathogens and compare them to modern samples. The reason it is important for medieval historians to understand these shifting modern understandings of plague's evolutionary history is that this new science also transforms how we should see the plague pandemics of the Middle Ages. I will only briefly discuss the earlier medieval pandemic, the Justinianic Plague, which serves as a "dress rehearsal" for the Second Pandemic. The Second Pandemic, in contrast, is uniquely important. The fact that plague was still a very active disease at the dawn of the bacteriological age and

[14] Monica H. Green, "Putting Africa on the Black Death Map: Narratives from Genetics and History", *Afriques* 9 (24 December 2018), http://journals.openedition.org/afriques/2125.

[15] Monica H. Green, "Plague (*Yersinia pestis*)," *Encyclopedia of the History of Science*, general ed. Christopher J. Phillips (Pittsburgh: Carnegie Mellon University Libraries Publishing Service), forthcoming. The biovars were distinguished according to how they responded to different chemical tests. After Devignat coined the system in the 1950s, a fourth generic biovar, *pestoides*, was added. The entire system now is otiose and should be replaced by reference to genotypes, as are used in the present essay.

[16] See Monica H. Green, "The Four Black Deaths," *American Historical Review* 125, no. 5 (December 2020), 1600-1631. The scientific term for a sudden dispersal of identical clones of an organism that produce new lineages is "polytomy".

throughout the twentieth century is the principal reason that modern science has been able to make such radical interventions in reconstructing its history.

Although the late nineteenth-century laboratory revolution utterly transformed infectious disease research, making possible the microbiological approach that remains the foundation of the field, the laboratory created its own evidentiary barrier: only samples available for study in the laboratory itself could be entered into evidence about diseases. And since bacteria and viruses left no lasting physical traces prior to the development of techniques of preserving microscopic samples, it was impossible to trace their histories back before the laboratory age. Granted, the idea that infectious diseases had no history prior to the laboratory is a fiction: most researchers were practicing clinicians and understood diseases not simply from the evidence of cultures under a microscope, but from a host of clinical signs and symptoms, plus pathological lesions visible at autopsy. Many of these researchers also wrote historical accounts where they read into the writings of pre-modern physicians the presence of diseases they knew from their own clinical practice. Histories of infectious diseases in all the major literate traditions exist, or can be reconstructed, going back to Antiquity. The fact that every new history of plague was to some degree building on top of previous ones is, for better or worse, a truism worth keeping in mind.

2.3. Evolution as Philology: Making History out of Genetics

For various reasons, in the 1970s and later, doubts began to grow whether traditional "retrospective diagnoses" from written sources alone were an adequate, or even methodologically defensible, approach to the history of infectious diseases.[17] The most intense debate focused on plague. This debate about what "really" caused the Black Death (was it really plague, or was it smallpox or anthrax or a hemorrhagic fever or some other Disease X?) was settled by retrieval of *Yersinia pestis* molecular fragments in the 2000s. To be sure, knowing that *Yersinia pestis* (and not anthrax or some Ebola-like hemorrhagic fever or some unknowable "Disease X") was the cause of the Black Death is significant because it allows modern scientific knowledge about this extraordinarily lethal disease to be used analogically for historical investigations: for example, it can explain why pneumonic transmission (from inhaled bacteria) might present in contemporary descriptions of plague outbreaks in a different way than bubonic transmission (usually acquired from a flea bite).[18] But emphasis on the diagnostic value of aDNA research has led to a continued misunderstanding that molecular genetics merely serves to "confirm" the disease.

In fact, the real breakthrough in moving plague history into a new era came in 2011, when it was announced that *complete sequences* of *Y. pestis* had been retrieved from gravesites in fourteenth-century London. Rather than simply confirming *what* pathogen(s) are involved at specific times and places, whole-genome paleogenetics can say how all retrieved pathogens from historical samples relate to every other sample of the organism, no matter the time or place of retrieval. Taken together, such data helps establish a global family tree of all different strains of a pathogen. And information at that level of detail allows the beginning of real epidemiological investigations. For example, a particular point emphasized by the first complete sequencing of *Y. pestis* from the well-dated London Black Death Cemetery was that it differed so little from *Y. pestis* as it is known in the present day as to rule out greater genetic virulence as the cause for the Black Death's extraordinary mortality.

More than that, however, the singular value of whole-genome sequencing was that it could identify *different strains* of the organism. That value has become increasingly apparent in the past few years as more and more complete (or nearly complete) genome sequences are retrieved from archaeological samples. Whereas bacteriological (whole-cell) approaches governed historical thinking on plague's biology in Zabolotny's day, with no ability to discern one strain from another, once an increasing number of historical genomes could be compared to each other and to modern strains, it became possible to *put on the map* certain inferences about the migrations of plague strains as they moved into and through historical populations. For example, it is now possible to know that the East African plague focus Zabolotny included on his map (marked with a confident exclamation mark because it had been bacteriologically confirmed by Koch) is a focus of lineage 1.ANT, a descendant of strains that reached Europe in the fourteenth century.[19] Such analysis is still imperfect, given the limited number of aDNA retrievals (a point I will return to later in this paper). But the major outlines of plague's evolutionary history have now become apparent.

The key tool for reading and interpreting genetics studies in this new mode of analysis is the phylogenetic tree. This cipher of the "family genealogy" of pathogens is the Rosetta Stone that allows evolutionary genetics to communicate with historians. I have already given one example above to illustrate the concept of the Big Bang (Fig. 2), but here is another example of this Rosetta Stone at work (Fig. 3): a phylogenetic tree of the Justinianic Plague, the disease event which had hitherto been defined as centering on the Mediterranean and producing a sequence of outbreaks between 541 and ca. 750 CE. In fact, this pandemic, which would have started as a single transmission event, probably spanned at least half a millennium and covered many thousands of miles across Eurasia.

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17 The best-crafted statement of this skeptical stance remains Andrew Cunningham, "Transforming Plague: The Laboratory and the Identification of Infectious Disease", in *The Laboratory Revolution in Medicine*, edited by Andrew Cunningham and Perry Williams (Cambridge: Cambridge University Press), 209-44.

18 Ole Benedictow, *The Complete History of the Black Death* (Woodbridge: Boydell, 2021).

19 Green, "Putting Africa on the Black Death Map"; Green, "The Four Black Deaths".

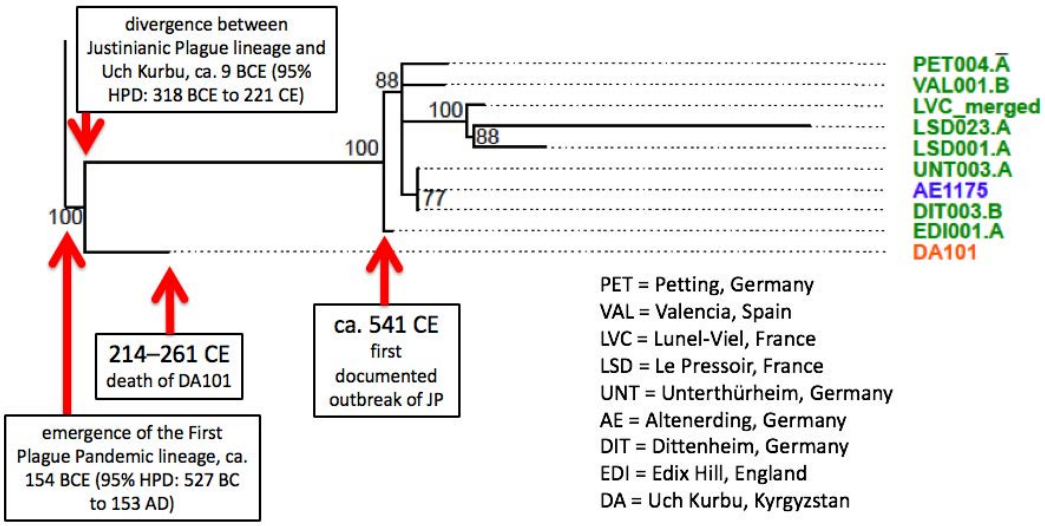

Fig. 3. Detail of the phylogenetic tree for Justinianic Plague strain genomes retrieved as of 2019. Reproduced from Green, "When Numbers Don't Count."[20]

In this section of the tree, nine genomes from Europe at the time of the Justinianic Plague (in green and blue) plus a tenth genome from Kyrgyzstan, dating to the third century (in orange), are shown in mutual relation to each other. The sample from England (EDI001, from Edix Hill, near Cambridge) is shown to be basal ("evolutionarily older") than all the other samples retrieved from European sites that, on the basis of their dates, can be associated with the Justinianic Plague as traditionally described from Mediterranean and European sources. The basal placement of the Edix Hill genome is a surprising finding given that, according to our standard narratives of the timing and route of the plague's spread, southern England would be among the most distant locations in the former Roman Empire from the outbreak's origins in the eastern Mediterranean. Yet it is the tenth genome, the Kyrgyzstan sample (DA101), that actually tells us the most stunningly important new information. This is about three centuries earlier than the beginning of the Justinianic Plague outbreak as traditionally defined from documentary records. Between them, the Justinianic Plague strains from western Europe plus this Kyrgyzstan genome direct our attention to an area of Central Asia, which is still home to strains of *Y. pestis* related not only to the late antique plague pandemic, but to the later medieval one as well.[20] In other words, although universally conceived in historiography as a Mediterranean phenomenon, genetics reveals the Justinianic Plague biologically to be a disease event originating thousands of kilometers away. By what route plague made its trek from Central Asia to the Mediterranean, and when, we still don't know. But it is obvious that, at some level of analysis, our historical understanding of the Justinianic Plague must move to a scalar level of the Eurasian continent and cannot remain solely focused on the Mediterranean or the Roman Empire.

This new expansive geography, from Central Asia to England, along with an expanded chronology ranging over half a millennium, is the result of just ten genome sequences! The story of the First Plague Pandemic will certainly become more complicated and nuanced as additional genomes are retrieved. But it is clear that, even if its pace was much slower, the parallels with the Second Plague Pandemic are striking.[21]

3. Historians Making Sense of Plague Genetics

The "new genetics paradigm" transforms traditional approaches to the history of the Second Plague Pandemic by, in essence, taking the map that Zabolotny drafted in 1899 and sketching in the connections between the several foci of plague that were visible to him at the dawn of the bacteriological age. The resulting map is not simply two dimensions on a flat surface, but four dimensions with the added element of change-over-time. Understanding plague history as a biological continuum–whether or not humans were aware of its presence–not simply justifies the now traditional concept of the three plague pandemics (each of which can be recognized by their unique biological signatures), but it also facilitates reinterrogation of documentary sources for signs of underlying infectious disease activity that might have been associated with the disease we now understand as plague. First, however, a new definition of the Second Plague Pandemic–and the "Black Death" as a stage in that pandemic process–is needed.

3.1. An Epidemiological Definition of the Second Plague Pandemic: The Big Bang and Its Sequelae

What historians usually mean by the "Black Death" –what the "Great Mortality" or "Universal Plague" has

[20] On the significance of this region around the Junggar Basin and the Tian Shan mountains for plague history, see Green, "Putting Africa on the Black Death Map".

[21] Space does not permit a summary of one of the other parallels between the First and Second Pandemics: the role of climate change and volcanic activity. For the former, see Peter Sarris, "Climate and Disease," in: *A Companion to the Global Early Middle Ages*, edited by Erik Hermans (Leeds: Arc Humanities Press, 2020), 511-537. For the latter, see Green, "The Four Black Deaths", 1629.

meant for the past 700 years–is the sudden proliferation of plague through the lands of the Golden Horde and then into the Black Sea and the Mediterranean, and thence into Europe and North Africa.[22] The dates assigned are tied tightly to this geography: 1346-1351 (if the "end" of the outbreak is defined within western Europe) or 1353 (if in western Russia). Some narratives position the pandemic's origin right in the Caucasus; others in Central Asia, and one uniquely in southeast Asia. The latter places its passage across Central Asia in the 1330s, but no earlier.

Defined biologically, however, the Second Plague Pandemic should be seen as the sustained transmission of multiple clones of a single strain of *Yersinia pestis* that, once they moved into several new ecological niches, then continued to proliferate up to the present day, each niche giving rise to new lineages with their own genetic signatures.[23] To refer to fig. 2 again, everything that is a result of the proliferation at the center of the diagram, the Big Bang (indicated by the red circle), is part of the Second Plague Pandemic. As can readily be seen, this pandemic has left its footprint on most of Eurasia and East Africa; Branch 1 spawned the strains that would be involved in the Third (global) Pandemic. How much history is yet unrecorded between the few dozen historical genomes retrieved from Europe and western Russia and the two (thus far) from Central Asia, on the one hand, and the hundreds of modern genomes from elsewhere, on the other, is something we can only infer right now by going back and re-reading the documentary record.

Crucially, the traditional definition of the Black Death has always been based on human reports of human outbreaks. And until 2014, it had been based almost exclusively on *western* reports of these outbreaks. Although there is a tradition starting no later than 1349 that the pandemic affected or took its origin in "Khitai" or "China" a decade and a half before plague struck in the Mediterranean, and although there are indeed reports in Chinese sources of "epidemics" in Yuan (Mongol) China in the first half of the fourteenth century, no contemporary witnesses actually document the transmission of plague across central Eurasia in this period. There are, then, two major gaps in traditional understandings of the "Black Death": the absence of a narrative explaining what happened in Asia, and the absence of a narrative *connecting* what happened in central and east Asia to what happened in west Eurasia and north Africa.

Half a dozen recent studies have attempted to fill in these gaps in various ways. Starting with the latest paleogenetics study, I show why the new evolutionary understanding of plague's history demands that nearly everything we thought we knew about the Black Death merits rethinking in one way or another.

3.2. Saving the Phenomena: The Issyk Kul Narrative in Black Death Historiography

Shortly before his death from plague on 18 March 1349, the Aleppan historian and poet, Ibn al-Wardī wrote a poem on the advancing epidemic, *Risalah al-naba' 'an al-waba* (An Essay on the Report of the Pestilence). The poem merits much more attention than it has received in modern scholarship, not simply because its rhetorical character as a *maqāma*, a traveller's tale, is crucial to its interpretation,[24] but also because, having been included in multiple other plague treatises, it established key elements of the Black Death narrative in the Islamicate world, much as Boccaccio's *Decameron* would for Europe. For our present purposes, one of its key assertions was that "It [the pandemic] has been current for fifteen years. China was not preserved from it."[25] This double assertion–both the duration of the pandemic and its geographic extent–has been central to all modern thinking about plague's history. A similar assertion of the pandemic's vast geographic coverage and swift spread (perhaps influenced by Ibn al-Wardī) made its way into the fifteenth-century narrative of the Egyptian historian al-Maqrīzī (1364-1442), whose work would in turn influence the key eighteenth– and nineteenth-century European scholarship on the Black Death. These latter works, in turn (once translated into English and other languages), would establish the elements of Black Death narratives found in textbooks and encyclopedias the world over up to the present day.[26] Given this long-standing tradition, it is unsurprising that historians of the Mongol world have also adopted a compressed timeline for the late

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22 Nükhet Varlık, "Why is Black Death *Black*? European Gothic Imaginaries of 'Oriental' Plague", in *Plague Image and Imagination*, edited by Christos Lynteris (Cham: Palgrave Macmillan, 2021), 11-35.

23 On the importance of understanding plague pandemics as clonal proliferations of bacteria, see Monica H. Green, "Out of the East (and West and South): A Response to Philip Slavin," *Past and Present* 256, no. 1 (August 2022): 283–323.

24 Maurice Pomerantz and Jonathan Decter, "The *Maqāma* Genre and the History of an Islamicate Literary Form", *Intellectual History of the Islamicate World* 10, no. 1-2 (2022): 1-9.

25 Michael Dols, trans., "Ibn al-Wardi's *Risalah al-naba' 'an al-waba*. A Translation of a Major Source for the History of the Black Death in the Middle East", in *Near Eastern Numismatics. Iconography, Epigraphy, and History: Studies in Honor of George C. Miles*, edited by D. K. Kouymijian (Beirut: American University of Beirut, 1974), 443-55, at 448.

26 As explained by John Norris, "East or West? The Geographic Origin of the Black Death", *Bulletin of the History of Medicine* 51, 1 (1977): 1–24, at 4-5, the narrative of parallel plague outbreaks in China entered into western historiography via the Chinese imperial encyclopaedia *Ku Chin T'u Shu Chi Ch'eng* (*Gujin Tushu Jicheng*), published in A.D. 1726, which "records a series of unspecified 'pestilences' from 224 B.C. in various regions of China... down to the date of the encyclopaedia's publication". The *Gujin Tushu Jicheng* was used by Abbé (Joseph) de Guignes for his discussion of the Black Death in his *Histoire general des Huns, des Turcs, des Mongols &c...* (Paris, 1756-58); de Guignes says he had been led to this source by references he had found in "Aboulmahasen", i.e., Abū al-Maḥāsin Yūsuf ibn Taghrī-Birdī (d. 1470), a student of al-Maqrīzī who had noted that plague came from Cathay or "Tartary". De Guignes is then cited in passing by Kurt Polycarp Joachim Sprengel, *Beiträge zur Geschichte der Medicin* (Halle in der Rengerschen Buchhandlung, 1794), which fixes the Asia/China narrative in western historiography. The German plague historian, Justus Friedrich Carl Hecker, then reproduced de Guignes' note almost word for word in his 1832 *Der schwarze Tod im vierzehnten Jahrhundert* (Berlin: Herbig, 1832). Hecker's book, translated into English and a variety of other languages, became the foundation for most Black Death nar-

medieval pandemic,[27] as did the World Health Organization plague specialist, Robert Pollitzer, when he offered a brief historical introduction to his global survey of the disease's status in 1951.

Pollitzer was apparently the first specialist on plague to adopt additional information initially published in the 1880s but which stayed in limited circles for several decades thereafter. Beginning in the 1870s, Russian archaeologists working in an area near the endorrheic saltwater lake, Issyk Kul in what is now Kyrgyzstan, had discovered Christian burial grounds with multiple headstones, many of them carved not simply with the deceased's name but also their date of death. A number of deaths had occurred in two particular years, 1338-39 and 1341-42; for the former year, ten headstones also included the cause of death: *mawtānā*, "pestilence." The archaeologist who wrote up the principal report (in German) felt confident interpreting the Syriac word as meaning specifically *Pest*, plague, and that information made its way into a popularizing history of Central Asia Christians in 1928. Pollitzer, who knew that this region of Central Asia was a recently identified plague focus (thanks to the researches of his colleague and sometime co-author, the Malayan physician, Wu Liande), noted the date of the outbreaks near Issyk Kul and mused that the archaeological discovery of the graveyard proved that plague was present in Central Asia just a few years before it appeared in the Crimea in 1346. This pronouncement by the World Health Organization's own plague specialist seemed to cement the veracity of the medieval accounts: plague had indeed come from the east and it came quickly.[28]

In June 2022, a paleogenetics study appeared in the science journal *Nature* claiming to confirm everything that Pollitzer had inferred.[29] Retrieving some of the human remains that had been scattered from the Christian cemetery, the researchers found that three tested positive for *Yersinia pestis*. Moreover, two individuals yielded between them enough genetic material to recover 93.5% of the full genome, leading the researchers to declare not simply that this was a strain related to the postulated pre-Big Bang stage of *Y. pestis* development, but that this was *the* pre-polytomy strain. Using computer programs, they calculated that the strain most likely came into existence not earlier than 1308 and not later than 1338, the date of the burials. In short, they had pinned down almost precisely the moment and rough location of the Big Bang.

3.3. Arguments for a Thirteenth-Century Narrative

The *Nature* study would have seemed a great success–sophisticated science offering physical, quantifiable proof of what had previously only been speculation–had it not come *after* several other studies arguing that the Big Bang, the sudden, wide dispersal of a single strain of *Y. pestis*, occurred not in the fourteenth century, but in the thirteenth. When the Big Bang was first postulated in 2013 as a phylogenetic "event," its date could only be roughly estimated. It was proposed that it had occurred at some point ca. 1268, with a 95% confidence interval between 1142 and 1339.[30] At that time, no complete sequences from the Justinianic Plague had been retrieved (nor from the Late Neolithic or Bronze Age strains that would be identified starting in 2015). So it was still unclear how the pre-Black Death dating of *Y. pestis*'s evolution should be calibrated. Nevertheless, as more pre-Black Death genomes were retrieved, the estimated dating of the Big Bang did not shift appreciably; in fact, it got earlier.[31] Moreover, since it had also been postulated that plague's late medieval proliferation had likely occurred somewhere near where the greatest diversity of strains was found in the present day, eyes turned to the Tibetan Plateau as a possible Ground Zero.

The first historian to ask how the new information from genetics might help flesh out the history of the eastern prelude to the Black Death was Robert Hymes in his 2014 essay, "A Hypothesis on the East Asian Beginnings of the *Yersinia pestis* Polytomy". After working through phylogenetic indications for *Y. pestis*' presence in Asia (including the lack of evidence for plague's emergence out of Mongolia, making it unlikely that the Mongols already had experience with the disease prior to their imperial expansion in 1206), Hymes laid out evidence from documentary sources that a plague-like disease seemed to be involved in major sieges laid by the Mongols in the early thirteenth century. His most important witness to both the severity of the devastation and the character of the disease was one of the leading physicians in Jin-era northern China, Li Gao (1180-1251).[32] Hymes has since elaborated that work with two subsequent studies, one examining how Li might have gathered information about other Mongol sieges he did not

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ratives used throughout the world today (including the name, "the Black Death"); see Varlık, "Why is Black Death *Black*?".

27 For example, the several references to the Black Death in a commonly used encyclopedia of Mongol history seem to present a fusion of the narratives from several of these Islamic sources; see Christopher P. Atwood, *Encyclopedia of Mongolia and the Mongol Empire* (New York: Facts on File, 2004).

28 Pollitzer actually never said that plague had moved westward because of the outbreak in 1338-39, i.e., that there was a direct epidemiological chain of transmission in less than a decade. Yet that has been the interpretation commonly made of his statement. See R[obert] Pollitzer, "Plague Studies 1. A Summary of the History and a Survey of the Present Distribution of the Disease", Bullétin de l'Organisation mondiale de Santé/Bulletin of the World Health Organization 4 (1951): 475-533, at 477.

29 Maria A. Spyrou, *et al.*, "The Source of the Black Death in Fourteenth-Century Central Eurasia", *Nature* 606 (23 June 2022): 718–724.

30 Yujun Cui, *et al.*, "Historical Variations in Mutation Rate in an Epidemic Pathogen, Yersinia pestis," *Proceedings of the National Academy of Science* 110, no. 2 (2013): 577–582.

31 Several molecular clock estimates have been proposed since 2014, including one from 2018 estimating that the Big Bang occurred *ca.* 1196 (95 percent confidence interval, 961 C.E. to 1347 C.E.) or even *ca.* 1170 C.E. (921 C.E. to 1346 C.E.). See Maria A. Spyrou, *et al.*, "Analysis of 3800-Year-Old *Yersinia pestis* Genomes Suggests Bronze Age Origin for Bubonic Plague", *Nature Communications* 9 (June 8, 2018): 2234, Supplementary Table 9.

32 Robert Hymes, "A Hypothesis on the East Asian Beginnings of the *Yersinia pestis* Polytomy", *The Medieval Globe* 1 (Fall 2014): 285-308.

personally witness, the other digging deeper into how Li's thinking about this seemingly new epidemic disease and its characteristic symptom, the *geda* or bubo, developed not simply over the course of his career but also in the work of his students. In this latest work, in fact, Hymes establishes that the *geda* became a permanent part of Chinese medical tradition, lasting up until at least the eighteenth century.[33] In other words, he establishes an *unbroken* tradition in thinking about and responding to this disease for at least 500 years.[34]

After Hymes first published his "Hypothesis" in 2014, the phylogenetic understanding of plague's history shifted once again. The initial proposal for the Big Bang had been based on a project to sequence more than 100 modern genomes of *Y. pestis*. Most of them came from China. A study that appeared in 2017, however, provided sequencing data for a number of genomes from neighboring Kyrgyzstan. The results were striking. What had appeared from the Chinese data to be only rare strains clustered on China's western border seemed in the Kyrgyzstan data to be strains distinctive to the Tian Shan mountains, the bulk of which lie within Kyrgyzstan's borders. On the basis of this evidence, in 2018 and then again in 2020, I (having previously called for precisely this kind of rethinking of Black Death narratives on the basis of the new genetics) proposed that the Tian Shan, not the Tibetan Plateau, was the likely site of plague's proliferation in the Big Bang.[35] In the 2020 study and again in a co-authored piece in 2021 written with another medical historian, the specialist in Islamic medical history Nahyan Fancy, I pressed that argument further by presenting evidence for plague's involvement in another set of sieges, this time in Iran, Iraq, and Syria.[36] Moreover, I proposed a mechanism whereby plague might have been able to move long distances but not cause major human outbreaks along the way (and thus elicit notice by contemporary chroniclers). Millet was being collected from fertile lands in Uyghuristan (in the foothills of the Tian Shan) and shipped in the supply chains of Hülegü Khan's troops. This would have provided a perfect transportation vehicle for plague-infested rodents and their fleas. Moreover, like Hymes, Fancy and I found physicians who made new medical observations about the character of plague. Although none of those who wrote in western Asia claimed to be direct eyewitnesses to outbreaks, it was clear that they had some experience (perhaps at second hand) of describing the specific characteristics of the buboes. Thus, while the Islamic world already had a tradition of problematizing plague (*ṭāʿūn* in Arabic) as a unique disease, Fancy and I were able to document a marked shift in how the disease was talked about in medical writings in the latter decades of the thirteenth century.

3.4. Reconciling Conflicting Narratives

As will be obvious, Hymes (working on China) and myself and Fancy (working on western Asia) were prompted to re-interrogate the written records of these regions by hints coming from genetics. As is also obvious, however, our findings are incompatible with the recent study of the cemetery in Kyrgyzstan, which insists that plague's proliferation (which established all the four lineages documented by modern phylogenetics) did not occur until the fourteenth century, a hundred years or more after the events in east and west Asia. As I have noted in my most recent work, such discrepant findings leave the field in a state of limbo because the evidence currently available is not sufficient to answer all the questions–whether of the pathogen's evolution or human responses to a new disease threat–that have now been put on the table.[37] The genetic evidence in the latest study is partial: on the one hand, the retrieved genome from Kara-Djigach is incomplete and might yield a different story if it had even one additional nucleotide change; on the other, the dating calibration was done without consideration of the slower evolutionary rates of *Y. pestis* when it circulates in marmots, meaning that the dating algorithm may have produced dates too young. These are technical issues and will need to be addressed in specialized science studies.

It is, however, imperative that these gaps be addressed because the fate of future alliances between traditional modes of historical analysis and the "sciences of the past" hangs on the ability of practitioners in different fields, *and regular consumers of the historical analyses they proffer*, to understand the evidence and the grounds on which it is deemed "evidence" and interpretations extracted. The stakes couldn't be higher. Plague has now been implicated in the Fall of Baghdad, perhaps the most culturally influential siege waged by the Mongols in the thirteenth century. And the Mongol Empire–the largest land empire in human history–has now been intimately tied to a transformed ecological landscape that would eventually encompass much of Afro-Eurasia. All these historical connections disappear if the latest genetics redating of the Big Bang is accepted. Although a fourteenth-century scenario cannot, at this time, be ruled out, it should be noted that the study in *Nature* did not take into account an alternate phylogenetic calibration of the age of Branch 1, which pushed its origin back into the thirteenth century and in other respects complicated the "quick and straight" westward transmission in the fourteenth century demanded by the Issyk Kul narrative.[38]

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33 In fact, Zabolotny, who produced the 1899 plague map included above, reported in 1901 that Mongolian villagers still used the term *gada* for the buboes produced by plague. See Green, "Putting Asia on the Black Death Map", 73.

34 Robert Hymes, "A Tale of Two Sieges: Liu Qi, Li Gao, and Epidemics in the Jin-Yuan Transition", *Journal of Song-Yuan Studies* 50 (2021): 295-363; and idem, "Buboes in Thirteenth-Century China: Evidence from Chinese Medical Writings", *The Medieval Globe* 8, no. 1 (2022), 1-57.

35 Green, "Putting Africa on the Black Death Map"; Green, "The Four Black Deaths".

36 Nahyan Fancy and Monica H. Green, "Plague and the Fall of Baghdad (1258)", *Medical History* 65, no. 2 (April 2021): 157-177.

37 Green, "Putting Asia on the Black Death Map".

38 Andaine Seguin-Orlando, *et al.* "No Particular Genomic Features Underpin the Dramatic Economic Consequences of 17th Century Plague Epidemics in Italy", *iScience* 24, no. 4 (23 April 2021): 102383.

4. Paths Forward: Histories Informed by Science (and by the History of Science)

The contested dating of the Big Bang will not be settled here. We can, however, assess where Black Death studies stand now as part of the new narratives of the Second Plague Pandemic. The identification of four different (surviving) branches of plague's proliferation out of the Tian Shan, which by definition are all more or less coeval, means that we are looking for at least four different scenarios of plague proliferation in late medieval Central Asia. As I emphasized in my 2020 study, even when those proliferating strains were carried into new marmot populations, these were not contiguous with the long-standing marmot foci in the Tian Shan.[39] The likelihood is high, therefore, that the major plague dispersals were in one sense or another anthropogenic. The plague foci that Zabolotny observed at the end of the nineteenth century in northern Mongolia among tarbagans (*Marmota sibirica*), for example, may well have been seeded initially in the late medieval period.[40] For the westward transmission of plague, of course, I have also proposed an anthropogenic mode of transmission.

The addition of the paleosciences (and not just analogical inferences from modern science) allows much more of the landscape of plague's history to become visible. As the field develops in new ways, however, there is need to articulate and address new challenges. I focus here on two: 1) reckoning with what happens when we expand the map (or maps) of plague both geographically and across broader chronological dimensions; and 2) cautions we need to observe in embracing research that demands multidisciplinary inputs.

4.1. Shoe-Leather Epidemiology: Tracking Plague Historically

Whereas for Zabolotny in 1899 plague was just *plague*–indistinguishable from one region or continent to another–for researchers henceforward it will be possible to talk about specific strains, which will have their own unique histories and geographies. Realization that the Second Plague Pandemic involved at least four proliferations of highly lethal strains of plague out of the Tian Shan into new landscapes across Eurasia gives us the foundation for reconceiving plague's historical map. Branch 1 was the chief–and perhaps the only–product of the Big Bang to have reached western Eurasia (and perhaps Africa, too) in the later Middle Ages. Genetics now supports the idea that, with but one possible exception, the European experience of plague–not simply during the Black Death outbreak in the mid-fourteenth century, but also all subsequent outbreaks up to the eighteenth century–was the result of only one transmission of *Yersinia pestis* westward prior to the late nineteenth century.[41] This, of course, is Branch 1, indicated on Fig. 2 above, which has now been documented from European aDNA dating from the fourteenth to eighteenth centuries. This helps explain why the "Black Death" narratives as they developed from western Islamicate world and European sources seem to have no direct parallel (or even documentable connections) with the experience of plague elsewhere. If any reframing of the narratives of the western Islamicate world's or Europe's experiences of the Black Death is needed, it will likely have to do with the still unanswered questions of what initiated the particularly swift and successful spread in the mid-1340s of plague into human populations in the Ilkhanate and the Golden Horde and thence into the Mediterranean basin and parts beyond.[42] Whether Branch 1 had unique genetic characteristics that gave it exceptional ability to move at great speed through human populations remains to be seen.[43] It is also still unclear where the respective reservoirs were of Branch 1A (which largely remained within western Eurasia) and Branch 1B (which burned out in Europe but survived to send offshoots to both East Africa and the Tibetan Plateau).[44] In 2014, the possibility was first comprehensively advanced that the European Alps (which have ecological similarities to the high-altitude Tian Shan) may have served as a plague reservoir. Investigations are underway to determine whether another plague reservoir within the Ottoman world was established.[45] Determination of the approximate locations of such reservoirs will shed new light on various political and economic shifts that may have happened due to recurring plague outbreaks.

As noted earlier, plague has long attracted the attention particularly of economic historians, and looking at

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39 Green, "The Four Black Deaths", includes a supplementary file on "Marmots and Their Plague Strains".

40 Lineage 3.ANT2 (whose sister lineage is found in north-central China) is found in eight out of the twenty-one *aimags* (districts) of Mongolia, primarily in either tarbagans or their parasites. Lineage 4.ANT is found on the western border of Mongolia and southern Siberia in *M. baibacina* (the gray marmot). Both lineages are only minimally evolved from their post-Big Bang state.

41 The exception is the odd discovery that the oldest strain in the 2.MED lineage, 2.MED0, has been documented uniquely in the Pontic steppe north of the Greater Caucasus mountains. However, it is currently impossible to date the emergence of this strain; it might be no younger than the sixteenth century. The next oldest strains are found uniquely in northeast China.

42 The continued lack of any physical evidence of the arthropod vectors involved in the medieval and early modern plague outbreaks is the biggest impediment to answering this question. Speculations that human fleas or lice may have been involved are at the moment only that: speculations.

43 There is work underway to do a *de novo* sequence of an early seventeenth-century *Y. pestis* genome from London. This falls in the within-Europe lineage 1A1, and will allow the peculiarities of this lineage (which is now extinct) to come more fully to light. Hitherto, all plague work has been done in comparison with a modern genome from Colorado, which belongs to the 1B lineage. For a preliminary announcement, see Aida Andrades Valtueña, "Beyond Phylogenies: Advancing Analytical Approaches for the Field of Ancient Pathogenomics", PhD dissertation, Friedrich-Schiller-Universität Jena, 2021, 105-121.

44 On the idea that plague focalized within Europe, see Ann G. Carmichael, "Plague Persistence in Western Europe: A Hypothesis", *The Medieval Globe* 1, no. 1 (2014): 157-192; Philip Slavin, "Out of the West: Formation of a Permanent Plague Reservoir in South-Central Germany (1349–1356) and Its Implications," *Past and Present* 252, no. 1 (August 2021): 3–51; and Green, "Out of the East". Should aDNA ever be retrieved from the southern and eastern regions of the Mediterranean, the picture may grow even more complicated.

45 Nükhet Varlık, "The Rise and Fall of a Historical Plague Reservoir: The Case of Ottoman Anatolia", in *Disease and the Environment in the Medieval and Early Modern Worlds*, edited by Lori Jones (Abingdon, UK: Taylor and Francis, 2022), 159-183.

its effects regionally offers important insights. The Italian economic historian Guido Alfani has documented in close detail not only the effects of several post-medieval plague outbreaks, but shifts in wages and material wealth in early modern Italy. He finds abundant evidence that the Black Death (or perhaps the compounded effects of several waves of plague in the second half of the fourteenth century) did indeed contribute to a sizable reduction in wealth inequality. But it was only temporary and as it became clear that plague was now entrenched in the European landscape and sure to come again (even if no one could know precisely when), legal means were developed to ensure that wealth stayed within families even if whole households might suddenly succumb to disease. Through these and other mechanisms, even repeatedly afflicted areas did not see the same general economic devastation again. At least not until the seventeenth century, when a new wave of plague struck northern Italy around 1629-30, followed by another equally devastating one that hit the rest of the peninsula in the 1650s.[46]

Paleogenetics work has consistently been documenting two parallel lineages circulating within Europe since the late fifteenth century when Branch 1A divided further into two sublineages: one associated with ports extending from the North Sea and Baltic all the way to the Black Sea, the other found in Europe's heartland from Brandenburg in the north to the Italian Alps and eastern France.[47] This allows us to see that the plague strains that afflicted Italy in the 1630s were only distantly related to the strains that would strike northern Europe that same century, a story that agrees with what the epidemiologist (and sometime historian of early modern central Europe), Edward A. Eckert, recognized from archival data more than four decades ago.[48] Similarly, moving to a hemispheric level of analysis, it could be asked whether the framing of "Great Divergence" narratives–that is, the definitive split in the economic trajectories of Northern Europe and Asia–ought not be rethought in light of the long-term effects of plague on European as well as Asian polities. Scholars of China are only beginning to perceive the potential roles of what may have been post-Big Bang plague strains in later episodes of Chinese history.[49] No aDNA work yet sheds light on plague's history in China, but the value of comparative inquiries should already be obvious.

4.2. Remembering Where Our Stories Come from and Respecting Our Tools and Methods

Engaging with the biology of plague as it can now be reconstructed, and not solely with the epiphenomena of human plague outbreaks as historical actors witnessed and described them (and as accidents of preservation have allowed their accounts to survive), induces us to look at landscapes and pathways that were connected by biology, even if human actors did not perceive all those connections. However, the retrieval of several dozen historical genomes still leaves us a very long way from reconstructing the circumstances that caused the deaths of millions of people in the late Middle Ages and early modern period. Recognizing the still enormous lacunae in our evidence, and the mostly unarticulated gaps between types of methods used to find and interrogate disparate sources, calls for humility on the part of all parties that would investigate the pasts of infectious diseases. Here are three cautionary tales to serve as reminders that the new narratives we create are themselves provisional.

4.2.1. Unfinished Business: Curating Cultural Histories of Plague

I spoke above of recognizing that the "Black Death" narratives as they developed from western Islamicate world and European sources seem to have no documentable connections with the experience of plague elsewhere. That is, we have no clear proof that plague rapidly moved *across* Central Asia just prior to the outbreaks of the mid-1340s. But we do have historical sources that imply or assume that that transmission happened.[50] Rumors and cultural memories of plague filled in gaps that channels of contemporary communication left open. Remembering that knowledge is accreted in archaeological layers not only helps us (both historians and scientists) better interpret the perceptions of plague we have inherited, from medieval eyewitnesses right up through researchers in the early twenty-first century, but also helps us remain humble about our own still-limited vision. The juxtaposition of results from different disciplines helps such gaps become visible and prompts new research.

The recovered understanding of plague's likely role in the Fall of Baghdad in 1258 is one such example where hints coming from genetics induced historians to reinvestigate thirteenth-century records. The result was the quick discovery of testimony for the presence of plague (*ṭāʿūn*) and new debates among both medical and religious commentators about the nature of this frightening disease. And there was a secondary payoff: discovery of historical memories attempting to make sense of plague's new manifestations in the fourteenth century. Among these contributors to the Islamicate historical tradition was the Algerian-born historian and poet Ibn Abī Ḥajala

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46 Guido Alfani and M. Percoco, "Plague and Long-Term Development: The Lasting Effects of the 1629–1630 Epidemic on the Italian Cities", *Economic History Review* 72, no. 4 (2019): 1175–1201.

47 Most recently, see Seguin-Orlando, *et al.*, "No Particular Genomic Features", and the literature cited therein. On the question of plague's final disappearance from Europe, see most recently Paul Slack, "Perceptions of Plague in Eighteenth-Century Europe", *Economic History Review*, 75, no. 1 (February 2022): 138-156.

48 Edward A. Eckert, "Boundary Formation and Diffusion of Plague: Swiss Epidemics from 1562 to 1669", *Annales de Démographie Historique* 1978 (1978): 49-80; and idem, *The Structure of Plagues and Pestilences in Early Modern Europe. Central Europe 1560-1640* (Basel: Karger, 1996).

49 Timothy Brook, "Comparative Pandemics: The Tudor–Stuart and Wanli–Chongzhen Years of Pestilence, 1567–1666," *Journal of Global History* 15, no. 3 (2020), 363–379; Hymes, "Buboes in Thirteenth-Century China."

50 This is the discrepancy that Norris, "East or West?", and Benedictow, *The Complete History of the Black Death* (including in the original edition of his book in 2004), focus on in arguing for an origin of the pandemic in western Asia.

(d. 1375), who had lived through the Black Death while still resident in Damascus and had then lost his son to what was probably the third wave of plague in Cairo a decade and a half later. His tirade in a work composed in the mid-1360s about the Mongols' general destruction in the thirteenth century, set within a chronological list of plagues and other environmental catastrophes, was crucial testimony in Fancy and Green's reconstruction of that story. Ibn Abī Ḥajala knew full well what plague (*ṭā'ūn*) was; his own frame of experiential reference told him its symptoms and effects.[51] He did not need modern science. But we, clearly, needed modern science to reconnect us to the physical and cultural world that Ibn Abī Ḥajala inhabited. Had it not been for the "nudging" of paleogenetics work this past decade, the thirteenth century experience of plague and Ibn Abī Ḥajala's role a century later in creating a new historiography of plague would still lie unrecognized and overlooked.

Ibn Abī Ḥajala's treatise remains unedited, as do the majority of Arabic texts on plague written in the fourteenth and fifteenth centuries. And because so many texts are unedited, their intertextual connections remain unrecognized. This is as problematic for historical use of humanistic evidence as it would be if archaeologists did not properly record the taphonomic context of human remains when retrieving them from burial sites. Al-Maqrīzī's fifteenth-century fictions in stitching together stories of the Black Death's Asian origins are still treated as historical fact, rather than the pastiche of literary elements they are, because no critical philological work has been done on the first century of plague writing in the Islamic world. Mustakim Arıcı has done a signal service in newly surveying the corpus of Arabic and Turkish literature on plague, and it is hoped that his efforts will be followed by work from both literary scholars and historians to do these necessary "archaeological" excavations.[52]

4.2.2. Reviving the Art of Diagnosis

Rather than going down, estimates of the mortality caused by the Black Death have in general continued to rise. Not simply do plague mortality sites continue to be discovered (in some cases where there was no prior written record that any such event had occurred), but recalibrations of demographic data and new kinds of evidence have increased the sense of plague's devastation in many areas.[53] That so many contemporary terms for the Black Death focused on *mortality* reminds us that this was a disease that killed outright, and it did so with a ferocious swiftness. Collapsed population levels may have contributed to abandonment of certain areas, even when death was not universal. In other words, the demographic stamp on societies is itself a historical feature to be looked for, even in the absence of confirmatory aDNA. Granted, plague would never have been the only infectious disease any community was faced with. Nor, despite many Black Death maps that show "waves" of plague sweeping across whole continents, can we assume that it struck all areas equally.[54] Evidence that certain epidemics were *not* plague (such as has been found in a lethal outbreak in the German coastal town of Lübeck in 1367) should be an inducement to continually examine as many sources of evidence as we can, confirming that the epidemiological profiles we draw accord not only with the material evidence retrieved from bones and teeth, but also with the testimony of eyewitnesses.

I have laid out an algorithm of sorts for bringing together different kinds of evidence for plague's presence; none of the eleven types of evidence are decisive on their own for answering questions in plague history, but all are more persuasive when combined with confirmatory results from other sources.[55] Paleogenetic evidence will always be rare, expensive to produce, and tied to the sheer luck of archaeological recovery. Because plague is a disease of *landscapes*, however, and not an obligate disease found only in human bodies (as, for example, are smallpox or most other viral diseases), there are other kinds of evidence that can reasonably be assembled to suggest plague's presence. In 2018, Chouin and colleagues' archaeological work on sub-Saharan West Africa was not able to conclusively settle the question about plague's presence there, but it did establish persuasively that there was widespread depopulation in the region between the late fourteenth and fifteenth centuries.[56] In 2021, de Lépinau and colleagues examined the bioarchaeological evidence for multiple mass graves at Kutná Hora (Czech Republic), attempting to lay out criteria by

51 Fancy and Green, "Plague and the Fall of Baghdad".

52 Mustakim Arıcı, trans. Faruk Akyıldız, "Silent Sources of the History of Epidemics in the Islamic World: Literature on *Ṭā'ūn*/Plague Treatises", *Nazariyat: Journal for the History of Islamic Philosophy and Sciences* 7, no. 1 (May 2021): 99-158.

53 These rising estimates are particularly surprising when they come from England, where archaeological and bioarchaeological work from an unusually rich written record has already yielded so much evidence of the catastrophe's extent. See, for example, Hugh Willmott, *et al.*, "A Black Death Mass Grave at Thornton Abbey: The Discovery and Examination of a Fourteenth-Century Rural Catastrophe", *Antiquity* 94, no. 373 (2020): 179-196; Carenza Lewis, "Disaster Recovery? New Archaeological Evidence from Eastern England for the Impact of the 'Calamitous' 14th Century," *Antiquity* 90, no. 351 (2016): 777-797; and eadem, "Reconstructing the Impact of 14th-century Demographic Disasters on Late Medieval Rural Communities in England," in *Waiting for the End of the World? New Perspectives on Natural Disasters in Medieval Europe*, edited by Christopher M. Gerrard, Paolo Forlin, and Peter J. Brown (London: Routledge, 2020), 298-327. On the Islamicate world, see Stuart Borsch and Tarek Sabraa, "Plague Mortality in Late Medieval Cairo: Quantifying the Plague Outbreaks of 833/1430 and 864/1460", *Mamluk Studies Review* 19 (2016): 57–90; and Stuart Borsch and Tarek Sabraa, "Refugees of the Black Death: Quantifying Rural Migration for Plague and Other Environmental Disasters," *Annales de Démographie Historique* 2017 N°2, no. 134 (2017): 63–93.

54 On the genesis of the "waves" on Black Death maps, see David Mengel, "A Plague on Bohemia? Mapping the Black Death", *Past and Present* no. 211 (May 2011): 3-34.

55 Green, "Putting Asia on the Black Death Map", Table 3.1.

56 Gérard Chouin, special issue of *Afriques*, *Sillages de la peste noire en Afrique subsaharienne: une exploration critique du silence / Black Death and its Aftermaths in Sub-Saharan Africa: A Critical Exploration of Silence*, https://journals.openedition.org/afriques/2084; and Chouin and Lasisi, "Crisis and Transformation." Most recently, see Stephen A. Dueppen, *Divine Consumption: Sacrifice, Alliance Building, and Making Ancestors in West Africa*, Monumenta Archaeologica 48 (Los Angeles: UCLA Cotsen Institute of Archaeology Press, 2022).

which mass graves due to plague (or some other rapidly lethal infectious disease) might be differentiated from mass death due to famine.[57] Such rigorous specification of what can and cannot be determined from the evidence at hand serves as a worthy model for attempts at a new model of retrospective diagnosis. As with plague, because we have the benefit of modern epidemiological knowledge of major diseases and because so many resources are now available to rigorously document textual histories, landscape geographies, and human cultural responses, we can be demand multiple layers of evidence to support claims being made about the presence or epidemiological impacts of infectious diseases. There will remain many cases where we have to admit that evidence is suggestive but not conclusive. Such argumentative humility is a benefit to all, since it permits a firmer foundation when questions are later revisited and taken up anew.[58]

4.2.3. Humans, Biology, and Science as a Link Between the Two

In 2021, a specialist on east Mediterranean economic and cultural history, Hannah Barker, published a landmark study on the siege of Caffa and a story that had been told (from a unique source) about the beginning phases of the Black Death as it was viewed by Europeans. Not only did her investigation of the siege of 1346 and its aftermath absolve the Mongols from the terrible charge of biological terrorism (she argued that plague only started moving across the Black Sea in 1347 and had nothing directly to do with the siege of the city on the Crimea in 1346), but also, by demonstrating that grain (presumably plague-infested) was collected from multiple sites along the Black Sea coast, it put forward a new scenario of the physical circumstances of plague's importation into the Mediterranean. That a single rigorously-researched, archivally-based study can decisively change our understanding of when and how one of the largest sustained mortality events in history began holds an important lesson for those who propose definitive assessments about events ranging from the microbial to the stratospheric. Every story we tell has a history. And every argument we propose in reconstructing the histories of plague is made up of layers of prior truths. That includes the stories from which science investigations begin.

The human element–not simply as victims of plague but as active (if unwitting) agents in the disease's dissemination, as well as principal creators of the historical record itself–this human stamp is embedded at every stage of these stories. Indeed, humans are the wildcard in all plague reconstructions, since they behave the most erratically. Science, too, must be recognized as a human-enacted, human-driven endeavor. The advent of the genetics age in plague studies has demonstrated the need, among both historians and scientists, for greater care in assessing both the particular value of our evidence and also its many inadequacies, in terms of both coverage and representativeness. Just as it is necessary to rigorously interrogate the terminology being used to reference disease in historical sources, so there is need to interrogate the materials, methods, and assumptions that go into creating new scientific narratives about plague.

A final example. Continued research on the violence perpetrated on Jewish communities within Christian Europe in the wake of the Black Death confirms an absolute contrast with Islamic Iberia, North Africa, and the Middle East: in the latter regions, no persecutions have been documented at all.[59] To explain such drastically different responses to the same disease event, we need to look well beyond the bacterium and into the very soul of these cultures. But a new line of research in genetics (of humans this time, rather than the bacterium) has prompted a naïve argument that Jews were persecuted in Europe because a genetic feature common among persons of eastern Mediterranean descent: this genetic characteristic (which, if inherited from one but not both parents, conferred some resistance to plague) may have made Jewish populations in western Europe less susceptible to plague's effects. The problem with this argument is that *there is no evidence* that Jews were less susceptible; the information these researchers are citing comes from a fictitious line of argument in Judaic studies that can be traced back to the very end of the Middle Ages as the Black Death itself was fading from living memory.[60] Science that is grounded on such fictions is producing no more "objective" history than accounts based on uncritical uses of chronicles or poetry.

Historical rigor–whether the "historians" in question are literally that or scientists asking historical questions–demands that we acknowledge the limits of evidence coming from scientific investigations. As more and

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57 Auxane de Lépinau, *et al.*, "Entre peste et famine: caractérisation d'une crise de mortalité par l'étude de trois sépultures multiples du site de Kutná Hora – Sedlec (République tchèque, XIVe siècle) [Between Plague and Famine: Characterization of a Mortality Crisis Through the Study of Three Mass Graves from the Kutná Hora – Sedlec Site (Czech Republic, 14th Century)]", *Bulletins et mémoires de la Société d'Anthropologie de Paris* (BMSAP) 33, no. 2 (2021): DOI: 10.4000/bmsap.7664.

58 The new mass availability of texts (whether in print or manuscript) makes possible a new kind of philological rigor that should move the field permanently beyond simplistic "diagnoses" of disease based on interpretations of single words. For example, an argument has recently been made that mass mortality events during the Mongol era are due not to plague but to cholera; see Zsolt Pinke, Stephen Pow, and Zoltán Kern, "Volcanic Mega-eruptions May Trigger Major Cholera Outbreaks," *Climate Research* 79 (2019): 151–162. Here, however, is a case where insufficient philological rigor (in this case, regarding historical uses of the Arabic word *wabā'*, "epidemic", and its cognates in Persian and Turkish) seems to have driven an entire diagnostic narrative. On the manifold ways this error has been embedded in modern scholarship, see Claudia Maria Tresso, "India's Epidemics in the *Riḥla* of Ibn Baṭṭūṭa: Plague, Cholera or Lexical Muddle?", *Bulletin of the School of Oriental and African Studies* (forthcoming).

59 Younus Y. Mirza, "'It Was a Memorable Day' – How the Black Death United the Population of Medieval Damascus", *Maydan*, 30 March 2020, https://themaydan.com/2020/03/it-was-a-memorable-day-how-the-black-death-united-the-population-of-medieval-damascus/; and Tzafrir Barzilay, *Poisoned Wells: Accusations, Persecution, and Minorities in Medieval Europe, 1321-1422* (Philadelphia: University of Pennsylvania Press, 2022).

60 Kathryn A. Glatter and Paul Finkelman. "History of the Plague: An Ancient Pandemic for the Age of COVID-19", *American Journal of Medicine* 134, no. 2 (2020): 176-181; and Joshua Teplitzky, "Imagined Immunities: Medieval Myths and Modern Histories of Jews and the Black Death", *AJS Review* 2022, forthcoming.

more paleoscience work is published, there has been a tendency to treat results with a positivist attitude, as if scientific data is unimpeachable and transparent in yielding historical conclusions. It is not. In 2014, I called on fellow historians to recognize that genetics was now "a new player" on the field of historical research.[61] I invited historians not simply to recognize this new sister discipline, but to get to know its premises, its methods, and its forms of argumentation. Science–just like philology and paleopathology and demographic history–needs to be thoroughly understood for the claims it legitimately can and cannot make, and for the ways it can induce misreadings of its own evidence.

6.1. Primary Sources

Dols, Michael. trans., "Ibn al-Wardi's *Risalah al-naba' 'an al-waba*. A Translation of a Major Source for the History of the Black Death in the Middle East," in: *Near Eastern Numismatics. Iconography, Epigraphy, and History: Studies in Honor of George C. Miles*, ed. D. K. Kouymijian, 443-55. Beirut: American University of Beirut, 1974.

6.2. Bibliography

Alfani, Guido. "Economic Inequality in Preindustrial Times: Europe and Beyond". *Journal of Economic Literature* 59, no. 1 (2021): 3-44.

Alfani, Guido, and M. Percoco. "Plague and Long-Term Development: The Lasting Effects of the 1629–1630 Epidemic on the Italian Cities", *Economic History Review* 72, no. 4 (2019): 1175–1201.

Andrades Valtueña, Aida. "Beyond Phylogenies: Advancing Analytical Approaches for the Field of Ancient Pathogenomics", PhD dissertation, Friedrich-Schiller-Universität Jena, 2021.

Arıcı, Mustakim, trans. Faruk Akyıldız. "Silent Sources of the History of Epidemics in the Islamic World: Literature on *Ṭāʿūn*/ Plague Treatises". *Nazariyat: Journal for the History of Islamic Philosophy and Sciences* 7, no. 1 (May 2021): 99-158.

Atwood, Christopher P. *Encyclopedia of Mongolia and the Mongol Empire. New York: Facts on File, 2004.*

Barzilay, Tzafrir. *Poisoned Wells: Accusations, Persecution, and Minorities in Medieval Europe, 1321-1422*. Philadelphia: University of Pennsylvania Press, 2022.

Belich, James. "The Black Death and the Spread of Europe". In *The Prospect of Global History*, edited by James Belich, John Darwin, Margret Frenz, and Chris Wickham, 93-107. Oxford: Oxford University Press, 2016.

Benedictow, Ole. *The Complete History of the Black Death*. Woodbridge: Boydell, 2021.

Brook, Timothy. "Comparative Pandemics: The Tudor–Stuart and Wanli–Chongzhen Years of Pestilence, 1567–1666". *Journal of Global History* 15, no. 3 (2020): 363–379.

Carmichael, Ann G. "Plague Persistence in Western Europe: A Hypothesis", *The Medieval Globe* 1, no. 1 (2014): 157-192.

Cessford, Craig, *et al.* "Beyond Plague Pits: Using Genetics to Identify Responses to Plague in Medieval Cambridgeshire". *European Journal of Archaeology* 24, no. 4 (November 2021): 496-518.

Chouin, Gérard, and Olanrewaju Blessing Lasisi. "Crisis and Transformation in the Bight of Benin at the Dawn of the Atlantic Trade". In *Power, Political Economy, and Historical Landscapes of the Modern World: Interdisciplinary Perspectives*, edited by Christopher R. DeCorse, 285-306. Albany: SUNY Press, 2019.

Cui, Yujun, *et al. "Historical Variations in Mutation Rate in an Epidemic Pathogen, Yersinia pestis". Proceedings of the National Academy of Science 110, no. 2 (2013): 577–582.*

Cunningham, Andrew. "Transforming Plague: The Laboratory and the Identification of Infectious Disease". In *The Laboratory Revolution in Medicine*, edited by Andrew Cunningham and Perry Williams, 209-44. Cambridge: Cambridge University Press.

DeWitte, Sharon N., and Mary Lewis. "Medieval Menarche: Changes in Pubertal Timing in the Aftermath of the Black Death," *American Journal of Human Biology*, 33, Issue 2 (2021), Special Issue: Biocultural approaches to the plasticity of the human skeleton, https://onlinelibrary.wiley.com/doi/full/10.1002/ajhb.23439.

Dueppen Stephen A. *Divine Consumption: Sacrifice, Alliance Building, and Making Ancestors in West Africa*, Monumenta Archaeologica 48. Los Angeles: UCLA Cotsen Institute of Archaeology Press, 2022.

Eckert, Edward A. "Boundary Formation and Diffusion of Plague: Swiss Epidemics from 1562 to 1669", *Annales de Démographie Historique 1978 (1978): 49-80.*

Eckert, Edward A. The Structure of Plagues and Pestilences in Early Modern Europe. Central Europe 1560-1640. Basel: Karger, 1996.

Fancy, Nahyan. "Knowing the Signs of Disease: Plague in Arabic Medical Commentaries Between the First and Second Pandemics", in *Death and Disease in the Long Middle Ages*, edited by Lori Jones and Nükhet Varlık, 35-66. York: York Medieval Press, 2022.

Fancy, Nahyan, and Monica H. Green. "Plague and the Fall of Baghdad (1258)". *Medical History* 65, no. 2 (April 2021): 157-177.

Glatter, Kathryn A., and Paul Finkelman. "History of the Plague: An Ancient Pandemic for the Age of COVID-19". *American Journal of Medicine* 134, no. 2 (2020): 176-181.

Green, Monica H. "Flowers, Poisons, and Men: Menstruation in Medieval Western Europe". In *Menstruation: A Cultural History,* ed. Andrew Shail and Gillian Howie, 51-64. New York: Palgrave, 2005.

Green, Monica H., ed. *Pandemic Disease in the Medieval World: Rethinking the Black Death*, special inaugural issue of *The Medieval Globe* 1 (2014), http://scholarworks.wmich.edu/medieval_globe/1/.

[61] Monica H. Green, "Genetics as a Historicist Discipline: A New Player in Disease History", *Perspectives on History* 52, no. 9 (December 2014): 30-31.

Green, Monica H. "Genetics as a Historicist Discipline: A New Player in Disease History". *Perspectives on History* 52, no. 9 (December 2014): 30-31.
Green, Monica H. "Putting Africa on the Black Death Map: Narratives from Genetics and History". *Afriques* 9 (24 December 2018), http://journals.openedition.org/afriques/2125. This is part of a special issue of *Afriques* 9 (2018), *Sillages de la peste noire en Afrique subsaharienne: une exploration critique du silence / Black Death and Its Aftermaths in Sub-Saharan Africa: A Critical Exploration of Silence*, edited by Gérard Chouin, https://journals.openedition.org/afriques/2125.
Green, Monica H. "When Numbers Don't Count: Changing Perspectives on the Justinianic Plague". *Eidolon*, 18 November 2019, https://eidolon.pub/when-numbers-dont-count-56a2b3c3d07.
Green, Monica H. "The Four Black Deaths," *American Historical Review* 125, no. 5 (December 2020), 1600-1631; includes Supplemental Data, "Marmots and Their Plague Strains," online only (https://academic.oup.com/ahr/article/125/5/1601/6040962).
Green Monica H. "The Great Dying: The Epidemiological Implications of Old and New World Encounters, 1000-1800", *Isis Critical Bibliography, draft submitted 10 June 2021,* https://drive.google.com/file/d/1wYlHpY5l11HE5Vk2qwvxYSeiXKqEZQSo/view.
Green, Monica H. "Out of the East (and West and South): A Response to Philip Slavin". *Past and Present* 256, no. 1 (August 2022): 283–323.
Green, Monica H. "Putting Asia on the Black Death Map". *The Medieval Globe* 8, no. 1 (2022), 59-87.
Guellil, Meriam, *et al.* "An Invasive *Haemophilus influenzae* serotype b Infection in an Anglo-Saxon Plague Victim". *Genome Biology* 23 (2022): article 22.
Hymes, Robert. "A Hypothesis on the East Asian Beginnings of the *Yersinia pestis* Polytomy". *The Medieval Globe* 1 (Fall 2014): 285-308.
Hymes, Robert. "A Tale of Two Sieges: Liu Qi, Li Gao, and Epidemics in the Jin-Yuan Transition". *Journal of Song-Yuan Studies* 50 (2021): 295-363.
Hymes, Robert. "Buboes in Thirteenth-Century China: Evidence from Chinese Medical Writings". *The Medieval Globe* 8, no. 1 (2022), 1-57.
Kacki, Sacha. "Black Death: Cultures in Crisis". In *Encyclopedia of Global Archaeology*, edited by C. Smith. Cham: Springer, 2020, https://doi.org/10.1007/978-3-319-51726-1_2858-1, accessed 11 September 2022.
Kacki, Sacha. "Digging up the Victims of the Black Death: A Bioarchaeological Perspective on the Second Plague Pandemic". In *Waiting for the End of the World? New Perspectives on Natural Disasters in Medieval Europe*, edited by Christopher M. Gerrard, Paolo Forlin, and Peter J. Brown, 259-279. London: Routledge, 2020.
Mengel, David. "A Plague on Bohemia? Mapping the Black Death." *Past and Present* no. 211 (May 2011), 3-34.
Mirza, Younus Y. "'It Was a Memorable Day' – How the Black Death United the Population of Medieval Damascus". *Maydan*, 30 March 2020, https://themaydan.com/2020/03/it-was-a-memorable-day-how-the-black-death-united-the-population-of-medieval-damascus/, accessed 11 September 2022.
Mitchell, Piers D., *et al.* "The Prevalence of Cancer in Britain Before Industrialization". *Cancer* 127, no. 17 (September 1, 2021), 3054-3059.
Mulhall, John. "Plague before the Pandemics: The Greek Medical Evidence for Bubonic Plague before the Sixth Century". *Bulletin of the History of Medicine* 93, no. 2 (Summer 2019): 151-179.
Norris, John. "East or West? The Geographic Origin of the Black Death". *Bulletin of the History of Medicine* 51, 1 (1977): 1–24.
Pinke, Zsolt, Stephen Pow, and Zoltán Kern. "Volcanic Mega-eruptions May Trigger Major Cholera Outbreaks". *Climate Research* 79 (2019): 151–162.
Pollitzer, R[obert]. "Plague Studies 1. A Summary of the History and a Survey of the Present Distribution of the Disease", Bullétin de l'Organisation mondiale de Santé/Bulletin of the World Health Organization 4 (1951): 475-533.

Pomerantz, Maurice, and Jonathan Decter. "The *Maqāma* Genre and the History of an Islamicate Literary Form". *Intellectual History of the Islamicate World* 10, no. 1-2 (2022): 1-9.
Roosen, Joris, and Monica H. Green. "The Mother of All Pandemics: The State of Black Death Research in the Era of COVID-19 – Bibliography," 26 May 2020 (with subsequent updates), https://drive.google.com/file/d/1x0D_dwyAwp9xi9sMCW5UvpGfEVH5J2ZA/view?usp=sharing, accessed 07 Sep 2022.
Sarris, Peter. "Climate and Disease". In *A Companion to the Global Early Middle Ages*, edited by Erik Hermans, 511-537. Leeds: Arc Humanities Press, 2020.
Seguin-Orlando, Andaine, *et al*. "No Particular Genomic Features Underpin the Dramatic Economic Consequences of 17th Century Plague Epidemics in Italy", *iScience* 24, no. 4 (23 April 2021): 102383.
Slack, Paul. "Perceptions of Plague in Eighteenth-Century Europe". *Economic History Review* 75, no. 1 (February 2022): 138-156.
Slavin, Philip."Out of the West: Formation of a Permanent Plague Reservoir in South-Central Germany (1349–1356) and Its Implications", *Past and Present* 252, no. 1 (August 2021): 3–51.
Spyrou, Maria A., *et al. "Analysis of 3800-Year-Old Yersinia pestis Genomes Suggests Bronze Age Origin for Bubonic Plague". Nature Communications 9 (June 8, 2018): 2234.*
Spyrou, Maria A., et al. "The Source of the Black Death in Fourteenth-Century Central Eurasia". Nature 606 (23 June 2022): 718–724.
Teplitzky, Joshua. "Imagined Immunities: Medieval Myths and Modern Histories of Jews and the Black Death". *AJS Review* 2022, forthcoming.
Tresso, Claudia Maria. "India's Epidemics in the *Riḥla* of Ibn Baṭṭūṭa: Plague, Cholera or Lexical Muddle?". *Bulletin of the School of Oriental and African Studies* (forthcoming).
Varlık, Nükhet. "'Oriental Plague' or Epidemiological Orientalism?: Revisiting the Plague Episteme of the Early Modern Mediterranean". In *Plague and Contagion in the Islamic Mediterranean*, edited by Nükhet Varlık, 57-87. Kalamazoo, MI: Arc Humanities Press, 2017.

Varlık, Nükhet. "Why is Black Death *Black*? European Gothic Imaginaries of 'Oriental' Plague". In *Plague Image and Imagination*, edited by Christos Lynteris, 11-35. Cham: Palgrave Macmillan, 2021.

Varlık, Nükhet. "The Rise and Fall of a Historical Plague Reservoir: The Case of Ottoman Anatolia". In *Disease and the Environment in the Medieval and Early Modern Worlds*, edited by Lori Jones, 159-183. Abingdon, UK: Taylor and Francis, 2022.

Varlık, Nükhet. "Plague in the Mediterranean/Islamic World" [version 3]. *IsisCB Special Issue on Pandemics*, edited by Neeraja Sankaran and Stephen P. Weldon, submitted on 2022/04/13, accepted 2022,05/25, https://drive.google.com/file/d/1fPI4PhwbNcwt6dyZkwthRzHZNoeLabSs/view, accessed 11 September 2022.

Zabolotny, Danilo K. "La Peste en Mongolie Orientale". *Annales de l'Institut Pasteur* 13, no. 11 (1899): 833-840.