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ARTICLE

Plague history, Mongol history, and the processes of focalisation leading up to the Black Death: a response to Brack *et al.*

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Abstract
This essay responds to Brack *et al*., 'Plague and the Mongol Conquest of Baghdad (1258)? A reevaluation of the sources', which is a critique of our 2021 essay in this journal, 'Plague and the Fall of Baghdad (1258)'. We argue that Brack and colleagues have misunderstood our investigation as an attempt to pinpoint the exact timing of the outbreak of plague connected with the Mongol siege of Baghdad, and so believe that an altered timeframe invalidates our suggestion that plague was involved. Taking this opportunity to revisit the state of plague historiography in western Asia, we address four issues: (1) why Mongol historiography has, until recently, avoided the question of plague's late mediaeval resurgence within the Mongol Empire and why the 'new genetics' of plague now makes the question unavoidable; (2) why reconstruction of the biological processes of 'focalisation' is now the most urgent question in plague historiography since it constitutes what we call the prodromal stage of the Black Death pandemic; (3) how a newly informed biological perspective on disease history can allow a more sensitive reading of past observers' reports of epidemics; and finally, (4) what a plausible scenario might look like for plague's presence in western Asia and the eastern Mediterranean region in the late-thirteenth and early-fourteenth centuries as an emerging *zoonotic* disease with occasional epizootic and human outbreaks, before the more catastrophic outbreaks of the 1340s commonly referred to as 'the Black Death'.

Keywords: Black Death; Historical epidemiology; *Yersinia pestis* ecology; Zoonoses; Islamic medicine; Palaeogenetics

Introduction

In the three years since our essay, 'Plague and the Fall of Baghdad (1258)', was published in 2021, approximately 268 major studies have appeared contributing to the late mediaeval history of plague and its causative microbial organism, the bacterium *Yersinia pestis*.[1] As we write, at least half a dozen

[1]Nahyan Fancy and Monica H. Green, 'Plague and the Fall of Baghdad (1258)', *Medical History* 65, 2 (2021), 157–77. The cited figure comes from works published between 2021 and 15 March 2024 as listed 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_dwyAwp9xi9sMCW5UvpGfEVH5J2ZA/view?usp=sharing; the 15 March 2024 iteration of the bibliography is archived on *Knowledge Commons*: https://doi.org/10.17613/sc4h-fw44. This is a multidisciplinary bibliography on the late mediaeval plague pandemic from its origins up to ca. 1500. For a narrative overview of the field, see Nükhet Varlık, 'Plague in the Mediterranean and Islamicate World', *Isis* 114, S1: Bibliographic Essays on the History of Pandemics: An IsisCB Special Issue (2023), S313–62. For the specific contributions of genetics, see Monica H. Green, 'A New Definition of the Black Death: Genetic Findings and Historical Interpretations', *De Medio Aevo* 11, 2 (2022), 139-55; and Monica H. Green, 'Plague (*Yersinia pestis*)', *Encyclopedia of the History of Science* (Pittsburgh: Carnegie Mellon University Libraries Publishing Service, 2024), https://doi.org/10.34758/dy11-5697

more palaeogenetic studies are moving through peer review or are in press. It is, in short, a very active time for plague history. This has not always been the case. On the contrary, in the final two decades of the twentieth and first decade of the twenty-first century, certain aspects of plague history (like many areas of premodern infectious disease history) were moribund, the victim of the successes of medical history itself as it developed more self-critical perspectives on how information about the past could be gathered and responsibly analysed. On the question of plague in particular, continuing scepticism over whether or not the late mediaeval pandemic commonly known as the 'Black Death' had indeed been caused by the bacterium *Y. pestis* led many historians of medicine to avoid the field, save for certain aspects of social or economic history where the evidence of mass mortality was clear and its effects profound.

Since 2011 (almost a decade before the COVID-19 pandemic), however, the Black Death – and many other aspects of plague history – has seen a resurgence in interest. Two thousand and eleven was a pivotal year because it was then that the genie of molecular approaches to disease history was let out of the bottle by the recovery of *Y. pestis* from four bodies buried in two mid-fourteenth-century cemeteries in the centre of London.[2] These were not simply random fragments sufficient to confirm the presence of *Y. pestis* by a few diagnostic markers. No, these were nearly complete genomes which could be compared and analysed against every other genetically-sequenced isolate of *Y. pestis* anywhere in the world. A global history of plague was now possible.

Yet in ushering plague history into the genetics age, this technical achievement in molecular biology has also raised questions about how the physical evidence for microbial pathogens was going to be integrated into medical history. These challenges, far from being insurmountable, we feel, are the very warp and weft of the mantle that the field of medical history now needs to take up and bear. We are indeed in a new era of investigative possibility, and the challenges of a climatically- and microbially-changing future make responsible engagement with that history all the more pressing.

The essay by Jonathan Brack, Michal Biran, and Reuven Amitai offers us the opportunity to revisit the dossier of evidence we compiled in 2021 for the possible presence of plague in western Asia nearly a century before received historical narratives have suggested it was present.[3] We find it curious that on the cusp of a 'brave new world' of possibility in integrating physical and textual evidence, Brack and colleagues wish, on the one hand, to evoke one single palaeogenetic study as 'definitively proving' the *absence* of certain phenomena, and on the other, to revert to a decades-old body of evidence and methods that, even among text-based humanists, seems antiquated. In what follows, we draw on the empirical findings of plague scientists, archaeologists, and historians, as well as our own methodological interrogations of how work in disease history can be effectuated, not simply to argue for the validity of our original findings, but to expand them. Indeed, many points that Brack and colleagues make actually support our main argument as we shall demonstrate below.

Our arguments are presented under four headings. First, in the section 'Plague historiography and the Mongol Empire', we review the historiography of the late mediaeval plague pandemic as it pertains to western Asia and the Mongol Empire. Remarkably, Mongolists have generally refrained from engaging in plague studies despite clear evidence that the late mediaeval pandemic arose, at least in part, within the Empire's bounds. These historiographical traditions are then set into the context of the 'new genetics' to make two related arguments: that an ascertainment bias, due to the Eurocentric origins of both the field of palaeogenetics and plague history generally, leaves open far too many questions for 'definitive' proofs, positive or negative, to be claimed on most plague-related topics right now; and secondly, that the specific 'definitive proof' from genetics that Brack and colleagues invoke to claim a fourteenth-century origin of the Black Death has, in fact, already been challenged by plague historians and palaeogeneticists.

[2]Kirsten I. Bos *et al.*, 'A Draft Genome of *Yersinia pestis* from Victims of the Black Death', *Nature* 478 (2011), 506–10. For a survey of these developments in plague science, see Green, 'Plague', *op. cit.* (note 1).

[3]Jonathan Brack, Michal Biran, and Reuven Amitai, 'Plague and the Mongol Conquest of Baghdad (1258)? A Reevaluation of the Sources', *Medical History*, https://doi.org/10.1017/mdh.2023.38

In the section 'Focalisation and the methodological demands of gaps between the biological and documentary archives', we note that Brack and colleagues have fundamentally not understood that plague is an enzootic disease, meaning it persists evolutionarily in animals, specifically rodents. A central burden of the plague historian is not simply to chronicle *human* outbreaks, but to establish at least plausible scenarios for the generally undocumented stages of enzootic persistence of plague in animal reservoirs and focalisation of the disease in new landscapes when it is introduced into them. In other words, a comprehensive, global history of plague must explain all aspects of the 'trophic cascade' that moves *Y. pestis* between insect vectors, maintenance hosts (most likely wild rodents), commensal intermediate hosts (such as rats), and (rarely) humans. And it must explain how that process happens not just once, but repeatedly. Most of that history is undocumented, either by the written documentary archive (created by humans, of course) or, currently, by the palaeosciences.[4] Nevertheless, as we make clear by drawing on modern plague ecological and palaeogenetic studies, what we call a 'prodromal' stage is the necessary antecedent to any sustained plague pandemic, which is precisely what we believe Afro-Eurasia experienced in the thirteenth and early fourteenth centuries.

Having addressed the range of phenomena the plague historian must seek to plausibly claim plague's presence at any given time or place in the past, we then address, in the section 'Perceiving plague's presence: reading the past without a microscope', the arguments we have drawn from our mediaeval documentary sources. In combining evidence from the natural sciences with the documentary record, the disease historian's task is to make a plausible account of both the physical disease and the *human perceptions* of it according to the conceptual frameworks of past societies. For thirteenth-century western Asian societies, which largely functioned within the broader conceptual frameworks of Hippocratic–Galenic medical thinking, the crucial concept was that epidemic diseases (those that struck many people all at once) were due to miasms. As we argued in our original paper, that is precisely the scenario that the collective accounts of contemporary and near-contemporary chroniclers envisioned regarding the events of 1258. Hence, evaluating what happened at Baghdad in the context of what subsequently happened in Syria and Egypt in the following two years is not a wild goose chase, but an attempt to reconcile the historical actors' observations with what might have been an actual path of spread of plague through new rodent hosts and human populations in the region. In not understanding how we were moving back and forth between historical understandings of the disease and what we now know about *Y. pestis* to create a plausible path for the displacement of *Y. pestis* from its long-time reservoir near the Tian-Shan mountains to Western Eurasia, Brack and colleagues mischaracterize our main arguments by fixating on the timing of a given outbreak. In their minds, as long as a disease outbreak took place before the lifting of a Mongol siege, the outbreak could not have been caused by Mongol displacement of the bacterium. They maintain this despite themselves acknowledging at least two disease outbreaks before 1258 in cities under siege by the Mongols. They also incorrectly claim that the 'linchpin' of our argument is the account in a Persian chronicle copied by the physician–astronomer, Quṭb al-Dīn al-Shīrāzī (d. 1311) and that we 'somewhat interchangeably' use the terms *wabāʾ* and *ṭāʿūn* (ostensibly) to mischaracterize individual disease outbreaks as the plague for which, according to them, specific symptoms are not described.[5] We of course were very careful in identifying when a text uses *wabāʾ* (epidemic) and where one uses *ṭāʿūn* (plague), which is why we used the term 'plague-like disease' to broadly refer to lethal disease outbreaks in Egypt and Iraq, for which the more specific word *ṭāʿūn* is not invoked in the original sources. Our goal was to document that a specific plague outbreak is recorded for Damascus, and how 'chroniclers could classify the disease outbreak as only an "epidemic" [*wabāʾ*] … for Baghdad itself

[4]Two examples of work laying the foundations for investigation of rodent and arthropod history are He Yu *et al.*, 'Palaeogenomic Analysis of Black Rat (*Rattus rattus*) Reveals Multiple European Introductions Associated with Human Economic History', *Nature Communications* 13 (03 May 2022), 2399; and S.G. Medvedev, D.B. Verzhutsky, and B.K. Kotti, 'Species of the Genus *Xenopsylla* (siphonaptera; pulicidae) as Vectors of Plague Infection in its Natural Foci', *Parazitologiâ* 57, 4 (2023), 267–309 (in Russian).

[5]Brack *et al.*, *op. cit.* (note 3), [3-6, 5n17, 18].

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but as plague [*ṭāʿūn*] … for Damascus'.[6] We also showed that the Syrian outbreak came to be associated with the fall of Baghdad in a highly influential contemporary account that was repeated by several authors of the next two generations. These claims, which are the central claims of our paper, are not found in the chronicle copied by al-Shīrāzī. Of course, what this Persian chronicle provided us was a plausible mechanism for *how* the Mongols could have imported *Y. pestis* into the region from the Tian-Shan without their knowledge nor causing continuous outbreaks along the way, which is by way of grain imports. This is again an example of moving back and forth between our historical sources and their conceptions, and our modern understanding of disease ecologies to arrive at a plausible historical scenario for the displacement and focalisation of the bacterium.

Finally, in the section 'The case for plague's presence in the Western Ilkhanate in the late thirteenth and early fourteenth centuries', we return to the original question that prompted our 2021 essay: if a series of plague outbreaks did indeed occur in the western realms of the newly established Ilkhanate and Ayyubid Syria and Mamluk Egypt in the context of the Mongol conquests of the 1250s, and if physicians were responding to the new presence of the disease in their midst, why was that history forgotten and what does its recovery mean for us now? Brack and colleagues contend it was not 'forgotten'; they contend it never happened – or if there was any kind of epidemic, it was not plague. Clearly, as we acknowledged in our original work, there is an unevenness in the documentary record that is puzzling. As we point out here, there is still no 'smoking gun' of genetic evidence to prove that a new strain of *Y. pestis* was introduced into western Asia in the mid-thirteenth century. However, there is hardly any genetic evidence for infectious diseases in western Asia for the late mediaeval period, since the region has rarely been included in palaeogenetic investigations to date.[7] Nevertheless, the challenge of documenting plague in its pre-pandemic, prodromal phases means documenting it at transmission stages that would likely fall below human awareness. Physicians are an important exception, of course, and it was precisely because of the notes about plague (*ṭāʿūn*) in the writings of physicians (or scholars with medical training) that our attention was initially drawn to the question of the changed perceptions in the 1250s and after. Using the principle that multidisciplinary approaches must allow arguments to be constructed with corroborating evidence from multiple fields,[8] we offer a summary of the case for plague as it stands now. We present new evidence to support something our previous paper only hinted at: that the western Ilkhanate may, in fact, have been one of the regions in which newly introduced strains of *Y. pestis* focalised in the late thirteenth and early fourteenth centuries, creating the biological foundations for the explosive proliferation of plague in the 1330s and 1340s under the influence of changing climatic conditions.

Plague historiography and the Mongol Empire

In 2015, the late Thomas Allsen – widely hailed as one of the leading Mongolists of the last three decades – published a study on 'Population Movements in Mongol Eurasia'. In it, he included one and a half sentences on the Black Death, that 'complicating factor' in population loss under the Mongol regime. 'This scourge', he said, 'began in eastern Inner Asia in the 1330s, reaching the Crimea in 1346 from whence it spread into the Mediterranean and Europe'.[9] Allsen's epidemiological summary – vaguely conjuring a sort of dark cloud sweeping westward across Eurasia in under two decades – is, in fact, the standard narrative given in virtually all textbooks on mediaeval and

[6]Fancy and Green, *op. cit.* (note 1), 159.

[7]A preliminary study announcing Justinianic Plague era *Y. pestis* genomes retrieved from Jerash, Jordan, is: Rays Jiang *et al.*, 'Unraveling the First World Pandemic in an Ancient Cosmopolitan City with Archaeological and Genetic Evidence', *Research Square*, preprint, 10 Jan 2024, https://doi.org/10.21203/rs.3.rs-3688671/v1.

[8]Monica H. Green, 'Putting Asia on the Black Death Map', *The Medieval Globe* 8, 1 (2022), 59–87, especially 72-84.

[9]Thomas T. Allsen, 'Population Movements in Mongol Eurasia', in Reuven Amitai and Michal Biran (eds.), *Nomads as Agents of Cultural Change: The Mongols and Their Eurasian Predecessors* (Honolulu: Hawaii University Press, 2015), 119–51, at 136.

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global history in recounting the origins of the Black Death. What is striking is that, in support of the historicity of this massive demographic catastrophe, Allsen (a formidable researcher in most of the major languages used in the Mongol realms) could only cite two monographs from the 1970s: William McNeill's largely outdated *Plagues and Peoples* (1976), and Michael Dols' still-indispensable *The Black Death in the Middle East* (1977).[10] Allsen's passing reference to the Black Death was in fact the only time the pandemic was mentioned in the 355-page book where his essay appeared, a volume wholly devoted to 'nomads as agents of cultural change'. A veritable industry of Mongol Empire studies in the past two decades shows a similar tendency to skirt around the Black Death and, even when acknowledging it, to document it only by reference to dated work.[11] Exceptions are the recent works by Marie Favereau, who presents differing accounts of the pandemic's origin and route in her two recent books, and Peter Jackson, who, more valuably, reviews many of the standard primary sources already invoked by Dols fifty years ago, though with important additions from Russian and Persian literature not examined by Dols.[12] Neither Favereau nor Jackson, however, engage with the scientific literature on plague's biology, ecology, or evolutionary development. The latter is mentioned in passing in the Introduction and Epilogue of the 2023 two-volume, 1522-page *Cambridge History of the Mongol Empire*, but it is not meaningfully integrated into the narratives; in fact, plague is shunted aside in the chapter on 'The Climate and Environment of the Mongol Conquest' as a topic to be deferred to future studies.[13]

So why has Mongol historiography largely avoided the topic of the Black Death, treating it (if it is mentioned at all) as an inexplicable natural catastrophe that just happened to coincide with the collapse in the mid-fourteenth century of three of the four khanates established by Chinggis Khan's grandsons? Brack and colleagues, as Mongolists, may be better suited to answer that question, though we, as medical historians, can provide our own speculation. On the one hand, as has now been recognized numerous times, the Black Death itself, as a historical phenomenon, has largely been framed from Eurocentric perspectives.[14] The idea that it 'came from the East' is embedded in many

[10]William H. McNeill, *Plagues and Peoples* (Garden City, NY: Anchor Press, 1976); Michael W. Dols, *The Black Death in the Middle East* (Princeton: Princeton University Press, 1977).

[11]Green, 'Putting Asia', *op. cit.* (note 8), 82: 'This understanding that the Black Death had no history prior to the third or fourth decade of the fourteenth century, which has now been taken up by Spyrou and colleagues, is also reinforced by the consistent silence on plague in an increasingly large body of scholarship on the Mongol Empire, the largest land empire in human history'. Works that have focused on plague in the Mongol realms include the following: Paul D. Buell, 'Qubilai and the Rats', *Sudhoffs Archiv* 96, no. 2 (2012), 127–44, whose claims for the non-presence of plague in the Mongol realms are largely dismantled by Robert Hymes, 'A Hypothesis on the East Asian Beginnings of the *Yersinia pestis* Polytomy', *The Medieval Globe* 1 (2014), 285-308; Timothy May, *The Mongol Conquests in World History* (London: Reaktion, 2013), specifically Chapter 8, 199-210; and I. M. Mirgaleev and Roman Hautala (eds.), *ЭПИДЕМИИ И ПРИРОДНЫЕ КАТАКЛИЗМЫ В ЗОЛОТОЙ ОРДЕ И НА СОПРЕДЕЛЬНЫХ ТЕРРИТОРИЯХ (XIII–XVI ВВ.)* [Epidemics and Natural Disasters in the Golden Horde and Adjacent Territories (XIII-XVI centuries)] (Kazan: Institute of History. S. Marjani, Academy of Sciences of the Republic of Tajikistan, 2018).

[12]In her 2021 book, Favereau devotes the better part of a whole chapter to the Black Death, summarising the standard Issyk Kul narrative that the World Health Organization plague researcher, Robert Pollitzer, had popularised in the 1950s; see Marie Favereau, *The Horde: How the Mongols Changed the World* (Cambridge, MA: Harvard University Press, 2021), and, on Pollitzer's influence, Green, 'New Definition', *op. cit.* (note 1), esp. 146-7. In the map in her 2023 book, Favereau reverts to a narrative seemingly echoing McNeill, placing the pandemic's origin in the thirteenth century but in southeast Asia; Marie Favereau, *Les Mongols et le Monde: L'autre visage de l'empire de Gengis Khan* (Nantes: Musée d'histoire de Nantes; Ulaanbaatar: Chinggis Khaan National Museum, 2023), 30, 76-7, 142-3, and 267-8. See also Peter Jackson, *From Genghis Khan to Tamerlane: The Reawakening of Mongol Asia* (New Haven: Yale University Press, 2023), 139-65. Another exception to this general inattention to the late mediaeval pandemic is Uli Schamiloglu, who in several studies has speculated about the transformative effects of the Black Death in language shifts in the region. See, for example, Uli Schamiloglu, 'The Impact of the Black Death on the Golden Horde: Politics, Economy, Society, and Civilization', *Golden Horde Review / Zolotoordïnskoe obozrenie* 5, 2 (2017), 325–43.

[13]Nicola Di Cosmo, 'The Climate and Environment of the Mongol Conquest', in Michal Biran and Hodong Kim (eds.), *Cambridge History of the Mongol Empire*, 2 vols. (Cambridge: Cambridge University Press, 2023), vol. 1, 603–27.

[14]Varlık, *op. cit.* (note 1).

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contemporary European accounts, even though what 'the East' was varied from vague understandings of the Black Sea to imagined ideas of India or China. Actually *investigating* the source of the pandemic outside of Europe, let alone reckoning with the impact of the pandemic, however, has not been considered the burden of most plague historians. The most recent revision of a 'complete' history of the Black Death persists in its belief (first articulated in the original edition of 2004) that the pandemic originated out of ancient plague reservoirs in the Caucasus and had no appreciable effect on the Mongol world, most of which is literally left off the book's map.[15] The continued attraction of McNeill's half-century-old *Plagues and Peoples* lies in his willingness to paint a sweeping pan-Eurasian picture that ties together what was known about plague ecologies in the 1970s.[16] Dols, as we discussed in our 2021 essay, accepted the 'compromise' Issyk Kul narrative that the World Health Organization (WHO) plague expert, Robert Pollitzer, had popularised in the 1950s, which placed the pandemic's origins neither in far east Asia nor the region of the Caucasus, but at an intermediate point in Central Asia. That narrative – which enshrined not simply a geographical origin but a chronological one too (thanks to a well-dated outbreak of *mawtānā*[17] in a Christian community of Kara-Djigach, near Issyk Kul in what is now Kyrgyzstan) – was attractive because it told a simple story that lined up inherited narratives ('It came from the East') and archaeological support with an absence of any explicitly conflicting evidence.[18]

Getting beyond that simple narrative *has* been hard, if not impossible, because of the evidentiary disconnect between a rodent disease and human perception. In the section 'Focalisation and the methodological demands of gaps between the biological and documentary archives' below, we address the process by which *Y. pestis* becomes established in a new landscape, embedding itself in a rodent infrastructure that, along with its symbiont flea communities, allows *Y. pestis* to be perpetuated in a sylvatic cycle. Here, however, there is still a need to address one further aspect of plague historiography: the impact of the 'new genetics' and how it ties the Black Death even more firmly to the history of the Mongol Empire.

Brack and colleagues never mention the important refutation of a calumny raised against the Mongols with regularity since the nineteenth century: that is, that Mongol warriors 'initiated' the Black Death by hurling plague-infected bodies over the walls at the siege of Caffa in 1346, thereby infecting the Italian merchants in their enclave in Crimea, who in turn fled back into the Mediterranean carrying the disease with them. This accusation of bioterrorism has haunted Mongol studies, and may perhaps explain the reticence on the part of Mongolists over the last few decades to engage in plague scholarship. However, this story derives from a single fourteenth-century manuscript, which was not retrieved for modern scholarship until the mid-nineteenth century. In a recent and highly persuasive study, Hannah Barker demonstrates that the account of the siege found in Gabriele de Mussi's *Historia de morbo* (History of the Disease, written at some point between 1350 and his death in 1356) conflated different events, invented certain details, and collapsed the timeline of the likely transmission of plague via contaminated grain shipments out of the Black Sea.[19] Barker's work has had

[15]Ole Benedictow, *The Complete History of the Black Death* (Woodbridge: Boydell, 2021). This is a revised edition of *The Black Death, 1346–1353: The Complete History* (2004). The oldest living strains of *Y. pestis* in the Caucasus may have been there since the Bronze Age (see below) but since they are in no way genetically related to the strains documented from Black Death gravesites, this thesis is unpersuasive.

[16]A major critique of McNeill (*op. cit.* [note 10]) is long overdue. For now, see the brief comments in Christopher Atwood, 'The Empire of the Great Khan: The Yuan Ulus, 1260-1368', in Biran and Kim, *op. cit.* (note 13), vol. 1, 107-80; and Linda Nash, 'Beyond Virgin Soil Epidemics: Disease as Environmental History', in Andrew C. Isenberg (ed.), *The Oxford Handbook of Environmental History* (Oxford/New York: Oxford University Press, 2014), not paginated.

[17]The Syriac term *mawtānā* is equivalent to the Arabic term *wabāʾ*; both can refer generally to any epidemic disease, including plague.

[18]On the origin of the dating claims (placing the pandemic's origins in the 1330s) in Arabic plague historiography and the role of the World Health Organization's plague specialist, Pollitzer, see Green, 'New Definition', *op. cit.* (note 1), 146-7.

[19]Hannah Barker, 'Laying the Corpses to Rest: Grain, Embargoes, and *Yersinia pestis* in the Black Sea, 1346-1348', *Speculum* 96, 1 (2021), 97–126.

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the effect not simply of vindicating the Mongols of the Golden Horde of the charge of bioterrorism (she demonstrates that the siege ended well before plague was likely transmitted across the Black Sea), but she also links the transmission of plague with the vitally important history of long-distance grain shipping in the late Middle Ages.

Yet, just as Barker was ridding Mongol historiography of one association with plague, genetics was tying the Mongol Empire more firmly to plague's history with another. Ever since the Aleppan historian and poet, Ibn al-Wardī (d. 1349), wrote his *Risālat al-nabāʾ ʿan al-wabāʾ* (Essay on the Report of the Plague) just prior to his own death from plague, the major narrative tradition of the Black Death in Arabic connected the fate of the western Islamicate world with that of the Mongol Empire. This connection was further embellished by the fifteenth-century Egyptian historian, al-Maqrīzī (d. 1442), whose account has largely shaped modern narratives as they pertain to the eastern Mediterranean world. As has been established, the 'out of the East' narrative that these two authors advanced was enshrined in European plague historiography when an eighteenth-century historian collated Arabic accounts with Chinese encyclopaedic records, finding datable descriptions of epidemics that seemed to fit closely enough with Arabic accounts to infer that all of Eurasia was experiencing a common, swift transmission of a single common threat. When the WHO plague specialist, Pollitzer, was writing his brief summation of plague history in 1951, the European narratives already ensconced in general plague historiography could be combined not simply with a summary of the archaeological discovery of the Kara-Djigach site in the nineteenth century, but with recent ecological reports of plague in marmot populations of the nearby Tian Shan mountains.[20]

Most recently, environmental historian Philip Slavin has published a series of studies arguing for what we call the Quick Transit Theory: that is, the idea that a novel strain of *Y. pestis*, originating in the 1330s, moved swiftly and directly from the region of Kara-Djigach to the northern Caspian Sea and then to the Black Sea (an overland transit of over 3000 km) in the space of about eight years. At the core of Slavin's work is a 2022 article in the science journal *Nature*, which he produced with a team of geneticists, anthropologists, and a linguistic historian. Building on the work of the nineteenth-century Russian archaeologists who initially excavated the Kara-Djigach site, Slavin's team claimed to have identified the moment of origin of the Black Death pandemic – or rather, the Ur-moment, since they argue that the strain they retrieved from the cemetery of Kara-Djigach in Kyrgyzstan represents the stage of the development of *Y. pestis* just before the Big Bang, the sudden expansion of an ancient lineage of *Y. pestis* into new ecological niches from which the four modern branches of the organism arose.[21] This study is cited by Brack and colleagues as having 'decisively demonstrated' that the *Y. pestis* genotype involved in the Black Death emerged only in the fourteenth century, specifically sometime between 1308 and 1338.[22] Crucially, this dating comes well after the main expansionist phase of the Mongol Empire, under Chinggis Khan (d. 1227) and his sons in the first half of the thirteenth century. We find Brack and colleagues' absolutist claim surprising since it ignores already published research by other geneticists suggesting that the new lineage of *Y. pestis* involved in the Black Death (Branch 1) as documented in Europe had already split into two sublineages as much as a

[20]Green, 'New Definition', *op. cit.* (note 1).

[21]On the genesis of the concept of the Big Bang in plague's evolutionary history, see Green, 'Plague', *op. cit.* (note 1).

[22]Maria A. Spyrou *et al.*, 'The Source of the Black Death in Fourteenth-Century Central Eurasia', *Nature* 606 (23 June 2022), 718–24; cited by Brack *et al.*, *op. cit.* (note 3), [2]. In addition to this study, Slavin has pressed the same argument in a suite of other studies drawing on the single documented outbreak at Kara-Djigach and a neighbouring community near modern Burana where, however, no genetic data on *Y. pestis* has yet been retrieved: Philip Slavin, 'The Birth of the Black Death: Biology, Climate, Environment, and the Beginnings of the Second Plague Pandemic in Early Fourteenth-Century Central Asia', *Environmental History* 28, 2 (2023), 300–34; Philip Slavin, 'A Rise and Fall of a Chaghadaid Community: Demographic Growth and Crisis in "Late-medieval" Semirech'ye (Zhetysu), circa 1248–1345', *Journal of the Royal Asiatic Society*, series 3, 33 (2023), 513–44; and Philip Slavin, 'From the Tian Shan to Crimea: Dynamics of Plague Spread during the Early Stages of the Black Death, 1338-46', *Journal of the Economic and Social History of the Orient* 66, 5-6 (2023), 513–627. The alleged genetic primacy of the Kara-Djigach genome is also foundational to Slavin's work on strains of *Y. pestis* in Europe; see discussion below.

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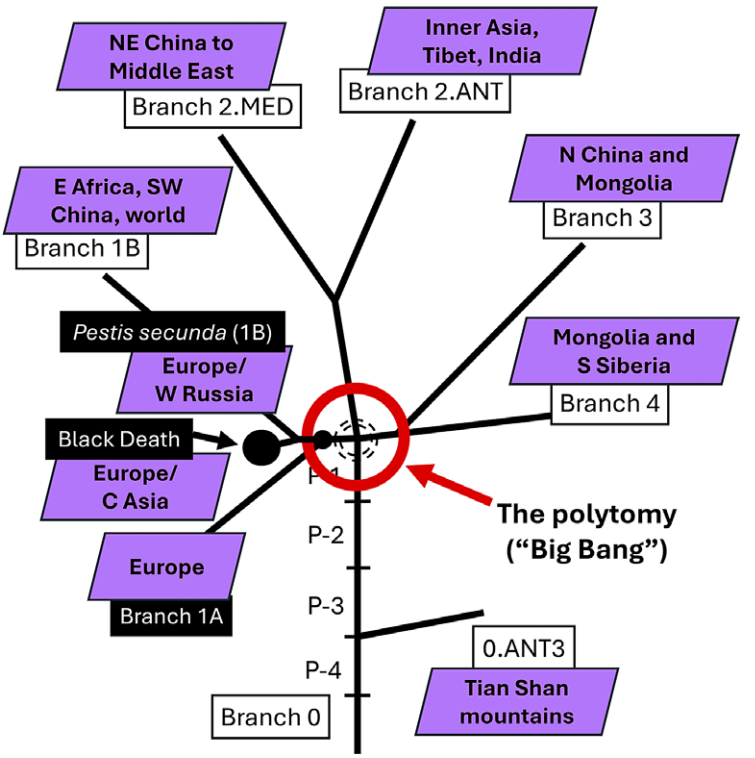

Figure 1. The Big Bang. A schematic phylogenetic tree of *Y. pestis* evolution from its probable later medieval proliferation in or near the Tian Shan mountains (the Big Bang) up through the documented geographic locations of the four extant lineages, Branches 1-4. Lineages documented solely from ancient DNA (aDNA) are indicated with a black box; those still living are in a white box. The geographic distribution is indicated in the rhomboids.
Source: The authors.

century before reported outbreaks in 1347/8 (see Figure 1 for an abstract detail of the *Y. pestis* phylogenetic tree).[23]

These debates about the evolution of *Y. pestis* are ongoing, and will likely continue for some time as geneticists incorporate more genomes into their collective databases and refine their phylogeny-

[23]The first phylogenetic analysis suggesting that Branch 1 split prior to the conventional starting date of the Black Death appeared before publication of Spyrou *et al.*, *op. cit.* (note 22); see Andaine Seguin-Orlando *et al.*, 'No Particular Genomic Features Underpin the Dramatic Economic Consequences of 17th Century Plague Epidemics in Italy', *iScience* 24, 4 (23 April 2021), 102383, which was cited in 2022 in both Green, 'New Definition', *op. cit.* (note 1), 148, and Green, 'Putting Asia', *op. cit.* (note 8), 71. Spyrou *et al.*, however, did not cite Seguin-Orlando *et al.*, so to date there has been no refutation of the latter's analysis. Moreover, Spyrou *et al.* never addressed the disparity between their current analysis and their own earlier 2019 phylogenetic tree which had clearly suggested that Branch 1 had split already by 1305! Since then, studies by two genetics labs have proposed phylogenetic analyses which likewise push the origins of Branch 1 (which reached mediaeval Europe) into the thirteenth century; see Katherine Eaton et al., 'Plagued by a Cryptic Clock: Insight and Issues from the Global Phylogeny of *Yersinia pestis*', *Communications Biology* 6 (2023), 23, specifically Figure S3; Katherine Eaton et al., 'Emergence, Continuity, and Evolution of *Yersinia pestis* throughout Medieval and Early Modern Denmark', *Current Biology* 33 (March 27, 2023), 1147–52.e5; and Pierre Clavel et al., 'Improving the Extraction of Ancient *Yersinia pestis* Genomes from the Dental Pulp', *iScience* 26, 5 (19 May 2023), 106787. Separately, two affiliated teams that also include Slavin have insisted that descendant lineages of Branch 1, found in European samples, *must* postdate the conventional dating of the European Black Death (1347–8) and therefore support the late origin of the Black Death strains as argued by Spyrou *et al.*, *op. cit.* (note 22). See Cody E. Parker *et al.*, '14th Century *Yersinia pestis* Genomes Support Emergence of *Pestis secunda* within Europe', *PLoS Pathogens* 19, 7 (2023), e1011404; and Marcel Keller *et al.*, 'A Refined Phylochronology of the Second Plague Pandemic in Western Eurasia', *bioRxiv*, https://doi.org/10.1101/2023.07.18.549544, posted July 19, 2023. On issues raised about their dating claims, see Monica H. Green, 'Assessment of the Dating Claims of Keller *et al.* 2023', *Knowledge Commons*, 25 August 2023, https://doi.org/10.17613/jr12-7b60

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deriving and dating methods. However, while geneticists continue to debate within their field, we historians must continue to work within ours. A principal challenge for historians making use of genetic data is that lacking the high-powered computers and bespoke software needed to do computations on many terabytes of data, we are dependent on the tidbits of genetic information and interpretive analyses that scientists choose to share. But as in all cases where historians do comparative work, drawing on the studies of colleagues when we cannot replicate access to their raw data, we apply our skills of inference and logical analysis to determine whether arguments are plausible and whether the collective body of evidence is mutually reinforcing. When we see scientists themselves disputing conclusions that rely solely on computational analyses, that is a signal to us that there is a need for further interrogation. Although we are not quite as sceptical as the research team that has done the most sustained analysis of the phylogenetic divergence of *Y. pestis* and dating claims, we do note their conclusion: 'genetic evidence alone is insufficient for accurately reconstructing the timing and spread of short-term plague epidemics'.[24]

Our reading of the data from the 2022 Kara-Djigach study, set within the wider context of plague science and historiography, is that, as had been suspected when the first epigraphic evidence from the cemetery was studied in the 1880s, the 'epidemic' (*mawtānā*) reported at Kara-Djigach was indeed caused by *Y. pestis*, meaning that the excess mortality in that community in 1338–9 was indeed a plague outbreak. However, the claim that the strain involved in these deaths was *the* ancestral strain to the Big Bang is far-fetched for several reasons. As noted, geneticists themselves have questioned the method of analysis used. Although the method of using predetermined diagnostic SNPs (single nucleotide polymorphisms, essentially 'typographical errors' in the genetic code at certain points along the genome) is well-established in palaeogenetic studies, it is not a foolproof method: it allows you to find what you have already deemed to be important, but it may also induce you to ignore variants that you did not expect to find. Subsequent analysis using a more inclusive method showed the Kara-Djigach strain to be firmly a part of Branch 1, more closely related to strains involved in European outbreaks of the 1340s (the historically documented Black Death) and not immediately related to the Big Bang at all (Figures 2A and 2B).[25] Moreover, from the simple standpoint of historical analysis, the Kara-Djigach study excluded comparative data from what must have been earlier evolutionary forms of *Y. pestis* (Branch 0 in the phylogeny), even though they would have come out of ecologically similar environments in Kyrgyzstan and surrounding regions, and were, it has been argued, involved in the Justinianic Plague pandemic in the early Middle Ages. Most importantly, the researchers did not satisfactorily address how their conclusions fit with the already published evidence for probable plague outbreaks in northern China in the prior century.[26]

To sum up: the Kara-Djigach site is of great importance for documenting the impact of plague on communities in Central Asia. It may eventually help explain the fate of similar Christian communities in central Asia and the history of plague in the Chaghadaid khanate, which would be split in two soon after this outbreak. However, if the phylogenetic critiques are correct, the site has no direct bearing on the question of the temporal origins of the Second Plague Pandemic as a whole. As we will discuss below, right now several European genomes (including that from Nabburg, highlighted in Figure 2B) seem to be more important in that regard.

It would be well to quickly review the evidence for an alternative narrative that appeared at the same time we published in 2021, along with evidence that has become available since then. As Brack and

[24]Eaton *et al.*, 'Cryptic Clock', *op. cit.* (note 23), abstract; cf. 11.

[25]This is presented graphically in Clavel *et al.*, *op. cit.* (note 23); see figs. 2A and 2B below. The lead author of the Kara-Djigach study, Maria A. Spyrou, is a co-author on Clavel *et al.* 2023.

[26]Hymes, *op. cit.* (note 11). Hymes has since published two additional studies that carry forward his arguments; see 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 Robert Hymes, 'Buboes in Thirteenth-Century China: Evidence from Chinese Medical Writings', *The Medieval Globe* 8, 1 (2022), 1–57.

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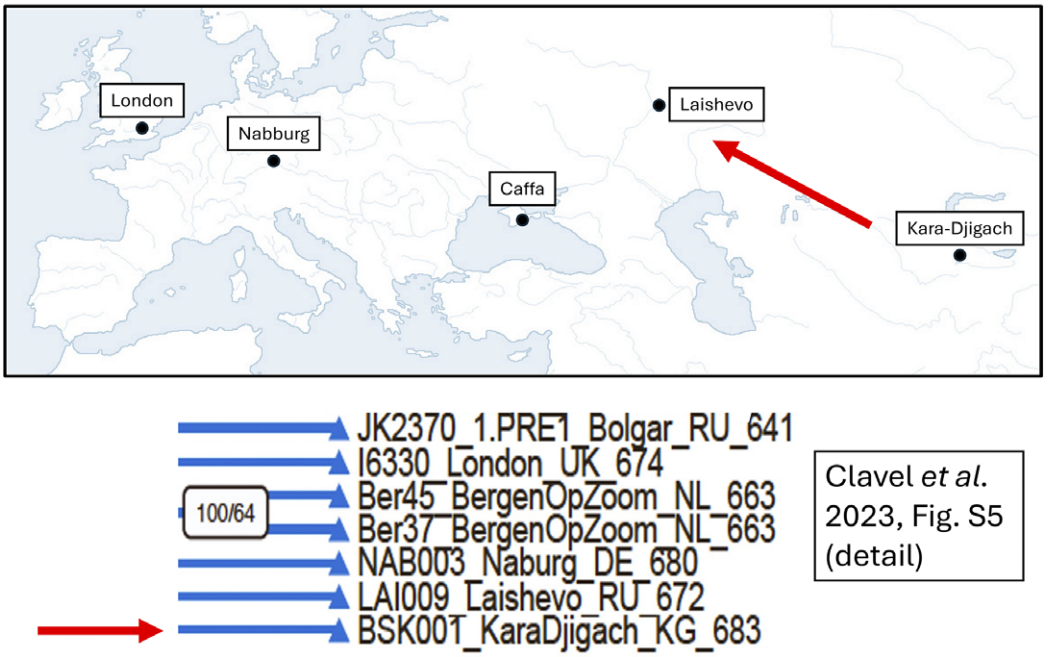

Figure 2A. Where the Kara-Djigach genome falls in a phylogeny based on SNPs. Above, a map showing the location of key Second Plague Pandemic *Y. pestis* genomes retrieved from archaeological remains, as well as the location of the port city, Caffa. Source of map: Wikimedia Commons. Below is a detail from the phylogenetic tree for Branch 1 of *Y. pestis*, structured according to the SNP-based analysis used by Spyrou *et al*., 'The Source of the Black Death' (note 22). In this analysis, the Kara-Djigach genome (BSK001, marked with an arrow) falls basal to (evolutionarily earlier than) all the other early Branch 1 genomes.
Source: Clavel *et al*., *op. cit.* (note 23), Figure S5 (detail). The arrow on the map has been added to show Spyrou *et al*.'s proposed directionality of spread.

colleagues have noted, our 2021 essay on Baghdad was the sequel to Green's single-authored 2020 essay, 'The Four Black Deaths'. There, Green (1) summarised the evidence already proposed by geneticists and plague ecologists for the phenomenon of the Big Bang, its timing, and its likely geography vis-à-vis the locations of living descendant strains; (2) summarised Robert Hymes' initial arguments for the apparent association of Mongol sieges and plague-like mass mortality events in Song China in the 1220s and 1230s; and (3) proposed what was explicitly described as a *scenario* for how plague might have been moved long distances across Central Asia in the 1250s in such a way that would not produce mass mortalities (thereby decreasing the likelihood of being noticed by chroniclers) and yet effectively be delivered (along with suitable insect vectors) to new locales. The timing of the Big Bang could only be suggested along the lines of the time spans proposed by phylogeneticists: sometime between the late eleventh and early fourteenth centuries. No palaeogenetic proof for any of these claims was yet available.[27]

The latter reality still holds as of May 2024. With the exception of an anomalous *Y. pestis* genome from Denmark, announced in 2023, and another from Estonia, both of whose dating is still under debate, no *Y. pestis* genomes from the thirteenth century have yet been retrieved.[28] More to the point, however,

[27]Monica H. Green, 'The Four Black Deaths', *American Historical Review* 125, 5 (2020), 1600–31; this includes an online Supplemental Data file, 'Marmots and Their Plague Strains'.

[28]The genome G.371, from the Tirup cemetery at Horsens, Denmark, was radiocarbon-dated to calAD 1224–1280 (2-sigma) by Eaton *et al.*, 'Emergence', *op. cit.* (note 23). That date agrees with the body's archaeological disposition (roughly, 1150–1350 CE, on the basis of commonly accepted patterns of burial position). Nevertheless, the researchers deemed it to be fifteenth

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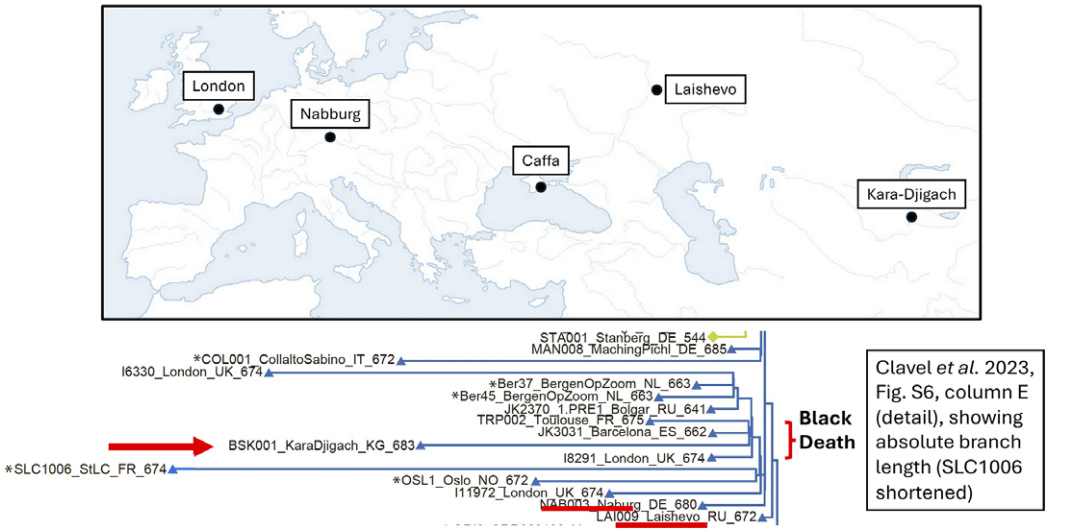

Figure 2B. Where the Kara-Djigach genome falls in a phylogeny based on whole genomes. Above, the same map as in Figure 2A. Below, using a different method of calibration in a second analysis, Clavel *et al.* (2023) show that the Kara-Djigach genome (again marked with an arrow on the detail of the phylogenetic tree) no longer falls in a basal position to other Branch 1 genomes, but is instead part of a clade (a group sharing a common ancestor) most closely related to genomes from European Black Death sites (marked by a bracket added by the present authors). The two most basal strains are those from Laishevo, on the Volga River, and Nabburg, in Bavaria, both of which are indicated on the map.
Source: Clavel *et al.*, *op. cit.* (note 23), Figure S6, column E (detail).

aside from two fourteenth-century genomes from western Russia,[29] there is as yet no late mediaeval genetic data from anywhere in western Asia or North Africa.

This last point is crucial. As we have noted repeatedly, palaeogenetics is a new field and is still developing not only its technical and analytical methods but also its basic databases. Every new genome that is retrieved – whether of pathogens or the human (or animal) hosts that harboured them – expands the field's ability to make comparative analyses. The most recent study of relevance is, at the time we are writing, still in development, but its survey of data can be referenced. For that study 1313 human remains from across Eurasia were studied, covering a span of 35,000 years up to the present day. In all those samples, thirty-nine *Y. pestis* genomes were retrieved (Figure 3). Yet when one looks at the database, among the *mediaeval* samples (of which there are many), there is not a single one that comes from the regions between the Caspian Sea and Egypt that make up the geographic area of our study.[30] The same omission holds true for most other palaeogenetic studies published to date. In short, while we cannot claim any genetic proof for our arguments, neither can the absence of evidence carry any argumentative force for the simple reason that little pertinent data has yet been assembled.

In sum, neither plague nor Mongol historiography nor even the first decade and a half of the era of palaeogenetics have prepared us particularly well for the current moment in which we find ourselves. The

century on the basis of its position in the *Y. pestis* phylogeny, claiming that the discrepancy might be due to a phenomenon in radiocarbon dating known as the 'reservoir effect'. On the Estonian sample, OTE001, see Green, 'Assessment', *op. cit.* (note 23).

[29]On the genome from early or mid-fourteenth-century Laishevo on the Volga River (LAI001), see Maria A. Spyrou *et al.*, 'A Phylogeography of the Second Plague Pandemic Revealed Through Analysis of Historical *Yersinia pestis* Genomes', *Nature Communications* 10 (2019), 4470; on the genome from nearby Bolgar City, see Maria A. Spyrou et al., 'Historical *Y. pestis* Genomes Reveal the European Black Death as the Source of Ancient and Modern Plague Pandemics', *Cell Host and Microbe* 19, 6 (8 June 2016), 874–81.

[30]Martin Sikora *et al.*, 'The Landscape of Ancient Human Pathogens in Eurasia from the Stone Age to Historical Times', *bioRxiv*, posted October 06, 2023, https://doi.org/10.1101/2023.10.06.561165. The 1313 samples are itemised in their Supplementary Table S1: Study samples metadata.

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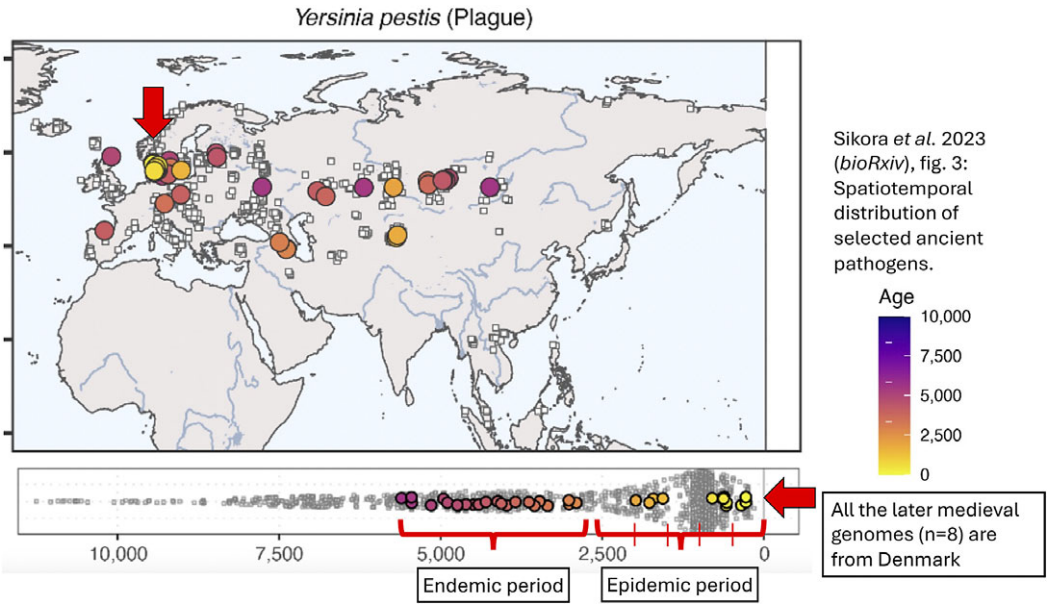

Figure 3. Spatiotemporal distribution of *Y. pestis* in Eurasia. A map and timeline showing the spatial and temporal distribution of 1313 human remains included in an in-progress study of pathogens found in Eurasian populations, from the Pleistocene to the late Holocene. The coloured circles here indicate remains that yielded traces of *Y. pestis*; dating is colour-coded (see original for full colour).
Source: Sikora *et al*., *op. cit.* (note 30), Figure 3, *Y. pestis.* Historical notes added by the present authors.

lack of any sustained interrogation of the origins of the Black Death within the Mongol Empire by specialists in the field has allowed the unfortunate effects of ascertainment bias to overhype the significance of the Kara-Djigach study. The stalled trajectory of document-based plague history has delayed the creation of even a preliminary dossier of key sources in Arabic, Persian, or other languages of the eastern Mediterranean and western Asia (a topic we return to below). The uneven geographic distribution of archaeological studies that might yield remains from burial sites pertinent to the late mediaeval history of this central region compounds the problem on the side of physical data.[31] Be that as it may, recent events in global health have made it clear that ignorance of past pandemics is no longer justifiable. The rare trifectas of having documentary *and* archaeological *and* genetic evidence of the presence of *Y. pestis* for any particular historical place and time (which is what made the 2011 study of the London Black Death Cemetery so distinctive) cannot be held out as the standard that all plague histories can or must meet.[32] More archaeological and palaeogenetic evidence will certainly come to light, but it is likely, for the time being, to be random. In the meantime, historians need to set their sights on documenting and explaining other phenomena. As we have argued, noting anomalies in our sources is an excellent way to start.

[31]On the fate of remains excavated from the Bab al-Ghurayb cemetery in Cairo, see Stéphane Pradines, 'Archaeological Excavations of Bāb al-Ghurayb Cemetery: Plague Epidemics and the Ruin of Fourteenth-Century Cairo', *Mamlūk Studies Review* 24 (2021), 117-68. On problems in inferring lines of evolutionary or epidemiological development from the *Y. pestis* genomes that are currently available, see Monica H. Green, 'Out of the East (or North or South): A Response to Philip Slavin', *Past & Present* 256, 1 (2022), 283–323; and Hendrik Poinar, 'Past Plagues: On the Synergies of Genetic and Historical Interpretations of Infectious Disease', in: *Death and Disease in the Medieval and Early Modern World*, ed. Lori Jones and Nükhet Varlık (York: York University Press, 2022), 319–40.

[32]Green, 'Putting Asia', *op. cit.* (note 8). It should be remembered that even in the case of Kara-Djigach, we have no *documentary* evidence that any plague outbreak ever took place there. Even archaeologically, there is no explicit signal of mass death: unlike sites that have attracted attention in Europe, the Kara-Djigach site has no mass graves. For a review of the evidence for plague in the Chaghadaid khanate, see Slavin, 'A Rise and Fall', *op. cit.* (note 22); and Jackson, *op. cit.* (note 12).

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Focalisation and the methodological demands of gaps between the biological and documentary archives

In the summer of 2019, public health officials in Colorado (USA) cancelled a camping event planned as a prelude to an outdoor rock concert. *Yersinia pestis*-infected fleas had been found parasitizing prairie dogs (small burrowing rodents) in the area where campers were expected. *Yersinia pestis* had arrived on the Pacific coast of California about 120 years earlier, but by the 1940s plague was well-established in various rodent communities in inland Colorado and other western states, where it persists to this day.[33] This is the process of focalisation. No human infections occurred in Colorado in 2019, but that was because a public health surveillance system for plague was already in place. That is how plague remains controlled in almost all the areas where it persists in the world today.

'Focalisation' is a term that historians have recently adopted to explain a historical phenomenon of plague: its tendency to intrude into and then persist in certain regions for decades or even centuries, allowing it to manifest in human outbreaks periodically but then 'disappear' for years at a time. Obviously, plague never 'disappears' since it is a living organism and must continue to persist through cycles of reproduction. But as evolutionary and ecological perspectives on plague's history get pushed further and further back into the past, the question has come to the fore of *where* plague has been able to persist long-term in ecological niches of rodent hosts and insect vectors, or indeed, in the soil itself. Where those niches exist away from human habitation, there will be no human plague outbreaks. But when those isolated niches are disrupted in one way or another and start establishing offshoots in places near human habitation, new possibilities open up for human infection.[34]

Plague ecology, the study of plague in its natural habitats among wild rodents, is directly a product of the bacteriological age, when the micro-organism, *Y. pestis*, could first be tracked in its movements between rodent and flea species. The concept of long-term *foyers* (hearths or, in Latin, *foci*) of plague began to be investigated by plague researchers in the late nineteenth century. By the 1950s, developments in the biochemistry of plague allowed a kind of crude differentiation of strains of *Y. pestis*, and a theory was proposed that connected these different strains with different pandemics of the past. Because the ecological character of *Y. pestis* was being discovered at exactly the same time as the Third Plague Pandemic was spreading new strains of *Y. pestis* around the world, ecologists (who coined the term 'focality') were able to watch the processes of focalisation in real-time as the plague spread to regions of the world where it had (apparently) never been present before: Madagascar, South America, and the Pacific coast of North America. Much of the most important field research on plague has been done in these newly infested landscapes. Although certain genetic features of the Third Pandemic strains may limit our ability to draw direct parallels between modern field and lab studies and mediaeval presentations of the disease,[35] recognition of the overall genetic similarity of modern and mediaeval *Y. pestis*

[33]Kyle Harris, 'The Harshest Tweets About Phish's Prairie-Dog-Plague Flea Problems', *WestWord*, 21 August 2019, https://www.westword.com/music/twitter-turns-cruel-after-plague-infested-prairie-dogs-shut-down-phish-concert-camping-11455085; Alicita Rodriguez, 'Plague in Denver? Infected Prairie Dog Colonies Reflect Changes in Denver-area Ecosystem', 10 September 2019, *YourHub* (*Denver Post*), https://yourhub.denverpost.com/blog/2019/09/plague-infected-prairie-dogs-not-cause-for-great-alarm-in-denver/250039/.

[34]It might be helpful here to offer a more zoonotically-focused definition of the disease phenomenon of plague than the human-focused WHO definition cited by Brack *et al.*, *op. cit.* (note 3), [3n6]. Adélaïde Miarinjara et al., 'Socio-ecological Risk Factors Associated with Human Flea Infestations of Rural Household in Plague-endemic Areas of Madagascar', *PLoS Neglected Tropical Diseases* 18, 3 (2024), e0012036, state that 'Plague is principally a flea-borne rodent disease, characterized by circulation within resistant rodent populations, inducing low or no mortality but allowing persistence of the pathogen in the environment (enzootic plague), and transmission between susceptible rodent populations inducing high mortality (epizootic). Humans are most likely to become infected when flea numbers are high and epizootic plague is decimating a susceptible rodent population, as infected fleas from dead rodents are seeking new hosts'.

[35]The most important distinction between the Third Pandemic strains, in the lineage 1.ORI, and all earlier strains of *Y. pestis* is the former's acquisition of a prophage, a kind of viral addition to the bacterial genome. See Joanna H. Bonczarowska *et al.*, 'Ancient *Yersinia pestis* Genomes Lack the Virulence-associated YpfΦ Prophage Present in Modern Pandemic Strains', *Proceedings of the Royal Society* B 290 (2023), 20230622.

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allows historians to engage in productive speculation about the climatic and faunal environments in which *Y. pestis* could have thrived in the past.

To return to our rock concert in 2019, fortunately the detection of plague was made early and although rock fans were disappointed to have their camping plans cancelled, no humans were harmed during what might have turned into an epizootic and even epidemic event. But had such a scenario presented itself, say, 800 years ago, what kind of historical evidence might we expect to find? One camper dies: bad luck. Three campers die: something's wrong; others flee. A hundred campers die: it would probably only be in this last instance that we'd expect any kind of comment about the event in a local chronicle, and even here it might not rise to levels of higher political (and hence, administrative) importance. Yet in all these scenarios, *Y. pestis* would have already been present.

This is why, in addition to the concept of focalisation, we now add the concept of the 'prodrome' of the pandemic. 'Prodrome' is a medical term meaning 'a symptom, sign, or condition that is characteristic or premonitory of the onset of a disease'.[36] It refers to the state of a patient *after they have already been infected* but before the distinctive effects of the disease have become manifest: for example, the time between infection (via inhalation) of smallpox and the full eruption of that disease's characteristic pustules. In our usage, the prodrome of a plague pandemic would mean that the pathogen is already present in a certain environment, just as it was in the Colorado case where the plague was found among the prairie dogs, but has not yet erupted into full-blown epidemics in human populations that would make its presence abundantly apparent. What we have yet to learn are the signs that indicate its 'invisible' presence in an age without microscopes or indeed any concept of microbes, sometimes literally under the feet of human observers. In the Colorado case, modern science and medical history have allowed us to reconstruct how *Y. pestis* came into Colorado's rodent populations decades before the rock concert in 2019. What we have been lacking for the late mediaeval period is the cooperation of document-based historical investigations and those of the biological sciences to tell us a comparable story. The availability now of well over 100 genomes of *Y. pestis* from the period of the Second Plague Pandemic, from areas ranging from Central Asia to Iberia and Scandinavia, has opened up the possibility to think about focalisation in deeper time scales. Indeed, the ambitious study examining human remains in Eurasia from across a time span of 35,000 years, referenced above, supports what had already been an emerging impression of the history of *Y. pestis*: that it arrived on the scene as a human affliction about 6000 years ago, spread within human communities across Eurasia for about the next 3000 years with enough regularity to be called 'endemic', and then transitioned to a punctuated state where, after several hundred years of invisibility in the (human) archaeological record, it emerged three times into a 'pandemic' phase, moving quickly across landscapes and causing at times massive mortalities in human communities.[37] Only this last, pandemic phase is captured clearly in our documentary records, which have in turn created fixtures in the scientific and historical literature of the past century as the First through Third Pandemics. Yet *Y. pestis* persisted throughout all the intervals in between. Establishing how to look for it in the absence of the descriptions of mass mortality we have been accustomed to expect (thanks to the memorable accounts of such writers as Procopius [d. 565], Ibn al-Wardī [d. 1349], Boccaccio [d. 1375] and many others) is the task ahead of us as document-based historians.

Perceiving plague's presence: reading the past without a microscope

Our 2021 essay was precisely an exercise in how to sift carefully through earlier chronicles to catch references to epidemics, odd disease events or mass mortality events to see if they could reveal evidence of the plague's prodromal stage. Robert Hymes had already found evidence for novel disease outbreaks associated with the Mongol sieges and conquests in early thirteenth-century China. Hannah Barker, as

[36] *Oxford English Dictionary*, s.v. 'prodrome (*n.*), sense 3', September 2023, https://doi.org/10.1093/OED/8267354039.
[37] Sikora *et al.*, *op. cit.* (note 30).

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already mentioned, had refuted the Italian de Mussi's siege of Caffa account of plague transmission and showed instead how grain shipments from the Black Sea region tracked plague outbreaks across the Mediterranean. Building simultaneously upon Hymes' findings and her own careful reading of results in genetics, archaeology, environmental sciences, and the histories of China, the Mongol empire and Islamic societies, in 2020 Monica Green offered a possible scenario for how *Y. pestis* could have focalised into four different lineages in her article, 'The Four Black Deaths'. Using references found in the Persian chronicle copied by al-Shīrāzī to both shipments of grain and epidemic outbreaks (*wabāʾ*) during Hülegü Khan's conquests in Iran and Iraq (1256–60), Green identified contaminated grain from the Tian-Shan region as the possible way that *Y. pestis* may have been introduced unknowingly into new environments. At the same time, Nahyan Fancy identified how physicians in the middle part of the thirteenth century (1242–70) were addressing new symptoms of plague which seemed to be based on experience with the disease in his chapter, 'Knowing the Signs of Disease'. Armed with a brief reference in Mona Hassan's text to the outbreak immediately after the fall of Baghdad of an epidemic disease (*wabāʾ*) – which she mistakenly translated as plague – in 2021 we widened our search to identify any other outbreaks or more evidence about that particular outbreak.[38] What we found was entirely unexpected and profound.

Multiple sources referred to a lethal disease outbreak in areas taken over by Hülegü's armies or lands adjacent to them, such as Syria and Egypt. The latter two sequences of outbreaks, in particular, took place months after the fall of Baghdad. And the most detailed account of the outbreak in Syria included clear references to it being plague (*ṭāʿūn*). In their article, Brack and his colleagues deny the presence of plague in Syria, claiming that 'there is nothing concrete' and no clear symptoms present in the contemporary chronicler, Ibn Wāṣil's *Urtexte*.[39] They even suggest that Ibn Wāṣil's use of the term *ṭāʿūn* to describe his patron's death was 'not on the basis of symptoms, but rather to assign' his patron the merit of martyrdom.[40] In our reading of the evidence, on the contrary, there are very concrete references to actual bubonic plague in Ibn Wāṣil's text which concur with some of the new symptoms found in the thirteenth-century medical corpus.

Ibn Wāṣil (1208–98) was a Syrian historian and judge from Hama. In his chronicle, he provides details of his former patron, the Ayyubid ruler al-Nāṣir Dāwūd's death from *ṭāʿūn* (plague) on the authority of the ruler's son and an eyewitness attaché, connecting this specific incident to a widespread plague outbreak in the region in the aftermath of the Mongol conquest of Baghdad. Brack and colleagues have now provided the full text which we could not include in translation in our original because of space limitations. But they have not understood the text correctly. Significantly, they missed the fact that the text describes three delirious dreams – a symptom that is (re-)associated with plague in the Arabic medical tradition only in the thirteenth century. Plague patients across different societies historically have referred to some type of pricking, piercing, or pain in a particular site in the dream, and then woken up to find a plague bubo on that site.[41] Ibn Wāṣil records that al-Nāṣir Dāwūd dreamt that his left side was speaking to his right side, informing it that soon it would be the latter's turn to be in pain. And sure enough, later the ruler started experiencing pain on the right.[42] Not recognizing the symptoms of plague, Brack and colleagues also err in their translation. First, al-Nāṣir complained of pain not 'on his right side'

[38]Hymes, 'A Hypothesis', *op. cit.* (note 11); Barker, *op. cit.* (note 19); Green, 'Four Black Deaths', *op. cit.* (note 27); Nahyan Fancy, 'Knowing the Signs of Disease: Plague in Arabic Medical Commentaries Between the First and Second Pandemics', in Jones and Varlık, *op. cit.* (note 31), 35-66; and Mona Hassan, *Longing for the Lost Caliphate: A Transregional History* (Princeton: Princeton University Press, 2017).

[39]We have chosen not to address their arguments about *Urtexte* for both space limitations and the fact that we ourselves highlighted in our original article how much later Mamluk authors like al-Dhahabī and al-Yūninī were relying on Ibn Wāṣil. There is nothing Brack and colleagues have to say with regards to recycling of materials that impacts our arguments in any way.

[40]Brack *et al.*, *op. cit.* (note 3), [14].

[41]For the absence of delirium as a symptom of plague and Ibn al-Nafis's account of delirious episodes during bouts of plague in Ethiopia, see Fancy, *op. cit.* (note 38), 59, 65.

[42]The transmission of *Y. pestis* from lymph node to lymph node, prior to moving into any other organ systems, has been documented in modern laboratory studies. See Toan Nham et al., 'Imaging of Bubonic Plague Dynamics by *In Vivo* Tracking of Bioluminescent *Yersinia pestis*', *PLoS ONE* 7, 4 (2012), e34714.

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but rather '*under* his right side (*taḥta janbihi al-ayman*)'. And since *janb* refers to the part of the body extending from the armpit down to the flank, the translation really should read that al-Nāṣir complained of pain 'in his right armpit'. Second, the caregivers did not 'kn[o]w that this was *ṭāʿūn*' but rather 'ascertained/confirmed that it was a *ṭāʿūn* (*taḥaqqaqnā anna dhālika ṭāʿūn*)'. The primary meaning of *ṭāʿūn* is a bubo, and the disease is given the same name in Arabic based on this primary symptom. The clear use of the indefinite *ṭāʿūn* means that the caregivers confirmed for themselves that what was in his right armpit was a bubonic swelling. This is not an attempt to metaphorically refer to al-Nāṣir Dāwūd's death as martyrdom from the plague, but rather his actual succumbing to plague after he first complains of a piercing pain in his left side on Wednesday, and then dies on Saturday from the disease.[43]

The reference to the right armpit takes on more meaning in light of other medical works from this time. As Fancy has shown, a key anomaly of the thirteenth-century medical discussions of Syrian authors, Ibn al-Quff and al-Sāmirī (both of whom composed their works after 1258), is that they restrict plague buboes to the armpits. We also know that al-Nawawī (d. 1277), a Syrian religious scholar writing after 1258, describes for the first time the existence of secondary cutaneous pustules, a key symptom of bubonic plague which is absent in all prior medical and religious literature. Focusing on post-1348 works, Michael Dols had mistakenly assumed that Ibn Khātimah (d. 1369), writing in Almeria in 1349, was the 'only writer' to distinguish clinically between the secondary pustules of the skin and buboes. Al-Nawawī not only records this clinical symptom but also associates the secondary pustules with the primary bubonic site of the armpits.[44] This restriction of the bubo to the armpits is an anomalous feature of the post-1258 plague discussions stemming from Syria since this restriction is absent in the work of Ibn al-Nafīs's earlier 1242 commentary, where the information on the plague is derived from his friend who visited Ethiopia. In the subsequent plague outbreaks of 1348, buboes were observed in all three primary sites again (neck, armpits, and groin), and pneumonic plague and the spitting of blood were associated with plague possibly for the first time. The memory of this restriction to armpits though is evident in the Mamluk author al-Ṣafadī's (d. 1363) account of the plague of 749/1348–9 that he wrote and sent to the religious scholar and poet, Bahāʾ al-Dīn al-Subkī (d. 1372). Here, al-Ṣafadī provides a couplet for each of the symptoms, buboes behind the ears, under the armpits, and in the groin as well as the spitting up of blood.[45] He clearly wanted to emphasise that buboes can break out in three different primary sites and not just one. Similarly, in the post-1348 commentary on the *Canon of Medicine*, al-Shīrāzī's student, Āmūlī (d. 1352) too (re)-associates the three sites (armpit, groin, and the ear/neck region) with bubonic plague, despite citing his teacher's claim that plague buboes are restricted to armpits.[46]

Having established that a plague outbreak had indeed occurred in Syria three months after the fall of Baghdad to Mongol forces, we used the earlier publications (including our own) to explain how the outbreak could have been caused by the Mongols unwittingly bringing *Y. pestis* into this region. We followed the reports of disease outbreaks following the arrival of the Mongols in the region, particularly those that took place after the Mongol conquest of Baghdad. Of course, our original article is careful enough to state that plague (*ṭāʿūn*) is almost exclusively used to describe the outbreak in Syria (especially the death of the ruler), while the outbreaks in Egypt, Iraq, Iran, and Anatolia generally use the term for epidemic disease, *wabāʾ* (Syr. *mawtānā*). However, it is worth emphasising that *wabāʾ* is the term used to describe the Black Death outbreaks of 1348 by at least two plague treatise writers: Ibn al-Khaṭīb (d. after 1374), from al-Andalus, and Ibn al-Duqmaq (d. 1407), from Mamluk Egypt.[47] Even the famous Moroccan traveller, Ibn Baṭṭūṭa (d. 1368/9), who was travelling through the region during the summer

[43]Ibn Wāṣil, *Mufarrij al-kurūb fī akhbār banī ʿayyūb*, Bibliothèque Nationale de France, Paris, MS Arabe 1073, https://gallica.bnf.fr/ark:/12148/btv1b110010632, fol. 130b-1a; Brack *et al*., *op. cit.* (note 3), [12].

[44]Fancy and Green, *op. cit.* (note 1), 168; Dols, *op. cit.* (note 10), 317.

[45]Ibn Shākir al-Kutubī, *ʿUyūn al-tawārīkh*, vol. 24, Topkapı Palace Museum, Istanbul, MS Ahmet III 2922, fol. 93a-4a.

[46]Muḥammad ibn Maḥmūd Āmūlī, *Sharḥ kulliyyāt al-Qānūn*, British Library, Oriental Manuscripts, Or. 3654, fol. 103a.

[47]Ibn al-Khaṭīb, *Muqniʿat al-sāʾil*, El Escorial, Madrid, MS Arabe 1785, 43r; and Ṣārim al-Dīn Ibrāhīm b. Duqmaq, *al-Jawhar al-thamīn fī siyar al-mulūk wa-l salaṭīn*, ed. Saʿīd ʿAbd al-Fattāḥ ʿĀshūr (Mecca, 1982), 387-8. We thank Mohamad Ballan for sharing these texts with us and alerting us to their use of *wabāʾ* to refer to plague.

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and fall of 1348, used *wabāʾ* preferentially to *ṭāʿūn* (which appears only once in the entire text of his *Riḥla*).[48] Similarly, *mawtānā* is the term used in Syriac chronicles to document the sixth and seventh-century outbreaks of the first pandemic[49] and is inscribed on the Christian gravestones from fourteenth-century Central Asia. We now know from recovered aDNA that *Y. pestis* was the pathogen involved in the first and second pandemic, and also the one found in the 1338/9 Central Asian graves. This should open up the possibility of treating any mention of *wabāʾ*/*mawtānā* as plague when there are other indicators that *Y. pestis* may have been involved.

Having said that, we did not use the terms 'interchangeably' ourselves in our 2021 essay (it is why we referred to plague and plague-like disease).[50] We knew (and documented) that our historical authors understood *ṭāʿūn* to be a type of *wabāʾ*, both caused by putrefaction of air such that a miasma stemming from one place, i.e. destruction of Baghdad, could be seen by our historical authors as causing a *wabāʾ* in Iraq, but intensify into a *ṭāʿūn* by the time it reached Syria. We also documented that the reports about the specific plague outbreak in Syria, and its connection to the fall of Baghdad, disappeared from the more widely-read fifteenth-century chronicles. Neither the Syrian plague outbreak, nor its connection to the fall of Baghdad is found in al-Shīrāzī's work, so his account is not the 'linchpin' for our 2021 essay, as Brack and his colleagues mistakenly claim.[51] Of course, what leads them to investigate the timing of a specific outbreak in a city that was besieged by the Mongols are two aspects: (1) they are unfamiliar with disease history, in particular, how plague focalisation and ecology work; and (2) they are looking for primary sources to directly connect the arrival of the disease to the Mongols. As they state bluntly while reporting on epidemic disease outbreaks during Mongol sieges of forts and cities, 'there is no evidence that the disease was brought by the besiegers'.[52] The fact that they are looking for evidence in our sources for the Mongol besiegers bringing a disease or 'serv[ing] as vectors'[53] shows that they do not fundamentally recognize that there is no germ concept of disease in the thirteenth century (at least not in Islamic societies or the Latin West). And this is in fact what we stated in our article:

> It should be stressed that for none of these authors, whether historians or physicians, were the Mongols seen as *bringing* the disease to the region (as we would now understand plague transmission in a biomedical framework). For Ibn Wāṣil, the anonymous author of *Ḥawādith*, and those who followed them, the Mongols *caused* an epidemic to erupt by the havoc they wrought, the dead bodies of the slaughter giving off smells that penetrated and corrupted the temperament of the ambient air.[54] (emphasis added)

Brack and colleagues' emphasis on whether or not a disease outbreak impacts a besieged city during or after the seige is lifted suggests an unfamiliarity with disease history, and especially the disease ecology of *Y. pestis*. Setting aside the discrepancy in the sources over the timing of the Baghdad epidemic (whether before or after the Mongols besiege the city), Brack and his colleagues claim that an epidemic outbreak even in the midst of long Mongol sieges in Lanbasar (1257), or even Girdkuh (1253), does not suggest the possibility of a 'disease … brought by the besiegers'.[55] They feel only if the outbreak were to take place immediately following the end of the siege would that somehow suggest the possibility of Mongols bringing the disease.

[48]Claudia Maria Tresso, 'A Two-year Journey under the Arrows of the Black Death: The Medieval Plague Pandemic in Ibn Baṭṭūṭa's Travels', *Journal of Arabic and Islamic Studies* 21 (2021), 137–89.

[49]Michael Morony, '"For Whom does the Writer Write?": The First Bubonic Plague Pandemic According to Syriac Sources', in Lester K. Little (ed.), *Plague and the End of Antiquity: The Pandemic of 541–750* (Cambridge: Cambridge University Press, 2007), 59–86.

[50]Brack *et al.*, *op. cit.* (note 3), [5n17].

[51]Brack *et al.*, *op. cit.* (note 3), [4].

[52]Brack *et al.*, *op. cit.* (note 3), [6].

[53]Brack *et al.*, *op. cit.* (note 3), [7].

[54]Fancy and Green, *op. cit.* (note 1), 170.

[55]Brack *et al.*, *op. cit.* (note 3), [5-6].

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Obviously, lacking genetic evidence we cannot yet say what strains of *Y. pestis* might have been involved in any of these outbreaks. It is certainly possible that, as has been documented for the Caucasus, much older strains of *Y. pestis* had survived in the regions the Mongols passed through and these outbreaks (assuming they are in fact plague) were caused by disturbances of pre-existing reservoirs.[56] However, Green already documented, in 2020, using the account found in the Persian chronicle copied by al-Shīrāzī, that the Mongols imported their own grain supplies from the Tian Shan region – precisely the ecological circumstance that would allow the importation of rodents and their fleas. As Green noted with respect to the Baghdad siege,

> This would also account for a further detail that al-Shīrāzī adds. It was not simply the besieged inhabitants of the city who became ill, but also the Mongol army itself: 'and many died of the disease.' Among those stricken (though he later recovered) was Hülegü himself.[57]

Given that Hülegü and his troops arrived at their base camp at Hamadan in 1257 (after having spent a somewhat erratic nine months regularly moving their base camp),[58] and given that, according to the chronicle copied by al-Shīrāzī, the grain supplies had been placed along the army's path *in advance of their arrival*, if indeed there were any sacks of contaminated grain in those supplies, they would have already been present in the region well before the attack on Baghdad in January 1258. As we have been insisting, plague is a zoonotic disease, whose hosts are rodents and whose vectors are fleas. Neither rodents nor fleas are prevented from crossing into cities by means that generally prevent or slow down considerably the movement of humans. So, if *Y. pestis* has arrived outside the city walls, the siege does not need to be lifted in order for the besieged city to suffer a possible outbreak.

Moreover, once the bacterium is introduced into a new environment, it needs to find appropriate hosts and vectors. The mere introduction of the bacterium does not necessarily entail a massive epizootic or human outbreak, since the bacterium needs to be able to proliferate in a sustaining animal population (rodents or other animals) and needs sufficient vectors (like fleas or lice) to transmit it into humans.[59] Which conditions are met at which time in which place are not easy to predict nor historically reconstruct, especially from sources that do not even associate the disease with germs, fleas and rodents. Additionally, we need to be aware of the biases of our sources. The contemporary chronicles that we used are not going to be concerned with deaths amongst low-ranking Mongol soldiers as much as they are with the vast population centres of the Islamic world, and occasionally some high-ranking Mongol officials. Given these constraints and biases, massive mortality from disease can be recorded for besieged cities even while the siege is ongoing with negligible reports on outbreaks amongst the besiegers. And given how the disease functions (i.e. that it needs vectors to transmit the bubonic plague from one person to another and is not otherwise directly contagious), it is not at all surprising that people could have travelled to Baghdad to enrich themselves upon the misfortune of those who died from it without contracting the disease.[60]

If our reconstruction of the circumstances of the arrival of *Y. pestis* in the region is correct (that is, it was brought to Iraq and its environs in Hülegü's grain supplies, arriving in or near Hamadan – Iraq al-ʿAjam – no later than 1257 and moving further westward thereafter), then the progression of the

[56]Indeed, we should also not forget that the Mongols had already arrived in western Asia in the 1220s and 1230s.

[57]Green, 'Four Black Deaths', *op. cit.* (note 27), 1622-3.

[58]John Masson Smith, Jr., 'Hülegü Moves West: High Living and Heartbreak on the Road to Baghdad', in Linda Komaroff (ed.), *Beyond the Legacy of Genghis Khan* (Leiden: Brill, 2006), 111–34, at 117 and 124.

[59]On the capability of human lice (*Pediculus humanus humanus*) as effective vectors of plague, see now David M. Bland et al., '*Yersinia pestis* Can Infect the Pawlowsky Glands of Human Body Lice and Be Transmitted by Louse Bite', *PLoS Biology* 22, 5 (21 May 2024), e3002625. Note that this study was performed with a strain of *Y. pestis* belonging to the 2.MED lineage. While this is found throughout the Caspian Sea basin now and is a descendant of the Big Bang proliferation, there is no evidence yet that Branch 2 was involved in late mediaeval outbreaks.

[60]Brack *et al.* suggest this lack of contraction of the disease (at least as reported in the sources) to negate the possibility of plague; *op. cit.* (note 3) [8].

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reported human outbreaks follows logically. We have evidence for a very clear outbreak of plague in Damascus three months after the Mongol destruction of Baghdad, in addition to other reported disease outbreaks in Egypt, Iraq, and Anatolia all taking place months after the fall of Baghdad. We see a continuing engagement with plague in medical works, religious texts and chronicles throughout the second half of the thirteenth and early fourteenth centuries. The fact that later chroniclers were relying on Ibn Wāṣil or other first-generation chroniclers is a fact we acknowledged in our original article, so the discussion by Brack and colleagues on *Urtextes* is unnecessary since a glance at our table reveals the dependencies. As for the Ibn Furāt (d. 1405) text that they provided, it may or may not hearken back to a work that was available to earlier historians. However, it should be obvious that Ibn Wāṣil provides testimony for a plague outbreak in Syria on the authority of those in the entourage of his former patron, al-Nāṣir Dāwūd, who died of plague. He explicitly links the Syrian outbreak using a miasmatic explanation with the destruction of Baghdad, since he begins the account of al-Nāṣir Dāwūd's death by stating: 'When the epidemic and plague intensified following the Mongol conquest of Baghdad'.[61] His linking was accepted by later scholars until the Syrian plague outbreak itself disappeared from the accounts of the fifteenth-century Mamluk authors, al-Maqrīzī, Ibn Ḥajar al-ʿAsqalānī (d. 1449) and Ibn Taghrībirdī (d. 1470), that have informed modern scholarship. Speculating over whether or not Ibn Wāṣil himself was relying on a further unidentified source is a moot point and does not change what we found. After all, given that Ibn Furāt does not cite sources in this passage but otherwise is, according to Brack *et al*., 'scrupulous' about that,[62] it is just as possible that *he* is the one piecing together information from the works of well-known, earlier Mamluk historians and religious scholars, such as al-Dhahabī (d. 1348), and al-Yūnīnī (d. 1326), rather than relying on some lost, original work.

The case for plague's presence in the Western Ilkhanate in the late thirteenth and early fourteenth centuries

Plague-related concerns and mass mortalities did not disappear after 1258. The concern for plague is most evident in the Muslim convert, physician, and vizier at the Ilkhanate court, Rashīd al-Dīn (d. 1318). In his introduction to the translation of a Chinese medical work into Persian at the Ilkhanid court, *Tānksūq-nāma*, Rashīd al-Dīn praises Chinese medical techniques and their ability to treat hot diseases. He gives three examples, all of which entail swellings and fever, and for the first and the third, delirium is also a symptom: *birsām*[63] (inflammation of the diaphragm), *dhāt al-janb* (pleurisy), and *ṭāʿūn* (plague).[64] In other words, plague is listed alongside two very well-known and regularly discussed (and encountered) diseases across mediaeval Islamic medical literature. Such matter-of-fact references to *ṭāʿūn* suggest plague was a disease to be feared and reckoned with in post-1258 Ilkhanid Western Asia. The outbreaks may have been small, though we would have to sift carefully through all the various records from the intervening years till 1348 to be sure. After all, the Syrian plague outbreak had dropped out of memory, too, until recently. Moreover, references to major epidemic disease outbreaks in the

[61]Ibn Wāṣil, *op. cit.* (note 43), fol. 130b. We are puzzled as to why Brack *et al.* feel Ibn Wāṣil 'does not make the connection with the Mongol attack on Baghdad in this long passage explicit' (*op. cit.* [note 3], 12). How much more explicit can he be? The account of his patron's death (provided by a member of his entourage) begins by linking the intensification of the disease where they are (Damascus and environs) to the Mongol conquest. This account itself comes at the conclusion of a discussion of al-Nāṣir Dāwūd being selected to lead an attack against the Mongols in Baghdad to lift the siege but then news arrives that it has already fallen. Then Ibn Wāṣil immediately refers to a plague spreading across Syria and Egypt on account of this corruption, starting first with the latter which he reports on his own authority.

[62]Brack *et al*., *op. cit.* (note 3), [15].

[63]The text can also be read as stating *sirsām* (inflammation of the meninges), though that condition too entails all three symptoms. On *birsām* and *sirsām*, see Nicola Carpentieri, 'On the Meaning of *Birsām* and *Sirsām:* A Survey of the Arabic Commentaries on the Hippocratic *Aphorisms*', *Mélanges de l'Institut Dominicaine des Études Orientales du Caire*, 32 (2017): 81–92.

[64]Rashīd al-Dīn al-Hamadānī, *Tanksūqnāmah yā Ṭibb-i ahl-i Khitā*, Facsimile prepared by Mujtabā Minūvī (Tehran: Dānishgah-i Tehran, 1972), 48–9.

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region in the intervening years exist. The Coptic historian Jirjis ibn al-ʿAmīd al-Makīn (d. 1293) describes an epidemic outbreak (*wabāʾ*) in Mardin in 658/1260, which occurred after a terrible siege of the city by Hülegü. In 694–5/1295–96, al-Birzalī (d. 1339) reported an epidemic (*wabāʾ*) in Cairo and Lower Egypt which killed up to 1500 people a day and upwards of 100,000 in total.[65] Intriguingly, this Cairo outbreak is mentioned by the Andalusian scholar and poet who settled in Cairo, Ibn Abī Ḥajala (d. 1375) in his plague list, but is left out of the subsequently more influential plague list of Ibn Ḥajar.[66]

This latter incident also points to another matter already attested by one of the contemporary observers discussed above. Brack and colleagues describe Bar Hebraeus as saying that 'there was a very severe famine and a pestilence (*māwthānā*) in the land of Babylonia (Senʿār), Assyria (Āthūr), Mesopotamia (Bēth Nahrīn), Syria (Sūrīya), and Anatolia (Bēth Rūmaye), so a young pigeon for a sick man was sold in Damascus for 12 Nasiri dirhams'.[67] This linking of famine (Syr. *kepnā marrīrā*) with pestilence became a very common element of catastrophic mortality events reported in Anatolia, Egypt, and even Europe, *up to and including episodes considered Black Death events.* In looking for epidemics that have plague-like mortality effects, a comprehensive history of this postulated prodromal stage of the Second Plague Pandemic under the Ilkhanate would look at changes in the landscape environment of the region, including signs of economic decline.

That task involves looking for factors that we know have contributed to the plague's eruption and persistence in other times and places. We already know that the region around the Caucasus Mountains was ripe for plague infestation. It still harbours living strains that must have emerged in the Bronze Age; palaeogenomes of even older strains have been retrieved from Bronze Age sites; and one sub-branch of another product of the later mediaeval Big Bang, Branch 2, has colonized the entire area around the Caspian Sea in modern times.[68] Which, if any, of these strains were involved in the extinction of the marmot populations that used to inhabit mountainous areas to the south of the Caucasus is unclear, though populations of the animal were still numerous enough in the later thirteenth century to induce Hülegü's son, Abaqa (r. 1265–82), to build a new palace at the Mongol summer camp between Lake Urmia and Hamadan because of its excellent hunting grounds. It was called Sughurluq, 'the place

[65]Claude Cahen, 'La *Chroniques des Ayyoubides* d' al-Makīn b. al-ʿAmīd', *Bulletin d'études orientales* 15 (1955-57): 109–84, 175; Abī Muḥammad al-Qāsim al-Birzalī, *al-Muqtafī ʿalā kitāb al-rawḍatayn*, ed. U. Tadmuri (Beirut: al-Maktaba al-ʿAṣriyya, 2006), 414–30. The Mamluk historian and religious scholar, al-Dhahabī (d. 1348), records both of these epidemic outbreaks, indicating that the Mardin siege lasted several months and the epidemic struck at the end of it, which led to the ruler dying of the epidemic after which his sons submitted personally to Hülegü; al-Dhahabī, *Taʾrīkh al-Islām wa-wafāyāt al-mashāhīr wa-l-aʿlām*, ed. U. Tadmuri (Beirut: Dār al-Kutub al-ʿArabī, 1990), XLVIII: 42; LII: 39-40. Bar Hebraeus also reports on the outbreak (Syr. *mawtānā*) in Mardin during the long and terrible Mongol siege, without which he believes Mardin would not have fallen to the Mongols; Salam Rassi, 'Records of Plague in 13th-century Syriac Sources from the Mongol Period', Conference Presentation, International Medieval Congress, July 3-6, 2023.

[66]Ibn Abī Ḥajala, *Dafʿ al-niqma fī ṣalāh ʿalā al-nabī al-raḥma*, El Escorial, Madrid, MS 1772, fol. 74a; and Ibn Ḥajar al-ʿAsqalānī, *Merits of the Plague*, trans. J. Blecher and M. Syed (New York: Penguin, 2023), 195.

[67]Brack *et al.*, *op. cit.* (note 3), [6]. Brack *et al.* use this passage to suggest that the disease outbreaks reported by Bar Hebraeus did not take place in the aftermath of the Fall of Baghdad in 1258 but 'three or four years' later. Once we shift our attention to understanding the prodrome of the pandemic, it does not really matter whether the outbreaks took place in 1258 or three years later. Nevertheless, it is worth emphasizing that Brack *et al.* might have misread the rest of the paragraph, since it is clearly not a digression referring to later events. Bar Hebraeus describes events related to the prized citadel of Arbil/Irbil immediately after the fall of Baghdad. The rebellions and attacks, including in Jūlmarg, all took place during the time when Badr al-Dīn al-Luʾluʾ was still alive, and he died in 1259. Brack *et al.* seem to have confused this first set of events which involved a Kurdish noble, Sharaf al-Dīn Kalālī, with a later set of events involving the same cities in 1261–2 in which another Kurdish ruler, Sayf al-Dīn Makalān, was involved; Ernest A. Wallis Budge (ed. and tr.), *The Chronography of Gregory Abû 'l-Faraj, 1225-1286, the Son of Aaron, the Hebrew Physician Commonly Known as Bar Hebraeus …* (London: Oxford University Press, 1932), 431; Fancy and Green, *op. cit.* (note 1), 165n37. Our thanks to Salam Rassi for additional advice on the reading of this passage.

[68]On the living strains in the Caucasus region, see Galina A. Eroshenko et al., 'Retrospective Analysis of Dissemination of the 2.MED1 Phylogenetic Branch of *Yersinia pestis* in the Caucasus', *PLOS ONE* 18, 3 (2023), e0283670. On the Late Neolithic and Bronze Age strains, see the most recent survey, Pooja Swali *et al.*, '*Yersinia pestis* Genomes Reveal Plague in Britain 4000 Years Ago', *Nature Communications* 14 (2023), 2930.

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abounding in marmots'.[69] How many other species of rodents and insects may have been involved in the plague's new focalisation in the region, we can only guess.

Rather than dismissing references to bad harvests and infestations of mice as *unrelated* to the plague (as Brack and colleagues do), we should instead recognize them as conducive to the plague's focalisation.[70] Bad harvests, whatever their cause, will put stress on rodent populations that rely on gleanings as a source of food. Changes in rodent movements will also mean changes in flea transmission. Once plague has entered a terrain, any new environmental stressors can change a relatively stable enzootic plague infestation into an epizootic one.

As for the reasons for the erasure of local epidemics from the historical record, we acknowledge that more research is needed. We have already stressed that our modern understanding of plague in the thirteenth and fourteenth centuries has been shaped by the later fifteenth-century historians, who were living in a post-Black Death world, witnessing major outbreaks of plague across many regions regularly. Michael Dols' 1977 narrative of the Black Death in the Middle East was built almost entirely from these late witnesses. That they should have frequently used the more clinically precise term *ṭāʿūn* (plague) is hardly surprising, given the ubiquity of the disease by the time they were writing. Indeed, already by the 1360s a *qadi* (judge) in the Levantine town of Safed was drawing on medically precise terminology to describe the symptoms of *ṭāʿūn*.[71] Nevertheless, post-Black Death writers continued to use the term *wabāʾ* for what clearly must have been plague outbreaks. If we are serious about investigating plague outbreaks during the prodrome of the pandemic as well as its crescendo in the 1340s, we need to be alert to the fact that not every human outbreak will be widespread, and not every outbreak would have provided real, trustworthy eyewitness reports of the actual course of the disease.

There is, finally, an additional issue: the failure to mention epidemics in a way we readily recognize. Here it is necessary to weigh not simply the likelihood that human outbreaks during the plague's prodromal stage may have been very small, but also the possibility that they were not seen as a 'disease' at all but some other malign force. Based on what we currently know about the geographic distribution of the pre- and post-Big Bang lineages of *Y. pestis*, it is possible that the Mongols had no long-term experience with plague prior to their expansion out of Mongolia and may not have had a pre-existing vocabulary to deal with it.[72] The speed with which the disease kills would have been shocking and they conceivably would have tried to understand this experience within their existing shamanistic frameworks. In three studies published in the past decade, the Bulgarian researcher Maximin Golev describes episodes of witchcraft accusations in the Mongol realms. Golev never makes any connection with plague, and only obliquely mentions disease as being a factor in one case. (In another case, the suspicious deaths are talked about as 'poisoning'.) But in all cases, the reactions are extreme, involving the killing of the alleged protagonists and the execution or chasing away of a large number of the protagonists' followers or associates. In other words, in no case are these responses small or insignificant.[73] One involves Hülegü chasing Jochid army members through the Caucasus: exactly the route that the plague travelled if we

[69]On the name Sughurluq, see Tomoko Masuya, 'Ilkhanid Courtly Life', in: *The Legacy of Genghis Khan: Courtly Art and Culture in Western Asia, 1256-1353*, ed. Linda Komaroff and Stefano Carboni (New York/ New Haven: Metropolitan Museum of Art, 2002), 75-103, 85. On the extinct Caucasus marmots, see N. K. Vereshchagin, V. G. Geptner, and A.S. Stroganova, 'O vremeni i prichinakh vymiraniya kavkazskogo surka' [When and Why the Caucasian Marmot Became Extinct]', *Doklady Vysshei Shkoly. Biologicheskie nauki* 2 (1959), 36–8; and N. K. Vereshchagin, *The Mammals of the Caucasus. A History of the Evolution of the Fauna*, trans. from the Russian (Jerusalem: Ismel Program for Scientific Translations, 1967), 282 and 744.

[70]Brack *et al., op. cit.* (note 3), [6].

[71]Mustakim Arıcı, 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, 1 (2021), 99-158, 119–20.

[72]This observation was first made by Hymes, 'A Hypothesis', *op. cit.* (note 11).

[73]Konstantin Golev, 'Witch Hunt in the Mongol Empire', *CAS Sofia Working Paper Series* 8 (2016), 1–36; Konstantin Golev, 'Witchcraft and Politics in the Court of the Great Khan: Interregnum Crises and Inter-factional Struggles among the Mongol Imperial Elite. *The Case of Fāṭima Khatun'*, Annual of Medieval Studies at CEU 23 (2017), 132–44; Konstantin Golev, 'Intra-Mongol Diplomacy and Witch-Hunt during the Dissolution of the Empire: The Witchcraft Trial at the Court of Hülegü', *Eurasian Studies*: Special Issue, ed. F. Fiaschetti, *Diplomacy in the Age of Mongol Globalization*, 17/2 (2020), 327–68.

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could assume that the plague evidence for Baghdad, Syria, and Anatolia is the same lineage that the geneticists have documented in Black Death-related sites from the Volga region.[74]

As we have indicated above, at the present moment genetics cannot yet confirm any particular narrative about when or via what route the strains of *Y. pestis* involved in the Black Death reached western Eurasia and North Africa.[75] Yet as Monica Green and André da Silva have recently suggested, there is mounting evidence that some new strains reached Europe before the Black Death as conventionally dated (that is, for Western Europe, 1347).[76] One example will suffice. In Figure 2B above, we flagged that the Bavarian town of Nabburg had yielded a *Y. pestis* genome that seemed to be evolutionarily earlier than that retrieved from the Kara-Djigach cemetery in Kyrgyzstan, dated to 1338–9. Although referred to by the researchers who originally sequenced it as a 'Black Death' genome, the Nabburg remains have only been dated radiologically, which produced the broad range of 1292–1392.[77] The nearby town of Amberg also has mass burial graves; these have not yet been tested for the presence of *Y. pestis* nor have they yet been radiologically dated, but the burials themselves show consistent signs of a severe cultural unease elicited by the manner in which these individuals died, which was almost certainly an epidemic since no signs of violence are apparent. In the case of Amberg, these abnormal burials are clearly the earliest in the site, which can itself be dated to the time of the hospital's founding in 1317.[78] A comprehensive assessment of this Bavarian evidence and other documentary and bioarchaeological evidence for the plague's possible presence in pre-Black Death Europe is underway. If these initial findings hold, then this will add weight to our general contention that strains now identified as part of Branch 1 of the *Y. pestis* phylogeny did indeed pass through both western Asia and Europe (and probably North Africa, too) several decades before the outbreak at Kara-Djigach in 1338–9.

It remains, of course, to explain why the Black Death wave of the plague would have been so catastrophically worse, with a far greater range of transmission, than any 'prodromal' phase we have yet been able to document. That is a question we hope to address in future work. For the moment, we would emphasise how much remains unknown about the crucial events between the 1330s and the mid-1340s. Beyond looking for the bacterial strains, insect vectors, and rodent hosts involved, we have yet to gather all the evidence in plain sight. Michael Dols, for example, writing in 1977, asserted that the earliest mention of plague in Armenian sources comes from 1348. In fact, he overlooked the clear references to 'pestilence' and 'plague' (in Sanjian's translation) in Armenian colophons from 1321, 1329, and 1337.[79] The earliest of these references came from the hand of a scribe from Ani, the Armenian city whose elites succeeded in accommodating well to Mongol rule, only to see the city collapse into financial (and it seems, demographic) ruin by the 1330s.[80] The city has lain in ruins ever since. Indeed, there are many puzzles about the collapse of both the Ilkhanate and trade in the region that have never been satisfactorily explained. Philip Slavin, arguing for a 'quick transit' of plague to the

[74]See note 29 above.

[75]And, of course, it remains unconfirmed whether we should speak of a 'Black Death' also occurring in East Asia. As noted above, the outbreak in Kara-Djigach in 1338/9 seems to be genetically related to the disease as it presented in western Europe, and not the more geographically proximate post-Big Bang lineages that remained in Asia.

[76]Monica H. Green and André Filipe Oliveira da Silva, 'Shifting Paradigms in Black Death Chronologies', *Religion and Urbanity: Reciprocal Formations*, 22 May 2023, https://urbrel.hypotheses.org/5550, DOI: https://doi.org/10.17613/2pn8-kr81

[77]Spyrou *et al.*, 'A Phylogeography', *op. cit.* (note 29), who treat the Nabburg genome as having the Black Death genotype, i.e., being identical to the genomes retrieved from documented Black Death sites (London, Barcelona, and Toulouse). Researchers who instead place the Nabburg genome in a different clade are Seguin-Orlando *et al.*, *op. cit.* (note 23) and Clavel *et al.*, *op. cit.* (note 23).

[78]Mathias Hensch, '"Das Ungewöhnliche im Grab": Bemerkungen zu einigen Gräbern des 14. Jahrhunderts auf dem Spitalfriedhof von Amberg in der Oberpfalz', *Mitteilungen der Deutschen Gesellschaft für Archäologie des Mittelalters und der Neuzeit* 36 (2023), 119–32.

[79]A.K. Sanjian (ed. and trans.), *Colophons of Armenian Manuscripts, 1301-1480. A Source for Middle Eastern History* (Cambridge: Harvard University Press, 1969), 64, 68, and 78-9; Dols, *op. cit.* (note 10), 46. The colophons show 'pestilence' first at Ani in 1321; then at Taron (just west of Lake Van) in 1329; then at the Mediterranean port city of Ayas in 1337.

[80]Nicholas S.M. Matheou, 'Crisis of Accumulation in the Chinggisid World-Order? The City of Ani and Ilkhanid Fiscal Administration', unpublished (cited with permission).

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north of the Caspian Sea, himself notes that the first chronicle reports of human plague mortality come from 1343 (two years before other reports from the Golden Horde) and these are from the *southern* shores of the Caspian Sea, not the north; he declined to offer an explanation.[81] It is unlikely that any single piece of evidence – even a newly sequenced genome – will settle a question so complex as the processes that led up to the events of the 1340s. We may need to look for several foci and several separate epidemics, rather than one single epidemiological eruption. The Black Death was the crescendo of slowly amassing forces: climatic as well as faunal and bacterial. The events of 1258 are only part of this much more expansive story.

Conclusion

We thank Drs Brack, Biran, and Amitai for engaging with our 2021 essay, and with some of our other work on the history of plague which, as they know, has been many years in development.[82] We have argued here, however, that they have overlooked our larger body of work and our ambitions in the history of medicine. Our intention has always been to understand the historical events that led to the dispersal of the bacterium from the Tian-Shan mountains and its focalisation in regions much farther away, giving rise to four distinct lineages, at least one of which (Branch 1) wreaked havoc upon major population centres in Western Eurasia for centuries. As stated by Green in 2020, 'this is not about assigning "blame." It is about documenting humans doing what humans do'.[83] It is also, increasingly, about documenting what bacteria, insects, animals, and even the earth itself do. We agree that there is room for valuable dialogue in reconstructing the textual documentation for this vital period in human history and we are as committed to philological rigour in these endeavours as Brack and colleagues are. Indeed, we are quite excited about the prospects of renewed attention to medical-historical questions made possible by long-standing and new digital humanities projects focusing on the mediaeval Islamicate world, which we have listed in the attached Appendix.[84] Such resources helped us discover an error in our original essay in citing the Syrian, Mamluk historian, Ibn Shākir al-Kutubī's (d. 1363) chronicle; this, in turn, opened our eyes to the likelihood that there was yet another unexplored wave of plague prior to the Black Death, in this case in 1057–8 in Samarqand and central Asia as recounted by the Ayyubid preacher and historian, Sibṭ ibn al-Jawzī (d. 1256).[85]

[81]Slavin, 'From the Tian Shan', *op. cit.* (note 22), 523-4 and 525-6. Jackson (*op. cit.*, note 12, 154) regrettably refers to reported outbreaks of *wabāʾ* in eastern Iran in 1336-7 as 'cholera'. There is no evidence that *Vibrio cholerae* would have been present in inland western Asia in this period. To our knowledge, there is no comprehensive assessment of the prevalence of this common historiographic error. On the recognition that cholera was in fact understood in the nineteenth century as a *new* disease in the Middle East, see Isacar A. Bolaños, 'The Ottomans During the Global Crises of Cholera and Plague: The View from Iraq and the Gulf', *International Journal of Middle East Studies* 51 (2019), 603–20. On the embedding of this erroneous translation of *wabāʾ* (and Persian *veba*) in scholarship on mediaeval India, 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* 86, 1 (2023), 55–77, esp. 63.

[82]The initial version of Green's arguments for a thirteenth-century origin of the Second Plague Pandemic, drawn at the time from the genetics of *Y. pestis* and referencing possible plague epidemics in Lanbasar and Syria in 1257–9 but not yet that in Baghdad, was presented at a conference in Jerusalem in December 2017 hosted by Drs Biran, Amitai, and Brack; see Monica H. Green, 'The Migrations of Plague in Mongol Eurasia: Reading Genetics as History', paper presented at 'Migrations in Mongol Eurasia: People, Ideas, Artifacts', Hebrew University, Jerusalem, 19 December 2017, *Knowledge Commons*, https://doi.org/10.17613/nypc-xm61

[83]Green, 'Four Black Deaths', *op. cit.* (note 27), 1631.

[84]Specifically for plague's history, an extraordinary project to list all known copies of plague treatises in Arabic and Turkish is already underway; see Arıcı, *op. cit.* (note 71).

[85]Nahyan Fancy and Monica H. Green, 'Plague and the Fall of Baghdad (1258) – CORRIGENDUM', *Medical History* 66, 3 (2022), 285. Sibṭ ibn al-Jawzī is a major source for the litany of eleventh- and twelfth-century plagues listed by Ibn Hajar, *op. cit.* (note 66).

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Of course, for both these unexplored waves of plague (or 'plague-like mortality events') in the eleventh and thirteenth centuries, we acknowledge that currently there is no palaeogenetic evidence for *Y. pestis* having been present in Iran, Iraq, Syria, or Egypt. But that is in fact true for most infectious diseases, for the simple reason that very little sampling has yet been done in this region.[86] Hence, saying categorically that something *did not* happen more than 700 years ago, when that 'something' would have been happening at the level of microbes, insect vectors, and small rodents, seems more absolutist than is wise at the present juncture. As we documented in our original essay, four thirteenth-century contemporary observers described actual epidemic outbreaks that occurred after the Mongol conquest of Baghdad in 1258, to which we can now add a fifth, Jirjis ibn al-ʿAmīd al-Makīn. What none of them commented on – nor should we reasonably expect them to comment on – were changes in the larger environment. Climate history has overwhelmingly documented the global effects of the 1257 Samalas volcanic explosion (in Indonesia) in terms of sulphur emissions and temperature changes; yet we are only beginning to learn how to perceive its effects on human actors and natural landscapes in subsequent years, the most volcanically active century of the Common Era.[87] Changes in flea (or lice) ecologies may be perceptible when scribes complain about their 'writing companions', but these sources, too, demand careful consideration within the constraints of their genres and vocabularies.[88] Our expectation is that additional evidence for the dramatic climatic and environmental changes in the thirteenth and fourteenth centuries will continue to accrue, and as these physical changes are more precisely dated, we will be better able to link them to political, economic, and social changes. We also expect that additional evidence will document what we have proposed as a prodromal phase of the Black Death pandemic. In the meantime, we look forward to increased dialogue and methodological understanding among all the scholarly disciplines that contribute to these investigations. And we look forward to an openness in addressing our ethical obligations in bringing balance and care to how we talk about the epidemiological challenges that past societies faced – including, as we have demonstrated, the Mongols themselves.

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Editors' Note. The authors wish for us to confirm that, as they are members of the editorial board of this journal, they were not involved in the peer-review process of the Brack et al article.

Appendix: On-going projects in the digital humanities

The Internet Archive (1996-), https://archive.org

al-Waraq Electronic Village, Abu Dhabi (2000-), https://www.alwaraq.net

Audition Certificates Platform, edited by Konrad Hirschler and Said Aljoumani, https://www.audition-certicates-platform.org/

[86]An example is the case of a thirteenth-century pregnant woman in what is now western Turkey, who likely died because of a uterine infection; see Alison M. Devault *et al.*, 'A Molecular Portrait of Maternal Sepsis from Byzantine Troy', *eLife* 6 (2017), e20983.

[87]Evidence for the epidemics of 1258–60 noted by Bar Hebraeus and several others, and a then-suspected global climatic event, was first gathered by R. B. Stothers, 'Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258', *Climatic Change*, 45 (2000), 361-74. Most recently, see Green, 'Four Black Deaths', *op. cit.* (note 27), 1629; Nicola Di Cosmo, Sebastian Wagner, and Ulf Büntgen, 'Climate and Environmental Context of the Mongol Invasion of Syria and Defeat at 'Ayn Jālūt (1258–1260 CE)', *Erdkunde* 75, 2 (2021), 87–104; Giuliana Albini, Paolo Grillo, and B. Alice Raviola, eds., *Il fuoco e l'acqua. Prevenzione e gestione dei disastri ambientali fra Medioevo e Età Moderna*, special issue of *Quaderni degli Studi di Storia Medioevale e di Diplomatica* 7 (2022); Laura Wainman, Lauren R. Marshall, and Anja Schmidt, 'Utilising a Multi-proxy to Model Comparison to Constrain the Season and Regionally Heterogeneous Impacts of the Mt Samalas 1257 Eruption', *Climate of the Past*, 20 (2024), 951–68; and Jihong Cole-Dai, Derek L. Brandis, and Dave G. Ferris, 'Five Large 13th Century C.E. Volcanic Eruptions Recorded in Antarctica Ice Cores', *Atmosphere* 15 (2024), 661.

[88]Anna Sirinian, 'Towards a Structural Analysis of Armenian Colophons', *Comparative Oriental Manuscript Studies Bulletin* 8, 1 (2022), 91–120. On fleas specifically, see Sanjian, *op. cit.* (note 79), 18, 24, and 199.

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EIS1600: The Evolution of Islamic Societies (c.600-1600 CE): Algorithmic Analysis into Social History, edited by Alicia Gonzalez Martinez, Hamid Reza Hakimi, Lisa Mischer, and Maxim Romanov, https://eis1600.github.io/

Idrīsī: An Open Library of Historical Geography of the Premodern Islamic World, edited by Osama Eshera, Fateme Savadi, and Saiiad Nikfahm-Khubravan, https://www.dabiran.org/idrisi

KITAB: Knowledge, Information Technology, & the Arabic Book, edited by Sarah Bowen Savant, https://kitab-project.org/

al-Maktaba al-Shamela (2005-), https://shamela.ws

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