Yersinia pestis, the Bacterium of Plague, Arose in East Asia. Did it Spread Westwards via the Silk Roads, the Chinese Maritime Expeditions of Zheng He or over the Vast Eurasian Populations of Sylvatic (Wild) Rodents?

Author(s): Ole J. Benedictow

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# *Yersinia pestis*, the Bacterium of Plague, Arose in East Asia. Did it Spread Westwards via the Silk Roads, the Chinese Maritime Expeditions of Zheng He or over the Vast Eurasian Populations of Sylvatic (Wild) Rodents?

Ole J. Benedictow
(University of Oslo)

## Introduction

Bubonic plague epidemics of the past caused demographic catastrophes. They affected the lives of people, populations and societal developments in profound ways which have attracted great scholarly interest in diverse disciplines of research. In recent years, scholars of the new discipline of paleobiology have developed biomolecular tools which enable them to detect ancient microbial DNA (aDNA) or other microbial elements, especially specific antigens of the protein capsules of bacteria. By now paleobiologists have published 43 individual studies of material taken from nearly 40 plague graves or burial pits and of several hundred individuals which consistently have yielded positive identifications of the bacterium *Yersinia pestis*.[1] In a recent important paper, the scientists conclude: "Together with prior analyses [...] our data from widely distributed mass plague pits ends the debate about the aetiology of the Black Death, and unambiguously demonstrates that *Y. pestis* was the causative agent of the epidemic that devastated Europe during the Middle Ages."[2]

The end of rash alternative microbiological theories meant that a cluster of important interconnected questions came in the focus: (1) When in the past did *Y. pestis* develop? (2) Where was the original homeland of plague? (3) What is the spatiotemporal history of its spread? (4) What is the evolutionary history of *Y. pestis* and its evolutionary phylogenetic

1 Ole J. Benedictow, *What Disease was Plague? On the Controversy over the Microbiological Identity of Plague Epidemics of the Past* (Leiden: Brill, 2010), pp. 381–395. This is a discipline in rapid development; one of the 43 studies published in recent years is cited in n. 2, below. A complete presentation of all paleobiological plague studies published by the end of 2012 appears in appendix 1 of my forthcoming monograph *The Black Death and Later Plague Epidemics in the Scandinavian Countries: Perspectives and Controversies* (Versita: 2013)

2 Stephanie Haensch [Hänsch] , Raffaela Bianucci, Michel Signoli et al. [with Barbara Bramanti in the final position of senior author and coordinator], "Distinct Clones of *Yersinia pestis* Caused the Black Death", *PLoS Pathogens* 6 (October 2010), pp. 1–8, esp. p. 5.

diversifications? (5) Where did the three known historical pandemics originate, the Justinianic[3] pandemic (541–766) and the second pandemic (1346–1722)? The origin of the modern or third pandemic 1894–c. 1940 is known but not the origin of its biovar. The solution of these questions depends much on the paleobiological identification and analysis of the (variants of) biovars of *Y. pestis* (*Antiqua*, *Medievalis*, *Orientalis*) at work in these pandemics. However, it may appear that the complementary significance of history is underrated as well as the indispensability of interdisciplinary co-operation.

## The Origin of Plague

A recent paper by a team of paleobiologists demonstrates the great opportunities offered by the new paleobiological science for a better understanding of the evolutionary development and history of infectious diseases, in this case bubonic plague.[4] The said team undertook comprehensive comparative studies of whole genomes of *Y. pestis* isolated from various global sources and conducted evolutionary development studies, "phylogenetic analyses on this sequence variation dataset". The conclusion was that Y. *pestis* "originated in China or FSU" [former Soviet Union[5]] >2,600 years ago and "spread through multiple radiations to Europe, South America, Africa and Southeast Asia".

> The geographical sources and evolutionary branch order of 2.MED[ieval] subpopulations, which arose >545 years ago, correspond with points on the former Silk Road [n. 15[6]], [...]

3 Ole J. Benedictow, "The Justinianic Plague Pandemics: Progress and Problems", *Early Science and Medicine* 14 (2009), pp. 543–548, esp. pp. 547–548.

4 Giovanna Morelli, Yajun Song, Camila J. Mazzoni et al., "*Yersinia pestis* Genome Sequencing Identifies Patterns of Global Phylogenetic Diversity", *Nature Genetics* 42 (December 2010), pp. 1140–1143. Published online (31 October 2010), pp. 1–4; doi: 10, 1038/ng.705, Online Methods, 2 pages.

5 The FSU is an unusual geographical term in a context that does not relate to recent political history. If this involves territories of the Soviet republics that became independent after the dissolution of the SU, for instance, Kazakhstan or Kyrgyzstan, one should be more specific. The expression also raises the question why the term Russia was not used, whether the reason was that it may carry political overtones. The term China is equally vague. It may include territories which did not form part of the area controlled by the Han Chinese in earlier times, for instance, Tibet, Manchuria, Mongolia/Outer Mongolia, Inner Mongolia, and Xinjiang; again, such a term could imply a very "special" political connotation. Western scholars are not always aware of these problems while Chinese scholars will treat them them more carefully. – That *Y. pestis* originated somewhere within this vast area does not in itself prove that China was visited by plague epidemics; rather, it must be established as a working hypothesis dependent in an ordinary way on specific relevant empirical verification for being transformed into a statement on reality at some level of tenability. See Lester K. Little, "Review Article: Plague Historians in Lab Coats", *Past & Present* 213 (Nov. 2011), pp. 267–290, esp. 281–282, 284. See also below pp. 4–5, n. 11, and p. 17, n. 63.

6 The authors' reference n. 15, "Silkroad Foundation. The Bridge between Eastern and Western Cultures. (2009) (http://www.silkroadfoundation.org/toc/index.html)."

> an extensive trade route from China to Western Asia between 200 BC and 1400. Other 2.MED1 isolates have been found in western China [...] as well as in Kazakhstan and the Caucasus [fn. 13], which supports the westward spread of 2.MED from China through trade articles that were carried along the Silk Road.

Referring to the biovars of the two earliest plague pandemics they also "invoke extensive spread of *Y. pestis*" of the "1.ANT[iqua]1 to 1ANT3 populations that have only been isolated from east and central Africa" which, according to

> the estimated age of 1.ANT1 (628–6,914 years ago) slightly predates the extensive voyages from China led by Zheng He between 1409 and 1433 (Supplementary Fig. 3a). These voyages involved up to 300 ships, some of which were up to ten times larger than those of contemporary European explorers and carried ~28,000 crewmen [n. 16[7]]. It seems highly likely that these ships were infested by rats, which could have transmitted *Y. pestis* from China to Africa.

Scholars doing research on Zheng He's expeditions will be concerned about the authors' reliance on Louise Levathes' popular non-specialist work.[8] They will also wonder about (at least) three problems associated with the reciprocal interdisciplinary usefulness of cooperation between history and paleobiology in the present phase of this topic: (1) The frequent use of chronological dating with the symbol >, greater than, without indicating how much greater. Although this is related to the age of 1ANT1, the time span of "628–6,914 years ago", as well as the statement that its origin would "slightly predate" Zheng He's voyages are both disquieting. The last point in particular reads like an unwarranted inference – a rather extreme assumption at best, that the reference to Zheng He's voyages is not impossible but tenuously linked to a major event near the outer "time fringe" of the time span in question. Besides that, the level of tenability is equal to the assumption that it arose well over 6000 years before these voyages and within the microprobabilities represented by 6000 unweighted years. This reflects the huge degree of uncertainty inherent in microbiological clocking techniques. The same problem surfaces in a statement of Achtman and others, namely that "*Y. pestis* [...] is a recently emerged clone", which "evolved from *Y. pseudotuberculosis* 1,500–20,000 years ago".[9] Such chronological delimitations are useless for historical or

7 In n. 16 the authors refer to Louise Levathes, *When China Ruled the Seas: The Treasure Fleet of the Dragon Throne, 1405–1433* (New York: Oxford University Press, 1996).

8 Personal communications with Roderich Ptak (Munich) and Mathieu Torck (Ghent). Also see Roderich Ptak's cautioning words that Levathes's book can be considered "a pleasant mixture of facts and fiction". See Fei Hsin (Fei Xin, author), John Vivian Gottlieb Mills (tr.), Ptak (ed.), *Hsing-ch'a sheng-lan. The Overall Survey of the Star Raft* (Wiesbaden: Harrassowitz, 1996), pp. 22–23.

9 Mark Achtman, Kerstin Zurth, Giovanna Morelli et al., "*Yersinia pestis*, the Cause of Plague, is a Recently emerged Clone of *Yersinia pseudotuberculosis*", *Proceedings of the National Academy of Sciences of the United States of America* 96 (1999), pp. 14043–14048; Mark Acthman, Giovanna Morelli, Peixuan

medico-historical analyses. The nearest time limit is not determined microbiologically but historically and opens the door to further chronological change by the historical method: "Justinian's plague was 1,500 years ago, and therefore, *Y. pestis* is at least 1,500 years old." (2) Despite the almost debilitating margins of uncertainty produced by biomolecular clocking techniques, the history of bubonic plague according to historical sources is mainly ignored with respect to the questions of when and where *Y. pestis* originated and the early history of how it began to spread from its original homeland. (3) When historical explanations or perspectives are presented in support of the biomolecular findings as in the case of the references to Zheng He's voyages or the role of the Silk Road, they are hardly supported by references to historical studies or exposed to source-criticism.

Problems nos. 2–3 will be addressed first. This will produce premises for addressing no. 1 and several questions associated with the spatiotemporal patterns of how *Y. pestis* spread from its original homeland to other regions, as well as the phylogenetic diversifications involved in the process.

A convenient starting point for the discussion is a recent monograph on the Black Death (1346–1353), which contains a concise presentation of the earliest (probable or certain) references to bubonic plague found in historical sources. According to this account, *Y. pestis* appears to have originated in the plague foci of central and eastern Africa or perhaps in the western Arabian plague focus.[10] This idea concords well with the view presented in Achtman et al. 1999, but was then rejected by Achtman et al. 2004 and completely substituted by Morelli's (et al.) theory of an East Asian or (peri-)Chinese origin. However, bubonic plague is not mentioned in Chinese written sources in an identifiable form, in a pathognomonic way, until 610 CE and 652 CE, when two medical texts refer to it as an endemic disease. This means that plague is first mentioned in China seventy years after the outbreak of the first plague pandemic in the West and in a form which indicates that the disease was known from sporadic occurrences, as contracted by hunters or other persons moving through the territory of a plague reservoir, usually at a distance from human settlements.[11] It is not mentioned

Zhu et al., "Microevolution and History of the Plague Bacillus, *Yersinia pestis*", *Proceedings of the National Academy of Sciences of the United States of America* 101 (2004), pp. 17837–17842.

10 Areas in the Democratic Republic of Congo (formerly Zaire), Kenya, Uganda, and Tanzania. See Eugene Tikhomirov, "Epidemiology and Distribution of Plague", in *Plague Manual: Epidemiology, Distribution, Surveillance and Control* (Geneva: WHO, 1999), pp. 11–42, esp.15 (map showing world distribution of plague foci) 16, 18–20; Norman Gratz, "Rodent Reservoirs & Flea Vectors of Natural Foci of Plague", ibid. pp. 63–96, esp. 69, 71–72. See also map on home page whocc-plague.

11 Ole J. Benedictow, *The Black Death. A Complete History* (Woodbridge, UK: The Boydell Press. 2004), pp. 35–54. Little, "Plague Historians in Lab Coats", maintains that the earliest mention of plague in Chinese sources in the medical compendium of 610 CE "essentially repeats a passage from a similar work of the third century BC". Since the earlier work is not identified and this work is not mentioned in his reference which is identical to mine, this interesting point appears unsubstantiated. Lien-Teh Wu,

again in China until almost one thousand years later, in 1642 CE, i.e., nearly 300 years after the second plague pandemic started in Europe – and then for the first time in epidemic form.[12] Conspicuously, according to the above dates, the outbreaks of plague in China can be seen as offshoots of the first and second pandemics in Europe, thereby supporting the hypothesis that plague spread from or via Europe eastwards to China and East Asia more generally. One may add that plague is mentioned in the Yunnan province for the first time in 1792 (see n. 11). Furthermore, bubonic plague is not described in Indian sources until the eleventh century CE and again not until the seventeenth century.[13]

However, the notion that *Y. pestis* spread from west to east across the Eurasian continent appears invalidated by Morelli et al. But Chinese historical sources do not support the idea of a (peri-)Chinese origin. A (peri-)Chinese origin must be presumed to have produced quite frequent outbreaks of plague epidemics which would occasion comments with recognizable descriptions in Chinese accounts and medical works. Instead, it seems likely that *Y. pestis* originated in rodent populations in the eastern regions of Russia, rather peculiarly referred to as the former Soviet Union (FSU), or in Mongolia and Manchuria, and so on.[14] These locations are not or only indirectly mentioned by Morelli et al. Historical sources pertaining to these regions suggest that plague made only rare incursions in epidemic form into China "proper", i.e., the territories of the Han Chinese. Here, the general territorial term "East Asia" will be used to cover all these areas.

## Did Caravans Spread Plague along the Silk Roads?

No historical evidence supports the notion that *Y. pestis* spread westwards from East Asia to Europe or the Middle East at any time along the different branches of the Silk Road(s) system. Distance is an important point of concern that needs to be considered in this context. Maps suggest that going from Luoyang or Xi'an (Chang'an) in China to Antioch or Tyre in

"Historical Aspects", in Lien-Teh Wu, J. W. H. Chun, Robert Pollitzer, C. Y. Wu, *Plague. A Manual for Medical and Public Health Workers* (Shanghai Station: Weishengshu, National Quarantine Service, 1936), pp. 1–55, esp. p. 11: "We have, however, failed to find any mention of the word plague [...] in any ancient Chinese medical publication. In spite of years of patient search [...] no reference to plague, *shu-yi*, or any malady showing symptoms similar to it could be obtained until we reached the year A.D. 610, when a certain book called *Ping-yuan* or "Sources of Disease" by Ch'ao Yuan-fang appeared." If substantiated, Little's point will not affect the empirical or methodological realities associated with the exquisite rarity of references to plague in the rich Chinese medical literature or change the fact that bubonic plague is mentioned signficantly earlier in classical Hippocratic and Hellenistic medical writings. See also above n. 5.

12 Lien-Teh Wu, "Historical Aspects", esp. pp. 10–13.

13 Benedictow, *The Black Death*, pp. 42–43.

14 See above n. 5.

the Levant, or to Tana on the Sea of Azov, or, for instance, to Kaffa (Feodociya) or Trabizond on the Black Sea, meant that a distance of roughly 8000 km had to be covered in all. But this does not include countless bends and turns, ascents and descents, which required additional time and "mileage". Therefore, the real distance on the ground was considerably longer than 8000 km. The view that plague contagion was transported over thousands of kilometers is highly problematic and requires evidence and discussion.

This involves several crucial categories, or necessary conditions, which have been consistently neglected: (1) the properties and conditions that would allow plague infected fleas (or rodents) to survive long-distance and long-term transportation and be infective on arrival; (2) the duration of caravan transports along the Silk Roads as a whole and along important segments; (3) the suitability of climatic factors. Information on these three dimensions must be "compatible" with transportation along the Silk Roads; if not, then the theory that plague was spread by caravans should be abandoned. Below we shall look at the above points in more detail.

(1) Most species of fleas are poorly adapted to human means of transportation. They are nest fleas; they stay in the nests of their hosts, are adapted by evolutionary selection to a specific microclimate and feed on their hosts. Their larvae are used to feeding on the faeces of the adult fleas. They are averse to light and avoid contingencies which may expose them to a bright environment, riding with their hosts or involuntary transportation. A typical nest flea like *Pulex irritans*, the so-called human flea, moves with human bedding and furniture. Over evolutionary time, this leads to strong specific biotopic adaptation(s) and a high degree of host specificity. Fleas are monozootic or narrowly restricted to a group of hosts with ordinary distribution in the area and interchangeable use of nesting facilities.[15] High degree of host specificity means that nest fleas are reluctant to feed on other animals than their true host(s) and will often be critically at risk if accidentally transported to another biotope or area wholly or nearly uninhabited by their specific host(s). This makes a role in the spread of plague by caravans or other forms of transportation unlikely for most species of fleas of sylvatic rodents (wild rodents[16]).

Only few species are fur fleas, adapted to spending much of their adult lives in their hosts' fur, enjoying there a pleasant microclimate and easy opportunity for feeding, as is the case with *Xenopsylla cheopis*, the usual flea of the black rat.[17] Fur fleas are adapted by evolutionary selection to the circumstances contingent on being scratched off or falling off. They are adjusted to being on their own and tolerate light. They will frequently fall off in the favoured

15 Robert Pollitzer and Karl F. Meyer, "The Ecology of Plague", in Jacques M. May (ed.), *Studies in Disease Ecology* (New York: Hafner Publishing Co., 1961), pp. 433–590, esp. 462.

16 Ibid., p. 440.

17 Ibid., pp. 461–462; Robert Pollitzer, *Plague* (Geneva: WHO, 1954), pp. 321–322.

environments of their hosts. In the case of *X. cheopis*, this will be in or near deposits of grain in granaries, commercial stocks and human households; therefore, this species has developed the ability to live of grain debris or dust. In Madagascar with a favourable climate, researchers discovered that *X. cheopis* could survive for months on grain debris. This suggests that transportation of infected rat fleas in corn or farina, which were common goods in medieval trade and traffic, was important.[18]

For the same basic reason, rat fleas are evolutionarily adapted to feeding on other common animals in the environment of their hosts. In the absence of their preferred host, they will, after a few days of fasting, readily attack cats, dogs and human beings. As fur fleas they will also jump onto human beings and ride in their clothing; generally, they are well adapted to transportation in textiles (see below). Thus, the plague flea "*par excellence*" satisfies several crucial conditions for being transported by humans over considerable distances as is emphasized in all standard works on plague.[19]

Caravan camels usually carried loads of around 150 kg which would include tents, cooking utensils, food, drinking water and supplementary fodder for the camels, especially dried peas; the weight of merchandise would be reduced correspondingly.[20] The merchandise that could absorb the extreme transportation costs all along the Eurasian landmasses and also suit the transportation of infected fleas (or rodents?) is inherent in the name Silk Roads. But standard works on bubonic plague do not mention the role of silk in the transportation of infected rat fleas. It is a fact that infected fleas are frequently transported over long distances in corn and farina and in cotton and wool both in the form of raw materials and woven fabrics including clothing in the luggage of travellers.[21] These goods are not sufficiently expensive per unit of weight or volume to bear the costs of caravan transportation at considerable risk over the Eurasian continent. They are also not so exquisitely unique to be in demand at the other end of the caravan roads at a much higher price than in China. However, this confirms the principal suitability of textiles as medium for the transportation of infected fleas, although the smooth and shimmering almost glassy surface of silk fabric may not be so well suited.

Hirst points out that in humid and moderately warm circumstances, with around 90 per cent relative humidity and below 15° C, as will be quite frequent at sea, rat fleas can survive unfed and in heavily infected conditions for at least fifty days. In natural conditions of 27° C,

18 L. Fabian Hirst, *The Conquest of Plague* (Oxford: Clarendon Press, 1953), pp. 172, 182, 242–243, 302–314, 320, 322–323; 330–331, 352; Pollitzer, *Plague*, pp. 320–335, 387.

19 Benedictow, *What Disease was Plague?*, pp. 151–193; Hirst, *The Conquest of Plague*, pp. 311–314.

20 Owen Lattimore, *Mongol Journeys* (London: Jonathan Cape, 1941), pp. 148, 150.

21 Benedictow, *What Disease was Plague*, 151–193. See also Index: "Medium of transportation of infected rat fleas"; Hirst, *The Conquest of Plague*, pp. 310–311, 316–320, 366–368; C. Y. Wu, "Insect Vectors", in L.-T. Wu et al., *Plague. A Manual*, pp. 285–290.

*X. cheopis* has transmitted plague after 29 days of starvation.[22] Hirst also underlines that maximum longevity under such circumstances may even exceed that time span, which makes it reasonable to cautiously extend the survival period to circa 1.5–2 months.

Depending on the ambient temperatures, wild-rodent fleas in southeastern Russia have been shown to harbour *Y. pestis* for 396 days at low temperatures of 0° C to 15° C which are quite usual in burrows. They could transmit plague after periods of starvation of up to 150 days, for nearly five months. In Peru, *X. cheopis* has adapted to the conditions in burrows of wild rodents which enabled them to survive for at least six months in the absence of hosts. However, survival in plague-infected state was not studied. This appears to be a singular evolutionary development and ambient conditions are so different from those prevailing in silk along the Silk Roads that the relevance of these results for the present discussion is uncertain. Moreover, in the USA, Eskey noted that plague-infected *X. cheopis* fleas in the conditions of his laboratory survived, on average, for not more than 16 days, with a maximum of 36 days. Under these circumstances, wild-rodent fleas survived considerably longer with operational vector capacity intact.[23] In the case of *X. cheopis*, Hirst's information on a period of infectivity for this species under the given conditions of up to two months seems a realistic maximum.

(2) This leads to our next point: the duration of transportation and climatic conditions as decisive factors. Around 1900, plague was repeatedly imported to England all the way from India in grain, cotton or sailors' luggage,[24] albeit with steamships sailing through the Suez Canal. These developments reduced the usual time of the voyages to well under two months and thus within the indicated time horizon for the survival of infective rat fleas.[25]

The time perspective of travel by Chinese camel caravans was very different. A caravan consisted of several files of up to 18 camels each with a camel-puller in charge of each file. The camel-puller led the first camel by a rope tied to a peg attached to its nose, so caravans travelled mostly in daylight and at the walking pace of men. They usually moved at a pace of 3–4 km per hour, distances covered per day would vary from 16 to 40 km, on average, probably not more than 25 km per day. Heavy sand would slow down the camels considerably and Chinese caravans would often stop in the case of rain or not break camp.[26] This means that a distance of 8,500–9,000 km would be covered in 340–360 travelling days. However, travel-

22 Hirst, *Conquest of Plague*, pp. 322, 324, 330–331; Pollitzer and Meyer, "Ecology of Plague", p. 468.

23 Ibid., pp. 468, n 78 and 32, pp. 584, 586.

24 R. Bruce Low, *Reports and Papers on Bubonic plague. An Account of the Progress and Diffusion of Plague throughout the World, 1898–1901* (London: H.M.S.O., 1902); David van Zwanenberg, "The Last Epidemic of Plague in England? Suffolk 1906–1918", *Medical History* 14 (1970), pp. 62–74; Benedictow, *The Black Death*, p. 20.

25 Ian Marshall, *Passage East* (Charlotsville: Howell Press, 1997).

26 Owen Lattimore, *The Desert Road to Turkestan* (London: Methuen, 1928), pp. 50–51, 83–84, 100, 108–115; Lattimore, *Mongol Journeys*, p. 157.

ling days were interspersed by numerous days of rest and recuperation for men and animals or by forced inactivity through inclement weather. Journeys along the length of the Silk Roads by camel caravans, normally by serial caravans with reloading of the goods, would last much longer than a year.

(3) The greatest danger to fleas under transportation is desiccation. Under the arid or desert-like conditions prevailing in much of the heartlands of Central Asia traversed by the Silk Roads, conditions must generally be considered unfavourable or adverse to the survival of fleas, much more than transportation at sea. Fleas are also vulnerable to cold and succumb rapidly at temperatures below 5° C, as is normally the case with insects which cannot regulate body temperature.[27] Cold and freezing temperatures are frequently encountered along many stretches of the caravan routes, especially at night, although the days can be quite hot, which activates the exposure to desiccation.[28] Clearly, the view that plague spread westwards from China or East Asia to Europe along the caravan routes bears several speculative components with independent potential for invalidation. Given these multiple uncertainties, it is highly unlikely that infective rat fleas or other species of fleas would survive caravan transportation in silk across the Silk Roads or substantial parts of the route system.

Morelli et al. claim that the Silk Roads were continuously open for trade and travel from around 200 BCE in the Hellenistic Period through the Roman Period and the Middle Ages until c. 1400; they support their view by an inaccurate reference to "Silk Road foundation. The Bridge between Eastern and Western Cultures 2009". Presumably, this refers to an article in volume 6 of *Silk Road*, where it is argued that the conquests of Alexander the Great in the 4th century BCE and the consequent spread of Hellenistic culture to the East had "prepared the way for the opening of the Silk Road".[29] The article does not maintain that the Silk Roads started functioning around 200 BCE and it does not say that it was (quite) continually functioning over the indicated period of 1600 years.

Trade along the Silk Roads depended on high profitability for the merchants and consequently on safety for the caravans and their costly goods. That required the existence of territorially contiguous political organization(s) which in return for some sort of toll payments and availability of attractive goods would see their interests served by making it reasonably safe and profitable to protect caravans transporting luxury goods over these enormous distances. The Silk Roads functioned efficiently only in historically relatively short windows in time.

27 Ole J. Benedictow, *Plague in the Late Medieval Nordic Countries. Epidemiological Studies* (Oslo: Middelalderforlaget, 1992, reprints 1993 and 1996), p. 165.

28 Lattimore, *Desert Road*, pp. 129, 159–160.

29 Yang Juping, "Alexander the Great and the Emergence of the Silk Road", *Silk Road* 6 (Winter/Spring 2009), pp. 15–22.

There is no evidence of contact between the West and China before c. 200 BCE and that evidence is only suggestive (Strabo 11.11.1). All earlier evidence of bubonic plague in the West, will exclude the Silk Roads from the discussion of where *Y. pestis* originated and how it subsequently was spread across the Eurasian continent. Rome's conquest of Egypt in 30 BCE improved the potential for contact but frequent wars with the Parthian Empire to 217 CE prevented for long periods commercial relations. In the intermittent lulls, silk was conveyed via the Parthians to the Romans. The distance from the Parthian capital of Ctesiphon to the important Chinese city of Luoyang at the beginning of the Silk Roads is over 7000 km. Goods were not transported over the entire route in a single trade venture. They were purchased and passed on by a series of intermediaries, agents who operated on varying parts of the routes and traded them in the vital markets of urban centres or oasis towns where they would be sold locally or for immediate transshipment or preliminarily stored for reloading. Eventually, after a couple of years as it may rather seem, some of the merchandise would make it all the way to the final destinations of the Silk Roads.

Apparently, the first travellers began to reach China along this route in the period 150–200 CE. The first Roman envoy arrived in China by the maritime route in 166 CE. This event is evidence of the viability of the maritime route at the time and that it was known in Rome. Evidently, all evidence of bubonic plague in the West predating the post-Augustan Roman Empire, the time of Emperor Nero, 54–68 CE, rules out for all practical purposes transportation of contagion along the Silk Roads to destinations associated with Roman trade connections.[30] When the Han dynasty collapsed in 220 CE, trade with the West was reduced to a minimum. Therefore, the Silk Roads may have functioned on a significant scale in relation to the Roman Empire only for quite a limited period.

Silk is generally considered to have been the exclusive cultural heritage of China. However, recent archaeological studies have identified silk fibres in two important sites of the Indus Valley civilization dating to c. 2450–2000 BCE, roughly contemporaneously with the earliest Chinese evidence of silk. This important new finding brings into question the traditional historical notion that sericulture and silk weaving was an exclusive Chinese invention[31] and consequently also the automatic assumption that all silk mentioned in Roman sources had originated in China. It may also have originated in India, possibly also in southwestern India where conditions are well suited for silk production. From there silk could have been trans-

30 Raoul McLaughlin, *Rome and the Distant East. Trade routes to the Ancient Lands of Arabia, India and China* (London: Continuum UK, 2010), pp. 83–108. Frances Wood, *The Silk Road: Two Thousand Years in the Heart of Asia* (Berkeley, CA: University of California Press, 2002), pp. 9, 13–23. Jérôme Carcopino, *Daily Life in Ancient Rome* (Harmondsworth: Penguin Books, 1978), pp. 188–189.

31 Irene Good, Jonathan Mark Kenoyer, Richard H. Meadow, "New Evidence for Early Silk in the Indus Civilization", *Archaeometry*, 51 (2009), pp. 457–466.

ported by ship the much shorter distances up the Persian Gulf or around Arabia to the Kingdom of Axum in present-day Ethiopia which at the time also included the present-day area of Eritrea on the Red Sea all the way to Djibouti (c. 400 BCE to 900s CE). Axum was the regional marine commercial power[32] whence goods, including silks, were transported by ship to the end of the Red Sea or by caravans over land to the Nile, and further to Alexandria or possibly Pelusium. From these ports, the merchandise was shipped to Rome, Constantinople and other Mediterranean ports.[33] It has long been known that pepper was imported to Rome from India via this sea route, which explains that the first Roman envoy to China used it. It may seem rather likely that silk was included in the cargo carried by ships along this route.

The Byzantine historian Procopius (c. 500–c. 570 CE) relates that two Christian monks discovered the secrets of silk production and that Emperor Justinian (527–565) sent secret agents to steal silkworm eggs and to bribe silk experts. They succeeded, and this started the silk production in Mediterranean countries which over the centuries developed into major artisanal industries. The West remained interested in buying gums and spices, the subject can therefore be resumed with the question of the origin of the Black Death.

The Silk-Road theory on the transcontinental spread of *Y. pestis* must be confronted by the earliest historical evidence on plague. Georg Sticker provides a remarkable gathering of the classical accounts and clinical descriptions by Greek physicians, which in the discussion of the present topic has been completely neglected so far.[34] Sticker and most other scholars who have used this material agree that indisputable accounts of serious plague epidemics in the Hellenistic period are found in the medical writings of Rufus of Ephesus, who lived around 100 CE. However, he renders comments on clearly identified outbreaks of plague as reported by the pupils of Dionysius (the Hunchback) relate to North Africa and the Middle East around 300 BCE:

> The buboes that are called pestilential, are very acute and very fatal, especially those which one may encounter unexpectedly in Libya, Egypt, and Syria, and which they say were accompanied by high fever, agonizing pain, severe constitutional disturbance, delirium, and the appearance of large, hard buboes that did not suppurate [secrete pus], not only in the usual regions of the body, but also at the back of the knee and in the bend of the elbow [...]

32 A good map is in the Wikipedia entry on Axum. The article on the Silk Road in that source is well written.

33 Lionel L. Casson, *The Periplus Maris Erythraei. Text with Introduction, Translation, and Commentary* (Princeton: Princeton University Press, 1989).

34 Georg Sticker, *Abhandlungen aus der Seuchengeschichte und Seuchenlehre*. Vol. 1, Part 1. *Die Pest* (Giessen: Alfred Tölpermann, 1908), pp. 17–23; Hirst, *Conquest of Plague*, pp. 6–11, 22–25, 35–50.

In Antiquity, Libya meant North Africa, Syria included most of present-day Israel, "Palestine" and Jordan. Subsequent epidemics are reported by Posidonius and Dioscorides in Libya about 50 BCE.[35] The clinical characteristics conform to modern medical descriptions of bubonic plague which is the only epidemic disease characterized by buboes. The reason is that infective (blocked) fleas deposit contagion at an intradermal level suitable for being drained through the lymphatic tracts to lymph nodes which, following infection, begin to swell and develop into buboes.[36] All the specified anatomical locations of buboes agree with modern studies of bubonic plague. Modern standard works and studies on bubonic plague emphasize that buboes are clinically characterized by agonizing, piercing or stabbing pain, which is also mentioned by late medieval chroniclers.[37] Around 100 CE, Aretaeus of Cappadocia, a Greek physician living in Alexandria and probably influenced by observations in the Middle East and North Africa, gave a clear description of epidemic plague: "The epidemic buboes in the groin are caused from the liver; they are very malign."[38]

Plague is mentioned in the so-called *Hippocratic Corpus* of medical books and writings, albeit only as an endemic occurrence.[39] These medical writings were ascribed to a great physician called Hippocrates (c. 460–c. 375 BCE) born in Cos I. on the coast of Asia Minor. Modern philological studies have shown that they must have been written over several hundred years and none can with certainty be attributed to him.[40] The famous medical school of Antiquity arose in Alexandria in the Hellenistic Period (323–30 BCE) where medicine was taught and developed on the basis of the *Hippocratic Corpus*. The references to endemic plague indicate that Greek physicians related also to areas where wild rodents functioned as plague reservoirs. In such areas, people would occasionally come across a rodent sick or dead from plague and be bitten by hungry fleas. Even today there are plague foci in Morocco, Libya, southeastern Turkey, Iran, Iraq and Syria, where cases of human plague are reported.

## Pre-classical Evidence of Bubonic Plague in the Middle East and Near East (Asia Minor)

Scholars have usually accepted as evidence of an epidemic of bubonic plague the Biblical account in *The Old Testament* (OT), 1 Samuel 5–6, and correspondingly in the Septuagint, I

35 Dioscorides was a Greek army surgeon in the service of Emperor Nero (54–68 CE).
36 See Benedictow, *What Disease was Plague?*, pp. 5, 313, 318, 320, 379, 625.
37 Benedictow, *What Disease was Plague?*, pp. 537–550.
38 Sticker, *Die Pest*, pp. 1–22.
39 Ibid., pp. 19–20.
40 William D. Smith, "Hippocrates", in *Encyclopædia Britannica Online*, 2011. Web. 14 Apr. 2011.

Kings 5–6,[41] on the Lord's punishment of the Philistines for having captured the Ark of the Covenant:[42]

> The Lord's hand was heavy on the people of Ashdod and its vicinity; he brought devastation on them and afflicted them with tumours.[a] [n. a = 1 Samuel 5:6 Hebrew; Septuagint and Vulgate tumours. "And rats appeared in their land, and there was death and destruction throughout the city"[43]]

This was reiterated as the Ark was moved to other Philistine cities, next to Gath:

> The Lord's hand was against that city, throwing it into a great panic. He afflicted the people of the city, both young and old, with an outbreak of tumours[b] [n. b: "1 Samuel 5:9 Or with tumours in the groin (see Septuagint)"]

And next, to Ekron:

> For death had filled the city with panic; God's hand was very heavy on it. Those who did not die were afflicted with tumours, and the outcry of the city went up to heaven.

The Philistines now understood that they would have to make peace and return the Ark and asked the Israelites how they could placate their God:

> What guilt offering should we send to him? They replied five gold tumours and five gold rats, according to the number of the Philistine rulers, because the same plague has struck both you and your rulers. Make models of the tumours and of the rats that are destroying the country.
> These are the gold tumours the Philistines sent as a guilt offering to the Lord – [...] And the number of the gold rats was according to the number of Philistine towns belonging to the five rulers – the fortified towns with their country villages.

Translation of the term "tumours" with buboes in this non-medical text should be unproblematic. In the translation of the *Septuagint* produced several centuries BCE it is stated quite clearly that the (usual) location was in the groin[44] (the origin of this comment is apparently not known).

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41 *The Septuagint* is the Koiné Greek translation of the Hebrew *Bible* (OT), the earliest extant version produced in Alexandria between the 3rd and 2nd century BCE. See also Benedictow, *The Black Death*, pp. 35–37.

42 http://www.BibleGateway.com was searched for modern Anglophone Bible texts, which led to a footnoted "New International Version" of 2010, and a translation of *the Septuagint* on http://www.ecmarsh.com/lxx/.

43 A comment on this text in the *New King James Version* states: "Probably bubonic plague".

44 Because of the sensitive sexual connotations, the verbatim translation of the *Septuagint* is that the Lord "smote them in their secret parts". For an improbable interpretation as bacillary dysentery, see Benedictow, *The Black Death*, pp. 36–37.

Skeletal remains of black rats dating from the Neolithic Period 2000–3000 BCE have been found in this region, which attests to their presence and the realism of this point.[45] The account of swarms of rats in the Philistines' land without mentioning of rat falls or disease among them is problematic. The point is that rats are cannibals. When they become seriously ill and cannot defend themselves, they desperately try to hide away in order to avoid being eaten more or less alive by their fellow rats. Quite generally, rats die out of sight and in quite inaccessible places. Dead rats are therefore rarely observed under plague epidemics, excepting a few sporadic cases and more conspicuously if they tend to nest in the roofs and fall down on the floors when the sudden onset of grave illness causes loss of balance (as I have shown at some length in my last monograph).[46] The latter phenomenon is presumably the background of the reference to rats but indicates that the Biblical account over time has become interspersed with dramatizing literary elements (as should be expected). The events and the combined references to gold buboes and gold rats are concrete and credible: bubonic plague is the only epidemic disease clinically characterized by buboes, the femoral-inguinal region is by far the most common anatomical location, and the disease is rat-borne. This takes (probably) the history of bubonic plague in the Middle East back to the 1050s BCE or 3060s BP, which should be compared with the dating by biomolecular clocking of the East Asian or Chinese strains or biovars of *Y. pestis* to >2600 BP. One must emphasize stronger than Morelli et al. the great uncertainty implied by the upper range of their dating. However, there is also a neglected alternative (see below).

## The Territorial Origin of the First Pandemic

Contemporaries provide information on the origin of the first (known) pandemic of bubonic plague, the Justinianic, which broke out in 541 CE. There is general agreement that the plague was shipped out of the Egyptian port city of Pelusium (on the eastern outskirts of the Nile Delta) to Constantinople whence it was distributed by ship to commercial hubs along the Mediterranean littoral. Some chroniclers inform that it originated in Ethiopia. Evagrius of Antioch asserts that it came from the Kingdom of Axum, the regional commercial hub and marine trading power.[47] From trading stations on the Red Sea cargo from India was transported to the end of the Red Sea or by caravans over land to the Nile whence the goods were moved to Alexandria or possibly Pelusium and shipped to Mediterranean ports.

45 Frederick Simon Bodenheimer, *Animal Life in Palestine* (Jerusalem: L. Mayer, 1935), p. 96; same, *Animal and Man in Bible Lands* (Leiden: E. J. Brill, 1960), pp. 20–21, 110, 128, 177, 179; Benedictow, *The Black Death*, pp. 36–38.

46 Benedictow, *What Disease was Plague?*, pp. 91–97.

47 Evagrius (author) J. Bidez and L. Parmentier (eds.), *The Ecclesiastical History of Evagrius with the Scholia* (London: Methuen, 1898; reprints Amsterdam 1964, New York 1979), p. 177.

Axum could not be the original source of the plague contagion which reached Pelusium, only the commercial epicentre of inadvertent transportation of the pathogen. Axum was about as far south in East Africa that many Romans and also Evagrius had useful knowledge. In a medical compendium produced by Ali ibn Rabban, the Arab physician, in 850 CE, the origin of plague epidemics is located to Sudan. In the thirteenth century, Ibn Nafis, the Arab physician, described plague buboes and reported that plague often occurred in "Ethiopia".[48]

This evidence points to several small plague foci of long standing south of Ethiopia, in areas of present-day Uganda, The Democratic Republic of Congo, Kenya and Tanzania where plague cases still occur endemically. Presumably, some of the outbreaks of plague reported and described in Antiquity originated there and gave rise to the more transitory plague foci in North Africa reflected in the plague cases described in Hippocratic and Alexandrine medical writings.[49] The Axumites were exposed to importation of *Y. pestis* because they had "close economic contacts with the inhabitants of inner Africa, thus providing an effective transport line for the disease".[50] In the first century CE, one of the sea lanes linked with the India trade led down the East African coast which the Romans then called "Azania" and at least to the port called "Rhapta". Raphta was apparently located in R. Rufiji's delta in present-day Tanzania which also exposed the Romans and Axumites to importation of *Y. pestis* from the cluster of small plague foci in East and Central Africa.[51] Apparently, the Justinianic pandemic originated there. Sarris points out that this geopolitical context of the early sixth century was arguably the crucial condition for the transportation of plague from Africa to Byzantium.[52] Taken together, historians' usual view that the first pandemic originated in East or Central Africa is based on significant but not conclusive evidence.

In 525 CE, Axumite forces invaded Himyarite Yemen in southwestern Arabia and established Axumite rule for most of the century.[53] This event exposed Axum to the mentioned plague focus of long standing in western Arabia stretching roughly 1000 km from northern Yemen via Jiddah and Al Madinah (Medina) to somewhere around Yanbu.[54] This event has

48 Michael W. Dols, *The Black Death in the Middle East* (Princeton: Princeton University Press, 1977), p. 15.

49 These plague foci were unstable, plague epidemics disappeared apparently from North Africa and the Middle East for centuries, for instance, before the Justinianic pandemic began in 541, and between 1057 and 1348.

50 Peter Sarris, "Bubonic Plague in Byzantium. The Evidence of Non-Literary Sources", in Lester K. Little (ed.), *Plague and the End of Antiquity. The Pandemic of 541–750* (Cambridge: Cambridge University Press, 2007), pp. 119–132, esp. p. 123.

51 Felix A. Chami, "The Egypto-Graeco-Romans and Panchea/Azania: Sailing in the Erythraean Sea", in P. Linden and A. Porter (eds.), *Trade and Travel in the Red Sea Region* (London: Society for Arabian Studies, 2004), pp. 93–104. See also above n. 29.

52 Sarris, "Bubonic Plague in Byzantium", p. 123.

53 John Donolly Fage, *A History of Africa* (London: Unwin Hyman, 1988), pp. 53–54.

54 Pollitzer, *Plague*, p. 29. See also Map 2 in Benedictow, *The Black Death*, p. 46.

an interesting chronological relationship with the start of the first pandemic. It has been suggested on later evidence that the pandemic may have started in western Arabia. There is an account of an outbreak of plague in Yemen in 1157 CE that spread to Egypt.[55] This indicates that the Justinianic plague pandemic could have originated there, was transported by ship via a port on the coast of Axum or directly to the end of the Red Sea where it was (inadvertently) reloaded on camels and conveyed the short distance to Pelusium. Alternatively, it could conceivably have crossed the Red Sea by boat at its narrow southern end to present-day Djibouti and been transported by a caravan via Axum and Sudan to Egypt.[56] The plague epidemics mentioned in classical writings and the first pandemic could have originated in contagion from the plague foci in the East and Central Africa or possibly the plague focus on the western coast of the Arabian Peninsula. These perspectives are interesting for the further discussion of the Chinese or East Asian origin of plague.

## The Territorial Origin of the Black Death and the Second Pandemic

Unsupported by evidence, French paleobiologists recently maintained that the Black Death spread to Europe from India.[57] McNeill, arguing differently, has chosen an epidemic in China in 1331 as the point of departure for the Black Death's spread to West Asia. However, since this source gives no epidemiological or clinical evidence, it is based on a preconceived notion that the Black Death *must* have originated in China.[58]

In the discussion about the possible origin of plague, various papers by Daniil A. Khvol'sen [Chwolsen],[59] the Russian orientalist, have led to confusion. From 1886, he published studies of inscriptions on headstones from the years 1186–1349 in two large Nestorian cemeteries in Issyk-kul (near Chinas western border). The confusion arose when Pollitzer in his standard work on plague referred uncritically to comments in a secondary source relating that these graveyards contained headstones from the years 1338–1339 with

55 Dols, *The Black Death in the Middle East*, p. 33.

56 See also Sticker, *Die Pest*, pp. 24–35.

57 Gerard Aboudharam, Michel Signoli, Eric Crubézy et al., "La mémoire des dents: le cas de la peste", in M. Signoli, Dominique Chevé, Pascal Adalian et al. (eds.), *Peste: entre épidémie et sociétés/Plague: Epidemics and Societies* (Florence: Firenze University Press, 2007), pp. 207–215, esp. p 211. See the discussion of this topic in Benedictow, *What Disease was Plague?*, pp. 42–43; John Norris, "East or West? The Geographic Origin of the Black Death", *Bulletin of the History of Medicine* 51 (1977), pp. 1–24, esp. pp. 6–7.

58 William H. McNeill, *Plagues and Peoples* (Harmondsworth: Penguin Books, 1979), pp. 152–155, 272.

59 The name is transcribed erroneously probably in order to produce an amateurish adaptation to German pronunciation: it should be transcribed *Khvol'sen* (where *l'* represents the phonetic transcription of palatalized *l*, and *Kh* the Cyrillic letter *X* (pronounced *j*, as in Spanish *Juan*). There is no phonetic equivalent to *w* in Russian or the Cyrillic alphabet.

exceptionally high numbers of inscriptions stating that these persons had died of "plague".[60] Pollitzer and other scholars have taken this as prima-facie evidence of a bubonic epidemic and inferred that it must have been the Black Death on its westwards march from China.[61] Long ago, Norrris pointed out that this is erroneous. The gist of the matter is that 330 headstones contained the names of more than 650 persons who had been interred in the period 1186–1349. Among them 106 are specifically said to have died in the years 1338–1339 and, according to Khvol'sen, it is stated that about ten of them had died of "plague". However, the word Khvol'sen translated with "plague" has only the generic meaning of "pestilence", i.e. an "epidemic".[62] This means that there is no specific or concrete historical information indicating an outbreak of bubonic plague in the Far East for hundreds of years before or after the Black Death. In sum, the theory of a Chinese origin of the Black Death is unsubstantiated by historical data and has resumed the status of a speculative hypothesis. It lives, nonetheless, its own life released from the normal requirements of specific evidence.[63]

Usually, scholars approach the problem of territorial origin on the basis of the principle of proximate origin, because the shorter the distance to be covered, the fewer obstacles to dissemination. However, a Chinese or eastern central Asian origin of the Black Death is unlikely for a different but decisive reason. In the aftermath of the Mongol conquests, the caravan routes from China to West Asia and the Crimea had been re-established as important trade links in the 1250s. The Kipchak Khanate of the Golden Horde, the Mongols who had crushed the Kievan Russian state and ruled over the vast steppes of southern Russia, now played a constructive role. In 1266, the Mongol leaders of the Golden Horde ceded land to the Genoese at Kaffa in the Crimea, and later to both the Genoese and the Venetian merchants in Tana, the present city of Azov, with permission to set up a consulate, build warehouses and establish trading stations. The Italians soon fortified the towns to make goods and profits more secure. This is the political background of the flourishing trade between China and Europe in the second half of the thirteenth century, the significant window in time associated with Marco Polo.[64]

60 John Stewart and Samuel M. Zwemer, *The Nestorian Missionary Enterprise: The Story of a Church on Fire* (Madras: The Christian Literature Society for India, for T.T. & Clark, Edinburgh, 1928), p. 209; Pollitzer, *Plague*, p. 14.

61 See, for instance, McNeill, *Plagues and Peoples*, p. 155; Michel Drancourt and Didier Raoult, "Molecular Insights into the History of Plague", *Microbes and Infection* 4 (2002), pp. 105–109, esp. p. 105; Michel Drancourt and Didier Raoult, "Past Plague", in Raoult and Drancourt (eds.), *Paleomicrobiology. Past Human Infections* (Berlin etc.: Springer-Verlag, 2008), pp. 145–159, esp. 152.

62 Norris, "East or West?", p. 10, with specific references to Kvol'sen's works in n. 38.

63 Little, "Plague Historians in Lab Coats", p. 271. See, however, recently Joseph P. Byrne, *The Encyclopedia of the Black Death* (Santa Barbara, California: ABC-CLIO), pp. 48–49.

64 Dols, *The Black Death in the Middle East*, pp. 48–52.

However, the political and religious developments within the Mongol Empire in the decades preceding the Black Death had strong disruptive effects on trade and travel. There was a comprehensive conversion to Islam and the empire broke up into a number of often feuding Muslim states. This process inspired a new religious fervour and fulminating anti-Christian attitudes. The presence of heathen Christian merchants in their territories was considered increasingly intolerable and trade with Christians was prohibited. In 1313, the Kipchak Khanate officially converted to Islam, which unleashed a process of conversion among the local Tartar populations supporting the Mongols. Eventually, in 1343, Janibeg, the then Kipchak Khan, took military action in order to throw the Italians out of their trading stations in Tana and Kaffa and definitely end the trade with Christians in the lands of the Golden Horde. At the same time, he severed the trade link between China and Europe along the caravan routes.[65] The Italians were driven out of Tana in 1343, and were besieged in Kaffa in the same year, and again in the years 1345–1347.

It was indeed in 1346 that plague broke out in the Mongol army and was in some manner passed on to the besieged Italians.[66] It seems improbable that plague could have been passed on by trade and travel from China to the Italians in the Crimea under these circumstances. No merchants in their senses would risk precious goods and expensive and dangerous transportation over thousands of kilometres to the Christian Italian merchants across Muslim states which were intensely hostile to contact with Christians. At the time of the initial outbreak of the Black Death, the ruler had gone to war to drive away the Christian merchants, the towns of destination at this end of the Silk Roads were under siege and eventually defeated. This explains why the Black Death did not spread from southern Russia northwestbound into eastern Russia and in a westernly direction towards Europe. Instead, conspicuously the Black Death had to move all the long way around western Europe into the Baltic Sea and spread eastwards from the eastern Baltic coasts across Russia to the border with the Golden Horde.[67]

According to the principle of proximate origin, the plague focus closest to the area whence the Black Death was shipped to Europe, i.e. Kaffa in the Crimea, should be considered the most likely area of origin.[68] Importantly, Russian chroniclers state in no uncertain terms that, in 1346, plague broke out in the areas containing the plague focus stretching from

65 See, for example, Norris, "East or West?", p. 13.

66 Ibid., pp. 13–15; John Norris, "Response", *Bulletin of the History of Medicine* 52 (1978), pp. 114–120. It was certainly not disseminated into the beleaguered town by catapulting the bodies of those who had died of plague. Benedictow, *The Black Death*, pp. 51–53.

67 Benedictow, *The Black Death*, map pp. xviii–xix, and Benedictow, *What Disease was Plague?*, p. 2.

68 V. N. Fyodorov [often wrongly transcribed "Fedorov"], "The Question of the Existence of Natural Foci of Plague in Europe in the Past Past", *Journal of Hygiene, Epidemiology, Microbiology and Immunology*, 4 (1960), pp. 135–141.

the northwestern shores of the Caspian Sea into southern Russia in the direction of the Crimea. The most informative chronicle gives this account:

> In the same year [1346], God's punishment struck the people in the eastern lands, in the town Ornach [on the estuary of the R. Don], and in Khastorokan, and in Sarai, and in Bezdezh [at an arm of the R. Volga], and in other towns in those lands; the mortality was great among the Bessermens, and among the Tartars, and among the Armenians and the Abkhazians, and among the Jews, and among the European foreigners, and among the Circassians, and among all who lived there, so that they could not bury them [sic].[69]

The detailed information provided by this chronicler is credible and compatible with other information on the Black Death in this region and constitutes a meaningful history of origin in a known plague focus. It provides a geographical outline which contains a logical progression of spread from the territory of this plague focus southwards into the Caucasus and westwards into the Crimea. This comprehensive spread presupposes an outbreak in the spring of 1346 or in the early summer at the latest. Along the western route, the Black Death reached the Crimea and the Mongol-led Tartar army which beleaguered the Italians in Kaffa. Along the southern route, it ravaged the lands of the Circassians, the Abkhazians, and the Armenians along the eastern shores of the Black Sea and across the Caucasian region whence it could spread further into Asia Minor, the Middle East and Persia [Iran]. Obviously, the author had good informants. Spread along the caravan routes is not mentioned. The outbreak is clearly associated with the area of the plague focus that stretches from the northern and northwestern shores of the Caspian Sea into southern Russia. Several scholars have formerly suspected and suggested that the Black Death originated in this area, but did not know the Russian sources which supported this view.[70]

Other contemporary sources also state that the Black Death originated in this area. Nikephoros Gregoras, the Greek historian who lived in Constantinople and witnessed the ravages of the Black Death there in 1347, wrote that in the spring of 1346 plague came from "Scythia and Maeotis and the mouth of the Tanais [R. Don]". Scythia is the ancient, classical name of the area that was ruled by the Golden Horde. Spring is a likely season for the start of a plague epizootic among rodents that could translate into an epidemic among human populations and is also implied by the Russian chronicler. Also the Byzantine Emperor John (Ioannes)

69 Konstantin Georgevich Vasil'yev and Aleksandr Yevseyevich Segal, *Istoriya epidemiy v Rossii* [History of Epidemics in Russia] (Moscow: Gosudarstvennoye izdatel'stvo meditsinskoy literatury, 1960), p. 28. My translation from Russian. The Bessermens are a small people living in northeastern Russia and do not fit into the pattern. The author may possibly have garbled the name of the people of Bezdezh.

70 See, for example, Frank Macfarlane Burnet and David Ogilvie White, *Natural History of Infectious Disease* (4th ed. Cambridge: Cambridge University Press, 1972), p. 226; Norris, "East or West?", and Norris, "Response".

VI Cantacuzenos who abdicated in 1355 in order to write a history of the Byzantine Empire maintained that the Black Death started in Scythia (among the "Hyperborean Scythians").[71]

The Arab writer Ibn al-Wardi gathered information on the early phase of the Black Death from Muslim merchants returning to Syria from the Crimea. First, he makes the rather mythical statement that the plague started in the "Land of Darkness" and that it had been raging there for fifteen years before it moved on. However, he also learned that the epidemic raged in October–November 1346 in the land of the Uzbeks, a contemporary name for the territory of the Golden Horde. It had emptied the villages and towns of their inhabitants and spread to the Crimea and Byzantium.[72] His information agrees completely with an origin in the land of the Golden Horde, i.e. in southern Russia, which contains the local plague focus stretching towards the Crimea. The time perspective of the epidemic events in his account indicates that the outbreak around Kaffa occurred in the autumn of 1346. This rough outline of the movement of the Black Death in time and space accords well with the sparse information on what happened next.

The most detailed and dramatic account is related by Gabriele de Mussis of Piacenza (in northern Italy). Like Ibn al-Wardi, he did not witness these events himself but gathered together information from returning merchants. Also according to de Mussis, the Black Death started in 1346 in the lands of the Golden Horde ("among the tribes of Tartars and Saracens") and subsequently attacked the Mongol army which besieged Kaffa.[73]

## Was Plague Spread to East Africa by the Maritime Expeditions of Zheng He?[74]

Morelli et al. underline the "extensive spread of *Y. pestis* of the 1.ANT[iqua]1 to 1.ANT3 populations that have only been isolated from east and central Africa".[75] Rather problematically, as mentioned, they go on to state that the "estimated age of 1.ANT1 (628–6,914 years ago), slightly predates the seven maritime expeditions led from China by Zheng He between 1405 and 1433".[76] They continue rather speculatively with an inference purportedly at a high level of tenability implying solid underpinning by evidence that "it seems highly likely that these ships were infested by rats, which could have transmitted *Y. pestis* from China to

71 Christos S. Bartsocas, "Two Fourteenth-century Descriptions of the 'Black Death'", *Journal of the History of Medicine and Allied Sciences* 21 (1966), pp. 394–400, esp. pp. 395–396, 398.

72 Dols, *The Black Death in the Middle East*, pp. 41, 51–52.

73 Benedictow, *The Black Death*, pp. 48–67.

74 I would like to thank Mathieu Torck for his kind and valuable comments on an earlier version of my discussion of Zheng He's maritime expeditions.

75 Above: p. 3.

76 Jan Julius Lodewijk Duyvendak, "The True Dates of the Chinese Maritime Expeditions of the Early Fifteenth Century," *T'oung Pao* 34 (1938), pp. 341–412, esp. pp. 342–344.

Africa" (see above). This Chinese origin of plague in East Africa is unconditionally referred to in "Table 1: Routes of plague transmission". Evidently, such views require examination of the facts.

One should note the substantial problems associated with the written sources on these hugely impressive maritime expeditions, some of which sailed around 12,000 km. The archives were deliberately burned, the expeditions were almost forgotten by the Chinese themselves, and "they are known to us only in a most fragmentary way".[77] Much impressive and painstaking scholarly work has been invested in reconstructing a rough outline of their history from diverse and often younger sources involving much uncertainty and (chains of) hypothetical elements based on scholarly goodwill. Only slowly has a more critical attitude emerged uncovering some important problems.

The point of departure here is that, according to Levathes' monograph which is Morelli et al(iorum) source of information, some of the expeditions reached the coasts of East Africa.[78] This is confirmed by several scholarly studies: squadrons detached from the main fleet of the last three expeditions, 1417–1419, 1421–1422, 1431–1433, crossed from Aden over to East Africa. The first time they sailed down the coast at least to Malindi bay on the littoral of present-day Kenya (about 120 km northeast of present-day Mombasa), next time to Moghadishu and Barawa (Brava) on the coast of present-day Somalia, the third time again to Mogadishu and Malindi.[79] This means that these ships at least twice moved to the coasts of the East African and Central African plague foci (see above). However, it is overlooked that those voyages took place 1700 years after the first certain medical description of a plague epidemic in North Africa and the Middle East or 2300 BP. The first voyage occurred 868 years after the first (known) pandemic of bubonic plague in the West had its first great outbreak. Here one may also recall: Contemporaries maintained that bubonic plague originated in Africa, in the Kingdom of Axum situated in present-day Ethiopia and Eritrea. Since there is not a plague focus within the area of Axum, plague was presumably conveyed via this important maritime hub. As already mentioned, the Axumites had lively trade relations with the

77 Jan Julius Lodewijk Duyvendak, "The True Dates of the Chinese Maritime Expeditions", *T'oung Pao,* 34 (1938), pp. 395–396; John Vivian Gottlieb Mills, *Ma Huan, Ying-yai Sheng-lan: The Overall Survey of the Oceans's Shores* (Cambridge: Cambridge University Press, 1970), pp. 8, 247; Mathieu Torck, *Avoiding the Dire Straits: An Inquiry into Food Provisions and Scurvy in the Maritime and Military History of Chinad and Wider East Asia* (Wiesbaden: Harrassowitz, 2009), p. 156; Sally K. Church, "Zheng He: An Investigation into the Plausibility of 450-ft Treasure Ships", *Monuments Serica* 53 (2005), pp. 1–43, esp. p. 5. Also see Church's "The Colossal Ships of Zheng He: Image or Reality?", in Claudine Salmon and Roderich Ptak (eds.), *Zheng He: Images & Perceptions. Bilder & Wahrnehmungen* (Wiesbaden: Harrassowitz Verlag 2005), pp. 155–176.

78 Levathes, *When China Ruled the Seas*, pp. 19–21, 149–151, 171.

79 Jan Julius Lodewijk Duyvendak, *China's Discovery of Africa* (London: A. Probsthain, 1949); Mills, *Ma Huan,* pp. 13–14, 16 (map showing the itinerary of Zheng He's seventh fleet 1431–1433), pp. 20, 241.

interior of Africa – with links to the area of the present plague foci in East and Central Africa. They had also conquered Himyarite Yemen in southwestern Arabia in 525 CE, which exposed Axum to importation of plague from the old plague focus in western Arabia (see above). Furthermore, Axum traded actively with Egypt by caravans and ships; evidently, contaminated goods distributed via Axum could have reached Pelusium. This information on the origin of the first pandemic is therefore credible. That Morelli et al. link Zheng He's naval expeditions with the origin of these plague foci is obviously an anachronism.

However, the early Ming voyages deserve some consideration in relation to the role of ships in the possible long-distance dissemination of epidemic disease. The numbers of ships and crew, the distance sailed, opportunities for acquiring adequate provisions of food and water, rest and recuperation, and the isolation and care of diseased members – all these are important variables.

Referring to Levathes' monograph, Morelli et al. maintain unreservedly that "these voyages involved up to 300 ships, some of which were up to ten times larger than those of contemporary European explorers and carried ~28,000 crewmen [n. 16[80]]". The information on the number of ships and number of men appears to be broadly accepted by some leading scholars in this field of research who take the numerical information in Chinese sources on these matters with goodwill.[81] Medievalists knowledgeable of maritime history will point out that the comparison with contemporary European ships is untenable. The numbers imply that the crews on Zheng He's ships (including military personnel) numbered on average at least 93 men (but could have been considerably higher, see below). However, even the earliest specification of a European galley of 1275 CE refers to 108 oars(men). The size of galleys increased in the subsequent period. "Fleets of 14 Florentine great galleys", which put to sea in the summer at the time of Zheng He's voyages could be powered by 150 oarsmen each and have a total crew of over 200, around 3000 men in all.[82] From the thirteenth century, the Genoese and Venetian merchants "sailed" with these galleys to all parts of the Mediterranean and into the Black Sea all the way to Kaffa on the Crimea and Tana (present-day Azov) at the end of the Sea of Azov. From the 1270s at the latest, they "sailed" out of the Mediterra-

80 See above p. 3 and n. 7–8 with the references to Levathes, *When China Ruled the Seas*, pp. 19–21, 80, 82–83.

81 See, for instance, Mills, *Ma Huan*, pp. 27–32; Church, "Zheng He: An Investigation", pp. 22–23; Torck, *Avoiding the Dire Straits*, pp. 142–143, 153–166. More impressive views on the size of the ships and their "populations" can be found in many works. For an early reference, see Jan Julius Lodewijk Duyvendak, *Ma Huan Re-examined*, Verhandelingen der Koninklikje Akademie van Wetenscappen, Section of "Letterkunde", New Series, Part 32, No. 3 (Amsterdam: Noord-Hollandsche Uitgeversmaatschappi, 133), esp. p. 3.

82 Norman John Greville Pounds, *An Economic History of Medieval Europe* (London: Longman Group LTD, 1974), pp. 370–372; Michael E. Mallett, *The Florentine Galleys in the Fifteenth Century* (Oxford: Oxford University Press, 1967), pp. 17–20.

nean to London and Bruges.[83] The Arab chronicler Al-Maqrzi relates that the Black Death arrived in Alexandria in a galley which had put to sea from a Black Sea port with 32 merchants, and 300 men, slaves and crew on board.[84]

Like many scholars in this field of research Levathes starts by stating almost triumphantly that, according to Chinese sources, Zheng He's ships were around 140 m long. However, eventually 60 pages later she makes a rare but important source-critical admission with respect to size: "A wooden sailing ship of this length would be very difficult to manoeuvre, if indeed it were seaworthy, which seems doubtful."[85] This problem has long been known in the historiography of European shipbuilding. It is the reason the size of European sailing ships stabilized in the seventeenth and eighteenth century and ships did not exceed this limit until the1860s when hulls could be made of iron.[86] This makes the consonant assertions in the extant Chinese sources on the extreme size of these ships rather intriguing. It may seem quite incomprehensible or inconceivable rather that such giant and hardly manoeuvrable vessels should have put to sea seven times for exceptionally challenging two-year long expeditions and even have returned without significant losses. Evidently, the factual assertions on this matter should be related to with the full array of source-critical tools of the "Historian's Craft".

It took a Chinese professor of shipbuilding engineering to demonstrate that the information on the purported size of these ships was untenable and argue that the possible length should be reduced from 450 ft to 200–250 ft.[87] This seems now broadly accepted, but the underlying consideration could seem to be that this is the maximum size of a reasonably manoeuvrable wooden sail ship rather than solid evidence on the actual size of Zheng He's ships.[88] This proves that central Chinese sources on the expeditions are unreliable and given to gross exaggerations much like medieval chroniclers. Each piece of numerical information should only be accepted on the basis of reasonably tenable evidence and related to the concept of level of tenability. It is well known that the Chinese regime had at its disposal several hundred ships and that new ships were built for Zheng He's expeditions. However, there was also an urgent need for defence of the Chinese coasts, not least against pirates (especially Japanese). Presumably, not even the majority of these ships could be put at the disposal of

83 Pounds, *Economic History of Medieval Europe*, pp. 360–368; Robert.S. Lopez, *The Commercial Revolution of the Middle Ages, 950–1350* (Cambridge: Cambridge University Press, 1971; rpt. 1976), p. 109; Ferdinand Braudel, *The Mediterranean in the Age of Philip II*, Vol 1. (New York: Harper & Row, 1975), p. 302.

84 Dols, Economic History of Medieval Europe, p. 60.

85 Levathes, *When China Ruled the Seas*, p. 80.

86 Carlo M. Cipolla, *Before the Industrial Revolution. European Society and Economy, 1000–1700* (London: Methuen & Co., 1976), pp. 164–165.

87 Church, "Zheng He: An Investigation", pp. 1–2.

88 Ibid., p. 38.

Zheng He.[89] The number of ships of the fleets is said to have varied between 48 and 250. One of the better sources states that the fleet of the seventh expedition comprised over 100 ships. Sally Church's source-critical comment that it should rather be taken to mean "a large number", or perhaps of that order seems sensible. However, one may not agree that the concrete figure of 160 men on board a ship "is only slightly smaller than the 200–300 mentioned by Gong Zhen".[90] These considerations are suggestive of reductions of much the same order as with respect to the size of the ships. As now can be seen, the number of men participating in Zheng He's expeditions could have been considerably smaller than 28,000 and still be, of course, highly impressive. However, as Church states: "Despite the controversy surrounding the size of the ships, there does not seem to be much argument against the figure of 62 treasure ships or the figures of 27,000–28,000 people on them", i.e. an average of 435–450 men per ship; also an average of 500 men is positively related to.[91] This means that the size of the ships is halved to a hypothetical maximum for navigable wooden ships but the number of men on them remains unchanged. The structure of population density on board is sharply increased and the interpersonal space is correspondingly sharply reduced without leading to any consideration of conditions for the spread of epidemic diseases. If we rather take into account that the fleet also consisted of 38 smaller ships which may have had an average of 160 men on board, i.e., c. 6000 men, and the remaining 21,000–22,000 men were distributed on the 62 treasure-ships, they would on average carry 350 men, which still means that they would be very crowded.

Against this backcloth, one should also expect that negative information which would undermine the glorious objectives of the accounts would be omitted. The accounts of Zheng He's expeditions comprise, for instance, several years of exceptionally challenging and audacious sailing including long stretches of blue water sailing. According to these accounts, Zheng He's men were never surprised by storms and never lost a ship; there is only one case history of a single ship battered by a storm (as it seems) that succeeded in making it to safety, a happy ending suitable for being related by these sources.[92] The fate of the two armadas assembled by the Mongols for invasion of Japan (in 1274 and 1281), said to be destroyed by typhoons each time,[93] or the fate of the Spanish Armada, demonstrate that this is a hypothesis that stretches the bounds of our credulity. Also the case history of the ship with 160 men on board which was attacked by 4000 pirates but after "a series of twenty skirmishes" succeeded in returning to port intact,[94] shows that incredible stories with a happy ending can be

89 See, for instance, Torck, *Avoiding the Dire Straits*, pp. 108, 137–144, 154, 172–173.
90 Ibid., pp. 13–17, 22–23. Gong Zhen's report is among the first hand accounts on Zheng He's voyages.
91 Ibid., pp. 14–16 and n. 55.
92 Ibid., p. 14.
93 Ibid., pp. 142–143.

told. Evidently, the total absence of unhappy endings and the paucity of critical episodes or events are incredible parts of these accounts.

In those times there were no weather forecasts. Although many ships such as the ones built by the Vikings were suitable for long-distance navigation across open spaces, most vessels sailed along the coast. In the abscence of lighthouses, these ships would put up for the night at suitable places and wait for daylight. This greatly extended the time of voyages and also exposed the crew to pirates and military predatory action by local powers. Therefore European merchant ships opted to sail in convoys. More importantly, the great commercial powers of Genoa and Venice established numerous trading stations or colonial outposts along coastal sea lanes. In such locations, various organizations were continually in full swing preparing for the ships' arrival and worked hard to acquire facilities for recuperation, reserves of oarsmen, crewmen, and soldiers, stores of food from the surrounding areas where producers had adapted to this kind of demand and related business opportunities. Simply put, convoys could easily take refuge in such trade stations to avoid inclement weather or epidemic disease, to find rest and recuperate in safe circumstances, regularly and predictably take aboard fresh water and food, and supplement or substitute incapacitated or deceased crew members or soldiers. Their voyages were generally predictable, well organized and enjoyed logistic support.[95]

If the Chinese sources are taken literally, Zheng He's maritime expeditions would be on their own over enormous distances and very long periods. Only at Malacca (Melaka), so it seems, had the Chinese a "colonial" outpost and trading station comparable to the trading stations the Italian commercial powers established for their galleys along the sea lanes of the Black Sea and the Mediterranean.[96] Since the Chinese expeditions were not regular annual events, it is hard to see how the fleets' needs could be adequately met even there. Although the sources contain references to grain ships and water ships as ordinary parts of the fleets, "strikingly, the sources make virtually no mention of the mechanics of the provisioning during the expeditions". It may seem an understatement that "not every harbour in the Indian Ocean in the early fifteenth century would have been capable of supplying sufficient victuals for tens of thousands of sailors".[97]

94 Church, "Zheng He: An Investigation", p. 14.

95 Benedictow, *What Disease was Plague?*, pp. 587–588; Pounds, *Economic History of Medieval Europe*, pp. 363–368, Fig. 8.3 (= Map) p. 360; Eugene H. Byrne, *Genoese Shipping in the Twelfth and Thirteenth Centuries* (Cambridge, MA: The Mediaeval Academy of America, 1930; New York: Kraus Reprint Co. 1970), pp. 36–37, 44, 52.

96 Torck, *Avoiding the Dire Straits*, pp. 157–158, 161.

97 Ibid., pp. 157, 161. For a somewhat different approach with regard to Malacca, see Roderich Ptak, "Reconsidering Melaka and Central Guangdong: Portugal's and Fujian's Impact on Southeast Asian Trade (Early Sixteenth Century)", in Peter Borschberg (ed.), *Iberians in the Singapore-Melaka Area and Adjacent Regions (16th to 18th Century)* (Wiesbaden and Lisbon: Harrassowitz Verlag and Fundação Oriente, 2004), pp. 1–21, esp. pp. 3–5.

The problems are put in perspective if it is added that the fleets arrived unexpectedly without time for extensive preparations and establishment of new local food production and supply lines. Such investments would also be rather unmotivated since they would not be needed and highly unprofitable for several years on end. If the fleets had not arrived unexpectedly but with advance notice, would that not have provided the opportunity for hostile military preparations that would put the fleets in harm's way? So far no attempt has been made in European language works at estimating the amount of grain and fresh water required for such a huge number of men over a long period of time, or the number of supply vessels and the communication system needed to service individual ships of the main force. It appears rather impossible that a fleet carrying 28,000 men over a distance of 12,000 km could be adequately supported with food and fresh water without a system of politically secure trading stations comparable to the ones established by the Italians along the sea lanes of the Black Sea and the Mediterranean. Their supplies would include Mediterranean vegetables and fruits – and thereby minimize the problems of scurvy and malnutrition as well as reduced resistance to epidemic diseases, which the Chinese expeditions would have to face.[98]

One important difference could be that the Italian fleets were highly profitable commercial enterprises which operated with annual regularity and predictability, while Zheng He's voyages were costly "shows" of imperial power designed to nominally subdue distant ports and polities. Perhaps this may also explain the irregularity and unpredictability of the Ming expeditions, as well as their abrupt end. Liu Daxia, who was the Minister of War under the Chenghua emperor (1465–1487), made no bones about it: the maritime voyages were too costly in comparison with the profits they generated and "there had been too many casualties"; whether these "resulted from shipwrecks or disease", or from both, is not told. Be that as it may, Liu Daxia was so dead set against any resumption of these voyages that he ordered all relevant records burnt, hoping they would descend into oblivion.[99] This casts doubts on the extant accounts with no casualties, outbreaks of epidemics, shipwrecks or disastrous storms.

In the present context, the fact that Ming works on several extremely long voyages by huge maritime fleets do not mention epidemic disease on board ships crammed with crewmembers, oarsmen, and soldiers certainly stretches the bounds of scholarly credulity.[100] This indicates that the relevant accounts do not mirror reality in this respect. One should note that a mortality rate of around 20–25 per cent was usual on slave ships from Africa to America before 1700.[101] Contrary to frequent misconceptions the merchants had maximum in-

98 Ibid.

99 Ibid., pp. 16, 166–167,

100 There is a reference to sick soldiers on board Zheng He's ships in a late Ming novel (preface 1597), but this is a fictitious source and not a historical book. See Luo Maodeng, *Sanbao taijian Xiyang ji* (Beijing: Huaxia chubanshe, 1995), chapter 19.

101 Fage, *History of Africa*, p. 255.

centives for preventing mortality among the slaves, since they had been purchased from local African slave traders and all deaths underway were economic losses and counterproductive to the commercial purpose. The conditions for the slaves under transportation were therefore usually quite good for those times. For the same reason, the mortality among crew members tended to be higher than among the slaves.[102] Their death would avoid payment of wages and tend to be profitable for the slave merchants.

Predictably, studies of the slave trade have shown that the larger the ships and the higher the number of persons on board the ships, the higher the probability that epidemic disease would break out, since it increased the probability that at least one of those entering the ships would be incubating a serious epidemic infection. This was recognized by the slave trading companies.[103] Although Chinese sources are not much interested in epidemic diseases unless they were very serious and widespread, one should note that such epidemics are mentioned for different contexts in 1404, 1407, 1408, 1410, 1411, 1413, and 1414;[104] the usual array of other epidemic diseases spreading almost continuously among the general population was a matter of course not worthy of comments. This shows that the claim that Zheng He's ships were much bigger than European ships at the time should be taken to strengthen the case for regular outbreaks of epidemic disease among the 435–500 persons assumed to be on board (also if the number was 350–400). Quite likely there would also be the concomitant spread of two or more such diseases, which would have a potentiating effect on mortality, pushing death rates substantially beyond the levels caused by individual diseases. When the maximum size of the ships is about halved, with the number of people on board remaining the same, this would similarly have a potentiating effect on mortality rates.

Voyages from China to East Africa were roughly four times longer than from Africa to the West Indies or from Europe to America. If the return voyage is added, Zheng He's ships would sail roughly eight times longer than America-bound ships from the Old World. This implies much higher mortality rates, arguably again affected by the potentiating effects of repeated individual case histories of disease. *Ceteris paribus*, one should expect on epidemic grounds alone that hardly more than half of the participants saw China again. Mortality caused by shipwrecks and storms, hostile attacks and great difficulties in providing enough food for the men is then not included. Taking into account all these hazards, it would be realistic to suggest that considerably less than half the crew and soldiers and a strongly reduced and battered fleet would put into a Chinese harbour again. This makes it rather incomprehensible that no problems are mentioned and rather odd that these inherently hugely expensive ventures should be repeated many times despite having no apparent economic or

102 John Iliffe, *Africans. The History of a Continent* (Cambridge: Cambridge University Press, 1996), p. 136.
103 David W. Galenson, *Traders, Planters, and Slaves. Market Behaviour in Early English America* (Cambridge: Cambridge University Press, 1986), pp. 37–51.
104 McNeill, *Plagues and Peoples*, p. 272.

military motives of great importance. According to the medievalist historian's craft, contemporary accounts should on principle be related to with deep scepticism and exposed to relentless source-critical questions and demands for substantiating evidence. In the apt words of John Hatcher one should take into account the "overwrought imaginings and hopelessly inaccurate quantification of the chroniclers".[105] Certainly, the realities would unavoidably have been dramatically different. In this perspective, Liu Daxia's hostile comments are justified and his determined action is comprehensible.

Morelli et al. have provided a different but very strong argument in favor of the assumption that Zheng He's expeditions would unavoidably, one might say, have suffered a catastrophic fate: "It seems highly likely that these ships were infested by rats, which could have transmitted *Y. pestis* from China to Africa." If infected plague rats were on board these ships, the consequences would be disastrous. The main Icelandic source on the Black Death, the so-called *Lawman's Annal*, outlines such a scenario: "Several vessels, merchant ships and many other ships, sank or drifted widely around."[106] This relates to ships sailing only a tiny fraction of the distance covered by Zheng He's fleet.

Ships sailed from Europe to the Americas for the last 231 years of the second plague pandemic, from 1492 to 1722. Although transportation of plague by ship was a usual occurrence in the spread of European plague epidemics, no evidence suggests that any ship infested with plague made it to the Americas in that period. This is corroborated by Morelli et al.'s studies of American isolates of *Y. pestis* which all descend from the introduction of the third pandemic in 1900. With regard to the medieval period, it is commonly assumed that plague was transported half the distance to Iceland, where it unleashed two epidemics in the fifteenth century. However, when the sources and circumstances are scrutinized, the conclusion is that these epidemics cannot have been plague.[107]

Above we have already cited the Arab chronicler Al-Maqrzi who refers to the Black Death's arrival in Alexandria with a galley that had put to sea from a Black Sea port with 32 merchants and 300 men, slaves and crew on board. He continues by adding that when the ship put into the harbour of Alexandria, only four merchants, one slave and about 40 sailors were still alive.[108] This was the status after a voyage of roughly 1400 km, all in costal waters – a small fraction of the distance sailed by Zheng He's fleets. The galley would have had regular access to ports and trading stations on the way for fresh supplies of food and water and opportunities for recruiting sailors.

105 John Hatcher, *Plague, Population and the English Economy 1348–1530* (Houndmills, Basingstoke, Hampshire: Macmillan Education Ltd., 1977; several reprints 1982–1987), p. 21.

106 Gustav Storm (ed.), *Islandske Annaler indtil 1578* (Christiania [= Oslo]: Det norske historiske Kildeskriftfond, 1888; rpt. 1977), p. 275.

107 Benedictow, *What Disease was Plague?*, pp. 493–552.

108 Dols, *Economic History of Medieval Europe*, p. 60.

## The Alternative Explanation: The Spread Rates of Plague in Nature

Morelli et al(iorum) paleobiological determination of an East Asian origin of *Y. pestis* seems convincing and represents undoubtedly a major scholarly achievement. But their dating of the time of its origin and the spatiotemporal pattern of spread indicated by biomolecular clocking techniques are problematically inaccurate. Their highly disparate attempts at explaining the historical spread of *Y. pestis* either by caravans across the Eurasian continent or by sea from China to East Africa whence it could have spread to western Arabia, North Africa and the Middle East must be deemed untenable. This calls for a realistic alternative explanation of how *Y. pestis* could have spread out of its original homeland in East Asia which is compatible with the spatiotemporal perspectives given by historical sources.

In June 1900, plague entered a new continent, namely North America in San Francisco and began a transcontinental process of sylvatic spread among populations of various species of wild rodents. Seventy-five years later, plague had penetrated into twelve states and had crossed the middle of the USA at 100° longitude, a distance of around 2000 km from San Francisco; it had also invaded Canada in the North and Mexico in the South.[109] In the words of McNeill: "Such a vast area of infection, in fact, is equivalent to any of the long-standing plague foci of the Old World."[110] The average spread rate had thus been of the order of 25 km (16 miles) a year. It was mainly due to natural processes of spread caused by animal behaviour: contact between diseased and healthy rodents, sick rodents being caught by birds or beasts of prey and carried at a distance to nests or lairs, perhaps being lost on the way, the bloody remnants infecting scavenging rodents by infective droplets, and so on.[111] Human beings may also have played a part, inadvertently carrying plague-infected rodents or their infected fleas to new areas, causing metastatic spread and the rise of new effective centres of spread. However, McNeill concludes his discussion that "the geographic spread of plague infection in North America occurred naturally". It was basically passed on between colonies of ground-burrowing rodents: "The spread of plague in North America, while affected by such [human] acts, did not depend on human intervention."[112]

At average annual spread rates of 25–20 km plague would have covered the roughly 8000 km from a central location in East Asia to the Middle East in 320–400 years. This estimate

109 CDC [Centers of Disease Control and Protection], 2012: "Maps and Statistics: Plague in the United States", http://www.cdc.gov/plague/maps/index.html; WHO Expert Committee on Plague, *WHO Technical Report Series* 447 (1970), p. 6; Allan M. Barnes, T. J. Quan, Jack D. Poland, "Plague in the United States, 1984", *Morbidity and Mortality Weekly Report*. Supplement 34 (1985), pp. 9S–14S.

110 McNeill, *Plagues and Peoples*, p. 145.

111 Jack D. Poland, "Plague", in Paul D. Hoeprich (ed.). *Infectious Diseases* (Philaldelphia: Harper & Row, 1983), pp. 1227–1237, esp. 1230; Pollitzer and Meyer, "Ecology of Plague", p. 458.

112 McNeill, *Plagues and Peoples*, pp. 145–146.

can now be juxtaposed with Morelli et al(iorum) conclusion that "*Y. pestis* evolved in or near China" >2,600 years ago but also that 1.ANT[iqua]1 biovar developed 628–6,914 years ago. They seem to envisage a maximum age of *Y. pestis* in East Asia of over 6,914 years, since the real age would include the time of spread to East Africa and the development of this biovar. Clearly the spread rate of sylvatic plague is compatible with the historical data and easily within the enormous margins of uncertainty inherent in biomolecular dating techniques.

Modern maps show that plague foci of various wild rodents stretch almost continuously from Manchuria to the Middle East. There is a small hiatus from the western border of Mongolia about 400 km into Kazakhstan whence it runs around the Caspian Sea into Iran. Then there is a small break over to the plague focus stretching along much of the Iranian coasts on the Persian Gulf and continuously across eastern Iraq and northeastern Syria into southeastern Turkey.[113] Such breaks in a continuous series of plague foci do not mean that these areas are void of rodents, only that they are too few and live too dispersedly to entertain plague continuously. However, in years with extraordinary fertility among rodents, which tend to occur in short cycles, the disease could presumably close the gap by ordinary spread of sylvatic plague. The gaps could also be closed by birds of prey and predators of rodents carrying prey over short distances, or possibly in goods of caravans. Camels could possibly have been significant vehicles of transportation of plague-infected fleas. They are susceptible to plague infection and may perhaps occasion spread and be the source of infection of man and other susceptible animals.[114] After arrival in the Middle East, *Y. pestis* could easily have been spread by human agency to North Africa, southeastern Asia Minor, western Arabia, and to Central or East Africa, and trigger the formation of new plague foci. The plague foci of northern Africa, the Middle East and the Near East could be linked with the Biblical account of pre-classical plague and can explain the accounts of epidemics and endemic cases of plague and the clinical descriptions in classical medical works.

In the Middle East, *Y. pestis* would become involved with the black rat and "the rat flea *par excellence*" – *Xenopsylla cheopis*.[115] The epidemic powers of plague (as distinct from the epizootic powers) may have evolved in the Middle East as the black rat and *X. cheopis* adapted

113 WHOCC-Plague, 2012. Global Distribution of Plague 1970–2000. *Home page on plague on WHO's website*.

114 V. N. Fyodorov [often wrongly transcribed "Fedorov"], "Plague in Camels and its Prevention in the USSR," *Bulletin of the WHO* 23 (1960), pp. 275–281; A. B. Christie, T. H. Chen, Sanford S. Elberg, "Plague in Camels and Goats: Their Role in Human Epidemics", *Journal of Infectious Diseases* 141 (1980), pp. 724–726.

115 Eva Panagiotakopulu, "Pharaonic Egypt and the Origins of Plague", *Journal of Biogeography* 31 (2004), pp. 269–375.

to the new pathogen.[116] If so, this may seem to have triggered a new phase of spread of plague back eastwards with profound epidemic implications.

The unveiling of this process would require that archaeologists focus on identification of putative plague graves also outside Europe which could furnish paleobiologists with material. It puts also a new emphasis on the potential role of long-distance trade and travel by land and sea. This theory can explain the late references to plague epidemics in Chinese and Indian sources. Clarification of these perspectives may also herald a future role for paleoentomology and paleozoology.

116 Ibid.