Digitizing Historical Plague

To the Editor– Outbreaks of bubonic plague initiated by the flea-borne bacterium *Yersinia pestis* have repeatedly afflicted the Old World since the onset of the *'Justinian Plague'* in 541 AD [1]. The second European pandemic, the *'Black Death'* rapidly killed around half of the population during 1347–1353 AD. Both pandemics then persisted with recurrent local outbreaks over several centuries. The reason for the eventual cessation of each pandemic remains mysterious [1], particularly in light of continued activity in Asia [2] where the infection is enzootic in its natural rodent hosts [3]. Socio-political influences have often compounded the complexity of plague ecology, likely increasing the spillover of infection into human populations [1–3].

The threat from the plague bacillus, which still induces several thousand human cases annually, may well increase under projected climate change [1] – and, ominously, within the context of bioterrorism [4]. Knowledge of plague ecology, epidemiology, and pathophysiology is,

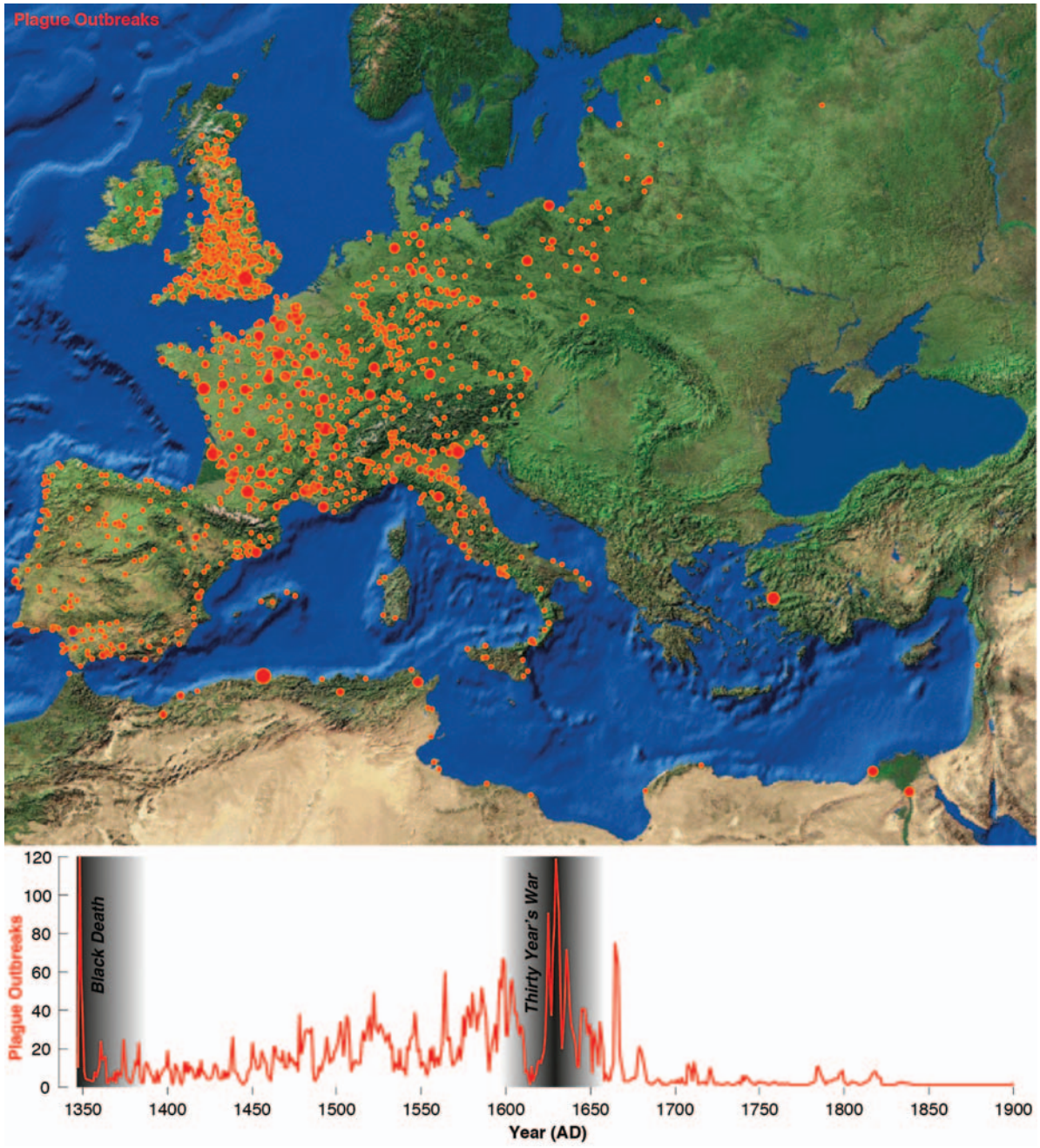

Figure 1. Spatiotemporal distribution of 6929 documented plague outbreaks [6] that occurred during 1347–1900. Circle size refers to local frequency, ranging from 1 outbreak in 544 locations to 146 outbreaks in London, United Kingdom.

however, mostly limited to its current endemic areas outside Europe [4]. Palaeoepidemiological evidence necessary for assessing climatic influences on this and other infectious diseases is still scarce [5].

Here we present newly digitized data on 6929 plague outbreaks that occurred between 1347 and 1900 AD across Europe (Figure 1), based on an inventory initially published 35 years ago [6]. This and comparable compilations should be of great value to researchers across diverse disciplines, providing insight on spatiotemporal patterns and dynamics of historical plague outbreaks. Remaining uncertainties though include geographically imprecise descriptions that prohibited the exact localization of 4251 out of 11 180 originally published outbreaks, and the annual resolution of the primary sources precludes tracking within-year dispersal routes.

Nevertheless, this annually-resolved and precisely localized archive, together with inventories from China [2], provides unique opportunities to assess spatio-temporal characteristics of historical epidemics, and to explore their causes and consequences. Where (via which harbors?) and when (once or repeatedly?) did the bacterium reach Europe and how was it then spread? Did trade routes, river systems, and forests affect the dispersal rate and virulence of *Yersinia pestis*, and was a wildlife reservoir involved? Historical documentary reports and dendro-dated wood constructions are valuable and increasingly available resources to enhance knowledge of plague-induced socioeconomic, cultural, and political instability of Medieval Europe. Linking palaeo-epidemiological and -climatological records will further reveal if the *Black Death* and subsequent outbreaks during the Thirty Year's War coincided with the most extreme climate fluctuations of the past millennium [7], when society was likely more vulnerable after crop failure and under-nutrition, and when wild rodent host populations were stressed and displaced. Many new research opportunities thus arise.

Notes

The dataset is freely available under: www.wsl.ch/fe/landschaftsdynamik/projekte/historical_european_plague/index_EN.

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