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Environmental drivers of Yersinia pestis – a holistic perspective on Medieval Europe

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Recent studies have indicated some evidence for a link between climate variability and plague (Yersinia pestis) dynamics in Central Asia and during most of the 20th century. An intensification of plague outbreaks via population peaks in its host-species, the great gerbil (Rhombomys opimus) and its fleas (Xenopsylla spp) has been found to occur during periods of warmer spring and wetter summer climate. This is important, as human epidemics of plague ultimately originate in its wildlife reservoirs.
Given the fact that Medieval Europe was strongly devastated by the Black Death – the second pandemic after the Justinian plague ∼540AD, and that the worldwide highest quality and quantity of climate proxy data exist for Europe, we here present, for the first time, a holistic approach to enhance understanding of the mid-14th century Black Death. This is of primary importance not only for medical/epidemiological research, but also for other scientific communities, because the Black Death disease had a sustainable impact on the socio-economic development, culture, art, and religion of Medieval Europe. Palaeoclimatic records of annually resolved European temperature and drought variability are compiled, a high-resolution time-series of anthropogenic deforestation is utilized, documentary archives of socio-economic relevance are considered, and the animal-born plague bacterium is placed in the ecological web.
Considering the European/North Atlantic sector and the last millennium, periods of high solar radiation and reduced volcanic activity shift the North Atlantic Oscillation into a generally positive mode, yielding towards warmer temperatures and an intensification of the hydrological cycle. We now argue that increased internal circulation resulted in an overall wetter and warmer climate ∼1350AD, which most likely was able to promote the prevalence of existing and widespread Yersinia pestis bacillus. Resulting outbreaks of bubonic plague could have been also supported by the high degree of anthropogenic deforestation of the continent (providing suitable habitats

for wildlife rodent communities), prolonged famine due to crop failure (decreasing human health conditions), and a severe Central European earthquake during the mid-14th century (increasing socio-economic vulnerability). This concert together with enhanced summer humidity most likely contributed towards the enormous dispersal rate of the Black Death.

Proxy reconstructions, model simulations, and eco-epidemiological findings additionally underline the archaeological hypothesis that the Black Death originated in Central Asia. Moreover, it is suggest that the frequency of human primary infection and, ultimately, the probability of epidemics, respond to climatic forcing on plague reservoir dynamics. Projected climate and land use land cover change will further complicate this relationship.