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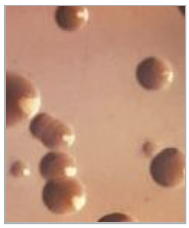
Plague in Asia linked to climate change

Modellers correlate climate fluctuations with cases of the disease in Central Asia



Agar culture growing colonies of *Yersinia pestis* bacteria.

Image credit: CDC/Dr. Brodsky

Climatic variations had a “significant” influence on the prevalence of plague in Kazakhstan and other regions of Central Asia in the early 20th century, and probably over the past 1500 years, according to the results of a modelling study[1] published online in *BMC Biology*.

The authors, an international team of researchers led by Kyrre Kausrud of the University of Oslo, Norway, found an association between climatic fluctuations and plague in both people and animal hosts. Their findings suggest the dreaded disease may resurge as a result of climate change.

“As plague activity in Central Asia seems to have followed climate fluctuations over the past centuries, we may expect global warming to have an impact upon future plague epidemiology, probably sustaining or increasing plague activity in the region... in the coming decades,” write Kausrud and colleagues.

Writing in an associated commentary[2], Anthony McMichael, of the Australian National University in Canberra, says the study suggests that bubonic plague “may not yet have run its course”.

“The magnitude of human-induced climate change is now at least as great as any of those historical changes noted in the... paper,” McMichael points out in an email to EHTF News. “In coming decades it will be significantly greater, so closer surveillance of plague patterns is warranted.”

The *Yersinia pestis* bacteria that cause plague are widespread in some rodents, and usually infect people through the bite of fleas that feed on these animal hosts. The most common form of the disease, bubonic plague, can kill up to 15% of patients who receive treatment, and up to 60% if left untreated. The more severe forms, pneumonic and septicaemic plague, have a 100% fatality rate in people who don’t receive treatment.

The disease has caused three pandemics over the past 2000 years, but what gave rise to these events remains unclear. Starting from Constantinople it spread farther into the Eastern Mediterranean in the 6th and 7th centuries, then reached Central Asia and China in the 14th century before it hit Europe, where at least a third of the population was decimated. With this latest pandemic — the Black Death — plague has left its mark on the human psyche as one of the most feared diseases.

Innovative and complex

The study by Kausrud and colleagues is “innovative”, according to McMichael, and one of few pieces of systematic research on climatic determinants of bubonic plague. But the findings are suggestive, not conclusive, he points out. “Hopefully, other researchers will now look a bit more carefully at local causal influences.”

The authors combined data on temperature, rainfall, and other climate-related variables to create 10,000 scenarios of climatic fluctuations in Kazakhstan over previous centuries. They compared these scenarios with data from the 20th century to fine-tune the model, and correlated climatic conditions with vegetation cover in the area.

Measures of climate and vegetation were then used to estimate plague prevalence in great gerbils — a rodent that serves as one of the main animal hosts of the disease. Rodents as well as the fleas that feed on them depend on the right climatic conditions and vegetation to survive.

For time periods in which the data overlapped, the authors found that climatic conditions, the abundance of vegetation and the prevalence of plague in gerbils were inter-related.

Taking advantage of a Soviet-led plague monitoring system run by the Kazakh health department for much of the 20th century, they took the analysis a step further, looking for a statistical link with human cases of the disease. “Climate-driven models trained on these data predict independent data on human plague cases in early 20th-century Kazakhstan... suggesting a consistent impact of climate on large-scale wildlife reservoir dynamics influencing human epidemics.”

A role for climate

The research raises questions over the role of climate change in a recent **outbreak of plague in Peru**, the first to occur

since 1994, where three people died and 31 became infected with *Y. pestis* bacteria. In early August, a fatal case of the disease was also **recorded in neighbouring Bolivia**.

"It is likely that [South] American rodents respond to climatic influences (and hence food supplies) as in Central Asia — but there will of course be differences in details of that ecology," notes McMichael.

A review article **published in 2008** points to evidence that human cases of plague recorded in the latter part of the 20th century in the US states of New Mexico and Arizona were preceded by delayed or above-average rainfall levels between winter and spring. It also cites evidence of unusually low temperatures, wet summers and warm springtime temperatures before each of the three plague pandemics.

Kausrud and colleagues note that their study supports the link between less dry conditions and plague outbreaks in gerbils, which in turn raises the risk of disease in human populations. They see an increasing probability of plague outbreaks in less developed and crowded parts of Central Asia as global warming continues, bringing changes to the hydrological cycle at a time when plague surveillance has weakened after the collapse of the Soviet Union.

Other factors, unrelated to climate, can also drive spread of this disease. They include population movement, conflicts, and changes in the virulence or other characteristics of the bacteria. "Major outbreaks are rare, and the causation is always likely to be multivariate," explains McMichael.

But the authors say the patterns shown in their study are "striking enough on several scales to suggest that the plague system has indeed been influenced by climate fluctuations over the past 1500 years".

References and links

1. Kausrud KL, Begon M, Ari TB, Viljugrein H, Esper J, Buntgen U, *et al*. Modeling the epidemiological history of plague in Central Asia: Palaeoclimatic forcing on a disease system over the past millennium. *BMC Biology* 2010, **8**: 112. **doi**: **10.1186/1741-7007-8-112**
2. McMichael, AJ. Paleoclimate and bubonic plague: a forewarning of future risk? *BMC Biology* 2010, **8**: 108. **doi**: **10.1186/1741-7007-8-108**

UK Health Protection Agency information about plague

World Health Organization information about climate change and human health

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