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## Plague in diachronic and interdisciplinary perspective. Report on Session TH5-05 at the 22nd Annual Meeting of the EAA in Vilnius, Lithuania

Doris Gutschmiedl-Schümann, Sacha Kacki, Marcel Keller and Christina Lee

Plague, an infectious disease caused by the bacterium *Yersinia pestis*, occurred in at least three major historical pandemics: the Justinianic Plague (6th to 8th century), the Black Death (1348-1352, with further epidemic outbreaks until the 18<sup>th</sup> century), and the Modern or Hong Kong Plague (19th to 20th century). However, it appears that the disease may be much older: DNA from Bronze Age human skeleton has recently shown that plague first emerged at least as early as 3000 BC. As any disease, plague has both a biological as well as a social dimension. Different disciplines can therefore explicate different aspects of plague which can lead to a better understanding of the disease and its medical and social implications.

The session was held on 2nd September 2016 as part of the 22nd Annual Meeting of the EAA with the aim of bringing together researchers from different disciplines who work on plague. It addressed a series of research questions, such as:

- Which disciplines can contribute to the research on plague?
- What are their methodological possibilities and the limitations of their methodologies?
- How can different disciplines work together in order to gain a more realistic and detailed picture of plague in different periods and regions?
- How did different societies react to plague? In which way may we prove or disprove evidence for such reactions – and which disciplines may contribute to the debate?
- What were the common aspects, and what the differences of the various plague outbreaks? Are there any epidemiological characteristics that are essential and/or unique to plague?
- What are possible implications of the pandemic spread and endemic occurrence of plague through the ages for the interpretation of historical and cultural phenomena?

The session ran over a full day, with 13 papers and one poster from contributors originating from six different countries: Canada, Denmark, Germany, Great Britain, Norway and USA. It opened with an introduction by Marcel Keller (Max Planck Institute for the Science of Human History, Germany), who gave a short review of the history of plague research from the 1890s (when Alexandre Yersin in 1894 discovered the bacterium *Y. pestis* as causative agent of plague in Hong Kong, and Paul-Louis Simond evidenced in 1898 the role of rats and rat fleas in the transmission of the disease) until recent times. He pointed out some milestones and main controversies in the history of plague research in different disciplines like history, archaeology, palaeogenetics, and epidemiology.

After this short introduction, Wyndham Lathem (Northwestern University, USA) introduced the three species of the *Yersinia* bacteria that cause disease in humans: *Y. enterocolitica*, *Y. pseudotuberculosis*, and *Y. pestis*. While *Y. enterocolitica* and *Y. pseudotuberculosis* cause mild, self-limiting gastrointestinal infections, *Y. pestis* is responsible for the rapidly progressing, invasive, and often fatal disease called plague. Although *Y. pestis* is thought to have killed over 200 million people throughout history, it is a relatively “young” pathogen, only recently emerged from *Y. pseudotuberculosis* between 5,000 – 20,000 years ago.

In a second talk, Wyndham Lathem discussed his recent results of microbiological studies reconstructing the evolutionary history of pathogenic *Yersinia* and *Y. pestis* in particular. He could show that the ‘ancestral’ *Y. pestis* was able to cause primary pneumonic plague and to spread directly via droplet infection, and not until later gained the ability to cause bubonic plague and adapted for the specific transmission route and insect vector.

Eva Panagiotakopulu (University of Edinburgh, Great Britain) detected plague and rat evidence in written texts in Mesopotamia and Egypt. She suggested that the bacterium *Y. pestis* and the black rat might both have spread from Central Asia along trading routes for lapis lazuli to Egypt. She showed that the regular flooding of the Nile brought humans and rats together in the remaining relatively small areas which were not affected by flooding, where *Y. pestis* could be easily be transferred from rats to humans.

Simon Rasmussen (Technical University of Denmark) presented the results from an investigation of 100 Bronze Age skeletal samples that lead to the detection of the so far oldest genetic evidence for *Y. pestis*. He connected a mass migration from the Steppes at the beginning of the Bronze Age and the contemporary population decline in Central Europe with local outbreaks of plague during this period.

Lars Walløe (University of Oslo, Norway) linked the Philistine epidemic, which is reported in the Bible (1. Sam. 6,5), to plague. Going back to the original Hebrew sources and later translations, he showed that an ignorance of specific diseases may lead to misinterpretation and inaccurate translations. This paper also suggested that the enigmatic sudden decline of the Mycenaean culture around BC 1200, which is mentioned in the Hebrew Chronicles, may be explained through an outbreak of this devastating disease.

John Mulhall (Harvard University, USA) revisited ancient written sources, where a close philological study uncovered evidence for plague in the medical sources of Antiquity, in particular the Hippocratic Corpus, Rufus of Ephesus, and Galen. The picture that emerges from the medical sources is that *Y. pestis* is not mentioned in the Hippocratic Corpus and was unknown to medical writers until around the first century BC, when sources cited by Rufus of Ephesus report a disease which resembles plague. It remains familiar to medical authors from the first century BC to the end of the first century AD, when both Rufus and Aretaeus demonstrate an awareness of *Y. pestis*. Intriguingly, Galen, who wrote only a few generations after Rufus in the mid-second century AD, does not show any awareness of bubonic plague.

Jennifer Klunk (McMaster University, Canada) introduced the phylogenetic tree of the plague-causing pathogen *Y. pestis*. Her presentation illustrated how genomic research of the last years has expanded this phylogenetic tree and led to the conclusion that the first and the second pandemic emerged independently from rodent reservoirs to humans.

Early medieval examples of plague graves from the cemeteries of Aschheim-Bajuwarenring and Altenerding/Klettham, both from Upper Bavaria, Germany, were investigated by Doris Gutmiedl-Schumann (Freie Universität Berlin, Germany). Both cemeteries show that plague victims were prepared for burial, and dressed and buried just like other deceased of their time. The grave construction, grave goods and layout did not differ from anyone who had not succumbed to the Justinianic Plague.

Michal Feldman (Max Planck Institute for the Science of Human History, Germany) presented recent results of a high coverage *Y. pestis* genome obtained from the previously presented site of Altenerding/Klettham. She showed that the same strain of *Y. pestis* was present in both Altenerding and Aschheim, and that this strain associated with the Justinianic Plague is likely to have become extinct.

Henry Gruber (Harvard University, USA) re-visited written sources. He showed that although there are no known texts from early medieval Valencia (Spain) which specifically mention the Justinianic Plague, there are written sources that might indicate the presence of the disease during the Visigothic period. He argued that burial regulations adopted by the Council of Valencia, held in 546 AD, could be linked to plague epidemics. He also argued for a closer investigation of written sources, not only for direct mentions or descriptions of the Justinianic

Plague, but for new regulations and changes which may have been implemented because of the disease, but which do not explicitly refer to it.

Aside from humans, domestic animals, too, could be affected by plague, as shown by Ptolemaios-Dimitrios Paxinos (Ludwig-Maximilians-Universität München, Germany). By using a zooarchaeological approach he demonstrated that a reduction of the size of a livestock occurred at various sites in the aftermath of the Black Death. He interprets this data as the result of deterioration in the living condition of such animals, either because of a climatic shift that leads to a shortage of fodder, or due to poor management by humans.

Julia Gamble (University of Toronto, Canada) investigates the mid-14th century Black Death by studying several burial sites from Denmark. She reported on the preliminary results of the study from an international team combining bioarchaeological and molecular methods that aims to further understand the epidemiology of plague in this region of Europe. In her presentation, she described three cemeteries containing plague victims which were confirmed through the recovery of *Y. pestis* DNA from the skeletal material. She compared this information with archaeological and anthropological evidence from these sites.

The final paper, presented by Maria A. Spyrou (Max Planck Institute for the Science of Human History, Germany) looked at reconstructed *Y. pestis* genomes from plague victims of the Black Death and in comparison with subsequent plague outbreaks. The DNA was obtained from three archaeological sites in Spain, Germany and Russia. The results of her study provides support for the hypothesis of a single entry of *Y. pestis* in Europe during the Black Death, with a later spread towards Asia, where it remained and became the source for the third pandemic, and contemporary outbreaks of the disease worldwide.

Before opening the final discussion there was a poster presentation by Katherine Eaton (McMaster University, Canada). She hypothesizes that historical outbreaks of plague may be reconstructed by mapping historic documents, which can offer a new framework for future palaeogenetic studies.

The sessions were interspersed with opportunities for discussion, in which speakers and the audience had more time to engage in a fuller debate of the research presented in the papers. The discussions and chat continued informally after the end of the session in a cozy cafe in the old town of Vilnius.