A single strain of plague bacteria sparked multiple historical and modern pandemics

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"Our study is the first to provide genetic support for plague's travel from Europe into Asia after the Black Death, and it establishes a link between the Black Death in the mid-14th century and modern plague," says first author Maria Spyrou of the Max Planck Institute for the Science of Human History.

The plague bacterium, *Yersinia pestis*, is one of the deadliest pathogens in human history, sparking three major pandemics: the Plague of Justinian, which struck the Roman Empire during the 6th and 8th centuries; the second plague pandemic, which first erupted in Europe in the mid-14th-century Black Death and continued to strike the continent in recurrent outbreaks until the mid-18th century; and the third plague pandemic, which emerged in China during the late 19th century.

Evidence based on ancient DNA samples and historical climate patterns has suggested that the recurrent outbreaks of the second pandemic were caused by multiple reintroductions of *Yersinia pestis* into Europe, most likely from Asia. Moreover, some scientists have recently suggested that the plague bacterium migrated from Europe to Asia after the Black Death, later giving rise to the third pandemic. But until now, genomic evidence to support this model was missing.

To shed light on the origin and path of the second pandemic, Spyrou and co-senior study authors Alexander Herbig, Kirsten Bos, and Johannes Krause of the Max Planck Institute for the Science of Human History collected samples from plague-infected individuals buried in mass grave sites in Barcelona, Spain, and Ellwangen, Germany, as well as a single grave in Bolgar City, Russia.

"The mass burials where our samples come from often represent events where hundreds of people died of plague during a single outbreak," Herbig says. "This gives us an impression about how significant the impact of this disease was during medieval times."
The Bolgar City site was dated to the second half of the 14th century using coin artifacts known to have been minted after 1362. Radiocarbon dates from bone fragments and tooth roots were estimated at 1300-1420 for Barcelona, 1298-1388 for Bolgar City, and 1486-1627 for Ellwangen.

Meanwhile, the Bolgar City strain shared similarities with the Black Death London strain as well as all modern strains. This finding supports the idea that one Y. pestis lineage traveled from Europe to Asia after the Black Death, later sparking the third pandemic and modern-day epidemics worldwide.

"Our most significant finding revealed a link between the Black Death and modern plague," Krause says. "Though several plague lineages exist in China today, only the lineage that caused the Black Death several centuries earlier left Southeast Asia in the late 19th century pandemic and rapidly achieved a near worldwide distribution."

In future studies, the researchers plan to gain additional insights into the entry and end points of the Black Death in Europe. They hope to expand their sample range and explore these regions further to better understand the route traveled by the disease, the evolutionary changes it acquired at different stages, and the toll it had on the human population.

"We hope that our findings will highlight the importance for more extensive sampling and sequencing of both ancient and modern plague isolates around the world, and open up new research themes regarding the role played by Europe and West Asia in plague's evolution and ecology," Bos says.

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