Johannes Krause examines historical pathogens: old pathogens in a new light

Palaeogeneticist Johannes Krause is drawn to ancient DNA. His work on the evolution of human pathogens shows that his findings are not purely of historical interest, but also enable conclusions to be made on future disease outbreaks and epidemics. In autumn 2012, Krause was awarded an ERC Starting Grant. Krause uses the grant to expand his research into plague and other historical pathogens that continue to be a threat to human health.

Palaeogeneticist Johannes Krause
© Friedhelm Albrecht, University of Tübingen

Dr. Johannes Krause, junior professor at the University of Tübingen, studied biochemistry but has a long-standing interest in the field of palaeontology. He became interested in genetic aspects during his studies in Ireland where he spent a year as an Erasmus student and was able to combine this interest with his other passion. Krause comments: "My one-year stay in Ireland helped me gain a thorough understanding of genetic aspects, which in turn sparked my enthusiasm for the field of palaeogenetics." His degree thesis focused on ancient genes and he was also involved in a highly regarded scientific project which demonstrated that the mammoth was more closely related to the Indian elephant than to the African elephant. "Our results were published in Nature, which for me was fantastic," said Krause with noticeable pride, as it is not very common for people of Krause's age to be able to add such a prestigious publication to their CV.

Krause did his doctoral thesis in the Leipzig-based Max Planck Institute for Evolutionary Anthropology, but back in 2003 he started working on own projects, examining both mammoth and cave-bear DNA. Krause also played a major role in the deciphering of the Neanderthal genome, a study which was published during his postdoctoral period at the Leipzig-based MPI. Johannes was also among the researchers who discovered the Denisova hominin who lived in the Altai Mountains in Siberia about 40,000 years ago. The University of Tübingen has played a major role in his career: in 2009, he was awarded the Tübingen Prize for Early Prehistory and Quaternary Ecology, which is awarded every year to talented young scientists for their achievements in the field of palaeontology. The prize was awarded for the first time in 1998 and is sponsored by the company EiszeitQuell. With a purse of 5000 euros, it is the most prestigious prize in the field of palaeontology.

Tübingen University establishes palaeogenetics department

As Krause considers the palaeontology department in Tübingen to be one of the strongest in Germany, he was delighted when the director of the department mentioned the university's plans to establish two junior professorships and encouraged him to apply. "With financial support from the Carl Zeiss Foundation, the University of Tübingen planned to establish two junior professorships. One of these positions, for which the university was specifically seeking a geneticist, was tasked with establishing the university's new palaeogenetics department. The position was a highly attractive offer, especially for someone of my age; I was not even 30 at that point," commented Krause who has been carrying out research and teaching students at the Institute for Scientific Archaeology at the University of Tübingen since 2010.

The most recent highlight in his professional career was the European Research Council (ERC) Starting Grant, which he was awarded in 2012. Every year, the ERC invites proposals from young scientists and funds outstanding projects for a period of up to five years. Krause has received 1.5 million euros for a project dealing with the evolution of infectious diseases with reference to pandemics. Krause will use the prize money to expand his team and hire up-and-coming international scientists, specifically to bring three doctoral and two postdoctoral students into the team. Research into old pathogens is not new to Krause: in 2011, he and his co-workers succeeded in deciphering the genome of a medieval Black Death pathogen. It turned out that all modern-day plague pathogens evolved from the medieval one.

Krause explains why this result is so remarkable: "Similar environmental conditions prevailed at the time when the plagues ravaged over medieval Europe and 19th century China. Nevertheless, the spread of the disease, its symptoms and mortality rate differed considerably between the two events. This is why for a long time it was assumed that the two epidemics were caused by two different pathogens and that the medieval strain no longer existed. However, genetic comparison of historical and modern plague strains showed that the strains split from each other in the 13th/14th century." The researchers from Tübingen reconstructed the DNA of the historical pathogen and compared it

The blessing of sick people (book illustration - 1360-75)

with DNA of modern bacteria using high-tech lab equipment such as DNA microarrays. The team deciphered the DNA using high-throughput methods and systems, including a highly efficient next-generation sequencer in the laboratory of the Department of Human Genetics.

Great value for modern infectious disease research

Krause plans to use the ERC money for investigating pathogens that occurred throughout Europe over the last 10,000 years. Krause and his team will also use pathogens that caused the Plague of Athens (around 430 BC), the Plague of Justinian (around 540 AD) and the Antonine Plague (180 AD). Krause believes that the latter was not due to a bubonic plague pathogen. “I believe that the Antonine Plague was a pox epidemic rather than a bubonic plague. We are fairly sure that the Plague of Justinian was the first bubonic plague epidemic,” said Krause who also hopes to find out when the pathogens jumped from chimpanzees to humans and how they adapted to their new host. “We want to find out as many details as possible on the potential modification of the plague bacteria over time. This will provide us with information about the mutation rate, which we would not be able to determine in the laboratory. The results will then help us to find out how quickly the pathogen mutates and becomes a threat to human health. This is of particular importance for antibiotic resistances, whose spread is closely linked to the mutation rate of the pathogen.” In addition to the practical benefit, Krause is also interested in aspects of basic research and hopes that his research on the adaptation processes of certain pathogens will contribute to expanding our knowledge about

Plague doctor (1656)

evolution in general.

As there are no plague bacteria fossils available, the team derives its research material from old skeletons of infected animals and humans. There are numerous palaeopathological collections around the world. The researchers from Tübingen have many international cooperation partners, which facilitates their access to sought-after samples. “We usually use bones, but teeth are also excellent pathogen sources for us. Teeth are like small containers whose dental enamel protects the tooth pulp against decay. We can isolate pathogen DNA from the dried blood contained in the connective tissue in the centre of the teeth, and this is a kind of molecular fossil,” explained Krause. It is far easier to get hold of modern plague pathogens. The pathogen is still around and leads to frequent plague outbreaks. “Every year, there are around a thousand plague cases. In America, there are frequent plague outbreaks in rodents. And this is quite alarming as fleas can transmit the disease to humans."

Further information:

University of Tübingen
Institute for Scientific Archaeology
Prof. Dr. Johannes Krause
Rümelinstraße 23
72070 Tübingen
Tel.: +49 (0)7071/ 29 - 74089
E-mail: johannes.krause(at)uni-tuebingen.de

Article

11-Feb-2013
leh (01.02.2013)
BioRegio STERN

The article is part of the following dossiers

Human infectious diseases: new threats

EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN