Wild African monkeys infected with the bacterium causing yaws in humans

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An adult female sooty mangabey (Cercocebus atys atys) in Taï National Park, Côte d'Ivoire infected with yaws. Credit: Helene De Nys/Taï Chimpanzee Project

An international research team, led by scientists from the German Primate Center, the Robert Koch Institute, the Max Planck Institute for Evolutionary Anthropology, McGill University, Masaryk University, the

University of Tübingen and the Max Planck Institute for the Science of Human History, has successfully recovered genomes of the bacterium Treponema pallidum, which causes syphilis and yaws in humans, from wild nonhuman primate populations across sub-Saharan Africa. Monkeys showed severe symptoms including lesions on their genitals, face, and extremities. The pathogen's genomes revealed that nonhuman primates across a large geographic range are infected with the same bacterium causing yaws in humans.

Co-lead author Sascha Knauf of the German Primate Center suggests that "the World Health Organization's efforts to eradicate human yaws must continue, but our finding of the widespread distribution of this pathogen in nonhuman primates calls for even more rigorous post-eradication surveillance in countries where nonhuman primates and humans coexist."

Yaws is caused by the bacterium Treponema pallidum subsp. pertenue, which is closely related to the bacterium causing the venereal disease syphilis, Treponema pallidum subsp. pallidum. Yaws is characterized by lesions of the skin, bones and cartilage and when untreated, can lead to disfigurement, disability, and sometimes death. It is thought to be primarily spread by skin to skin contact from human to human and despite the availability of effective antibiotics, yaws continues to affect thousands of people annually across at least 14 countries in the tropics, predominantly children. "The bacteria responsible for yaws were long thought to mainly infect humans, but this new research confirms that this is not the case," says co-lead author Verena Schuenemann of the University of Tübingen.

The international team first collected samples from sick wild monkeys in Tanzania, the Gambia, Senegal and the Côte d'Ivoire. These bacteria are extremely difficult to culture – the researchers generated full genomes using hybridization capture coupled with next generation sequencing.

Phylogenomic analyses showed that the pathogens infecting nonhuman primates and humans were extremely similar. In some cases the genomes were 99.989% identical, and no bacterial lineage was specific to humans or monkeys. "The yaws-causing strains infecting humans and nonhuman primates had extremely similar genome structures and only limited functional divergence," says co-corresponding author David Šmajs of Masaryk University. "More genomes of this pathogen infecting humans, including from ancient samples, will help us understand the evolutionary history of this bacterium and in particular if and how often spillovers between humans and nonhuman primates have occurred," says Johannes Krause of the Max Planck Institute for the Science of Human History and co-corresponding author.

Yaws has not been reported for several decades in humans in some of the countries where nonhuman primate infections were observed. "This suggests that if transmission occurs between nonhuman primates and humans, it happens at a low rate or that these spillover events rarely lead to establishment in the human population," says co-lead author Jan Gogarten of McGill University. The discovery of nonhuman primates infected with the same bacterium that causes yaws in humans across sub-Saharan Africa is an exciting indication that disease eradication efforts require multidisciplinary teams that include wildlife disease ecologists. Co-corresponding author Sébastien Calvignac-Spencer of the Robert Koch Institute says, "This is a nice example of an international One Health approach providing us with public health-relevant information. Improving surveillance in countries where potential zoonotic reemergence might occur may prove critical after initial eradication in humans."

More information: Sascha Knauf et al. Nonhuman primates across sub-Saharan Africa are infected with the yaws bacterium Treponema pallidum subsp. pertenue, *Emerging Microbes & Infections* (2018). DOI: 10.1038/s41426-018-0156-4

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