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The evolutionary history of **our oral bacteria**

Our mouths are a microecosystem for a community of microorganisms that live in different habitats, occupy specific niches and play particular roles in our biology and health. An international team of researchers recently investigated the oral microbiomes of Neanderthals, primates and humans, and discovered unexpected clues about human evolution.

The study, published in the *Proceedings of the National Academy of Sciences* (PNAS) in May, involved analysing the fossilised dental plaque of humans and Neanderthals spanning the past 100 000 years, and comparing it to that of wild chimpanzees, gorillas and howler monkeys. Led by scientists from the Max Planck Institute for the Science of Human History in Germany, the research team included representatives of 41 different institutions in 13 countries. One of these was Associate Professor Victoria Gibbon, a biological anthropologist in the Department of Human Biology at the University of Cape Town (UCT).

"In recent years, the human microbiome has become a popular topic," she says. "Using bacterial DNA obtained from tooth plaque from South African people who lived thousands of years ago has contributed to the better understanding of human history, human evolution and our early diets."

More specifically, the study suggested that the shift to a diet based predominantly on starch occurred much earlier than previously thought. This conclusion was based on the discovery that a subgroup of *Streptococcus* bacteria present in both modern humans and Neanderthals appears to have adapted to consume starch quite early in *Homo* evolution. Starchy foods – such as roots, tubers and seeds – are rich sources of energy, and previous studies have argued that a transition to eating such foods may have helped our ancestors to grow the large brains that characterise our species. But the current finding suggests that starchy foods became important in the diet even before the evolution of modern humans.

The other kind of calculus

Plaque is the sticky film that constantly forms on teeth but can be removed by brushing and flossing. It's made up of millions of bacteria, so scientists typically refer to it as 'dental biofilm'. Acids produced by the bacteria as they digest sugars cause tooth decay and gum damage. If allowed to build up, plaque precipitates minerals from saliva and calcifies into tartar, also known as 'dental calculus'. This is the harder, yellow or brown deposit that cannot be brushed or flossed away, and requires a visit to the dentist or dental hygienist for removal.

Before the time of toothbrushes... a Neanderthal tooth with a severe case of calculus.

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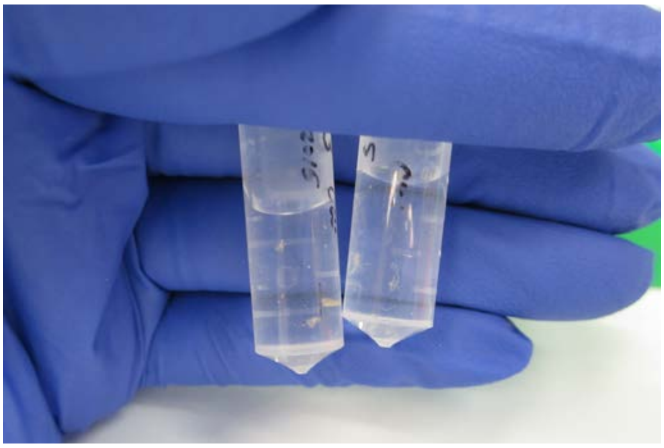

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Dedicated cleanroom facilities were used to prepare dental calculus samples for DNA extraction.

Given its longevity, it was dental calculus that the scientists targeted in the study, analysing samples and drawing upon previously published data from more than 120 individuals representing key points in primate and human evolution.

A challenging jigsaw puzzle

Working with DNA tens or hundreds of thousands of years old is highly challenging. Like archaeologists reconstructing broken pots, archaeo-geneticists have to painstakingly piece together the broken fragments of ancient genomes in order to reconstruct a complete picture of the past. For this study, researchers had to develop new tools and computational approaches to genetically analyse billions of DNA fragments and identify the long-dead bacterial communities preserved in archaeological dental calculus.

Using these new tools, researchers reconstructed the 100 000-year-old oral microbiome of a Neanderthal from Pešturina Cave in Serbia, the oldest oral microbiome successfully reconstructed to date by more than 50 000 years.

They were also able to identify 10 groups of bacteria that have been members of the oral microbiome for over 40 million years and that are still shared between humans and their closest primate relatives. Many of these bacteria are known to have important beneficial functions in the mouth and may help promote healthy gums and teeth.

Katerina Guschanski

Dental calculus was sampled from these gorilla specimens at the Royal Museum for Central Africa in Tervuren, Belgium.

Paleolithic connections

Although humans share many oral bacteria with other primates, the oral microbiomes of humans and Neanderthals are particularly similar. Nevertheless, there are a few small differences, mostly at the level of bacterial strains. When the researchers took a closer look at these differences, they found that ancient humans living in Ice Age Europe shared some bacterial strains with Neanderthals. Because the oral microbiome is typically acquired in early childhood from caregivers, this sharing may reflect earlier human-Neanderthal pairings and child rearing, as has been previously indicated by the discovery of Neanderthal DNA in ancient and modern human genomes.

The researchers found that Neanderthal-like bacterial strains no longer occurred in humans after about 14 000 years ago, a period during which there was substantial population turnover in Europe at the end of the last Ice Age. They point out that our microbiome is a particularly sensitive indicator of such major events, given that bacterial genomes evolve more quickly than the human genome.

Lead author of the PNAS paper, titled 'The evolution and changing ecology of the African hominid oral microbiome', was James Fellows Yates, a doctoral candidate at the Max Planck Institute for the Science of Human History.

"The tools and techniques developed in this study open up new opportunities for answering fundamental questions in microbial archaeology, and will allow the broader exploration of the intimate relationship between humans and their microbiome," he says.

Based on press releases issued by the Max Planck Institute for the Science of Human History and the University of Cape Town.
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