Small Things Considered

A Mouthful of Microbes
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by Gemma Reguera

After watching Hollywood movies of medieval knights with bright smiles, it may shock you to be reminded that their teeth looked anything but clean and healthy. Without good dental hygiene practices, bacteria colonize our teeth and can form thick multispecies biofilms (dental plaque). The initial colonizers are often harmless commensals, but other bacteria eventually join them, all feeding on the food debris that sticks to the biofilm matrix and soluble nutrients flowing through it. If allowed to grow thick, pathogens such as *Streptococcus mutans* and *Porphyromonas gingivalis* also join the biofilms, causing cavities and some forms of periodontal disease, respectively. Our medieval cousins did try to clean their teeth by rubbing mixtures of fresh or burned scented herbs and rinsing their mouths with solutions made of herbs, vinegar, wine, and alum. Yet these practices were not effective enough to prevent dental bacteria from colonizing our teeth and causing harm. As a result, cavities and abscesses were very common and medieval barbers found a profitable side job: pulling out teeth!

As the dental plaque forms, minerals from the saliva precipitate as calcium phosphate on the biofilm matrix. This creates a hard, rough surface that promotes more bacterial colonization and also provides a tough armor for the dental plaque. The calcified biofilms, also known as tartar or dental calculus, trap bacteria and food particles and preserve them for long periods of time. The preservation is so good that investigators from Australia were able to extract DNA from medieval dental remains and even from human remains from the Neolithic (early farmers) and Mesolithic (hunter gatherers). They then sequenced the hypervariable regions (V1, V3 and V6) of the bacterial 16S rRNA and profiled the microbial community. To prevent artifactual results, they followed strict procedures during sample collection, extraction, and DNA amplification steps and analyzed the data against rigorous authentication criteria. As controls, they also sampled modern plaque and calculus and used the sequenced data available in the Human Oral Microbiome Database (HOMD) for comparison.

A first glimpse at the phyla composition shows remarkable similarities in the community profiles of all the ancient and modern samples. All contained the 15 phyla commonly found in the modern oral microbiome, with highest percentages corresponding to the gram-positive phyla *Firmicutes* and *Actinobacteria*. However, analysis of the abundance of specific taxa in each phylum revealed a shift in dental plaque composition from the Mesolithic to the Neolithic period, which times the beginning of farming and the introduction of cereals in the human diet. The dental plaque of the hunter-gathering Mesolithic humans (7500–5450 BCE), whose diet was predominantly protein-based, was dominated by commensal bacteria in the *Clostridiales* and *Ruminococcales* groups associated with good oral health. By contrast, early farming groups from the Neolithic and medieval groups contained both nonpathogenic and disease-associated taxa. But here is the scary part: the cariogenic groups were most abundant in modern dental plaque! *S. mutans*, for example, was not detected in the Mesolithic hunter gatherers and early agriculturists of the Neolithic period, but its frequency increased progressively since then, reaching highest numbers in modern humans.

Dentistry and dental hygiene practices may have improved dramatically in modern times, but social inequalities still make dental care and preventive practices a luxury for many people. We also eat great quantities of processed sugars, and our mouths now provide Las Vegas-style buffets for pathogens. It is not surprising then that we carry more pathogens in our mouths than ever before. In addition, our dental plaque is less diverse. In ecological terms, less biodiversity means less productivity and less resilience against perturbations. Thus, our modern dental plaque is more vulnerable to dietary imbalances and/or invasion by less productive, potentially pathogenic species than our ancestors. Yet despite the fact that I harbor more pathogens in my mouth than my medieval great-aunt, I cannot but feel relieved to live in the 21st century, with toothbrush, toothpaste, dental floss, and regularly scheduled dental cleanings at my disposal. I shall remember to hug my dentist on my next visit.

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