

# Sweet tooth with good teeth

## - Low percentage of dental caries in a neotropical frugivorous bat –

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### Question

Why are frugivorous bats less affected by dental caries than humans?

### Hypothesis

- different oral microbial community than in humans
- variation in morphology and surface structure of the enamel of teeth

### Introduction

Dental caries is in the modern human society one of the most widespread diseases. It affects humans as well as most other mammal species. While there are many studies focusing on dental decay in humans and animal models, there is only little known about the complex microbiological and environmental interactions that lead to dental caries in wild animals.



Fig. 1: Frugivorous bat with fig (Photo C. Ziegler)

The frugivorous bat *Artibeus jamaicensis* (Chiroptera: Phyllostomidae) consumes mainly fruits with high content of sugar (up to 140 mM). However, its teeth are far less affected by cavities than in humans. We conducted a multidisciplinary study involving ecologists, microbiologists and dentists from the University of Ulm and specialists in LASER- technologies (ILM) to confirm this initial observation and to look for possible adaptations.

### Results

#### Microbiome:

- the composition of microorganisms in bats is in general similar to that of humans.

#### Surface structure:

- surface of bats' teeth resembles a hydrophobic double structure, which could impede the adhesion of bacteria and hinder plaque formation.

### Dental diagnoses

Bats were captured on Barro Colorado Island (BCI) in Panama. Teeth of captured bats were categorized using dentist's criteria for determining the incidence of dental caries. Among 230 individuals the prevalence of caries was 1.3 % (3 individuals). In comparison the prevalence of Europeans is 7.5 times higher (9.8 %). Only one individual showed dental caries without the context of traumatic wounds on enamel structure. Using Mira-2-Ton staining, we found that only 0.89 % of the bats' teeth surface was covered by bacterial plaque, which is clearly less than in humans. The combination of exposition of dentin together with a higher retention of plaque may be a probability of the development of caries lesions.

For microbiological analysis of the oral microbiome, we collected saliva from *Artibeus jamaicensis*, on average 130 µl per sample (Fig. 2).

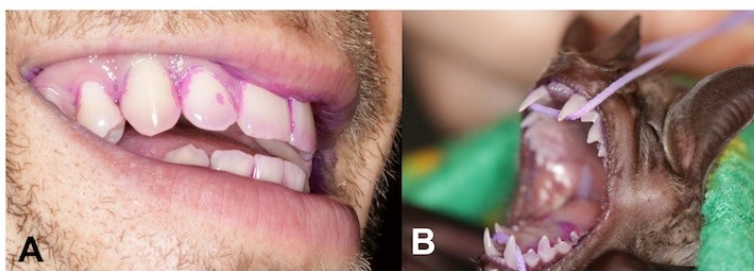


Fig. 3: Stained dental plaque of human [A] and *Artibeus jamaicensis* without plaque [B].

### Orale Microbiome of bats

To characterize the oral microbial community, we analyzed saliva of 204 bats. DNA was extracted and the amplified 16S rDNA was sequenced by 454-Pyrosequencing technique. Among these saliva samples, one sample came from an individual with dental caries.

The composition of microorganisms in the saliva of bats is in general similar to that of humans. This indicates that the saliva of bats does not contain substances which inhibit the growth of cariogenic bacteria. Development of dental caries is potentially possible, as we confirmed the presences of cariogenic bacterial genera in the bats' saliva (Fig. 5). Nevertheless these could not lead to dental caries, probably due the absence of dental plaque, as shown in our dental exam.



Fig. 2: Collection of saliva.

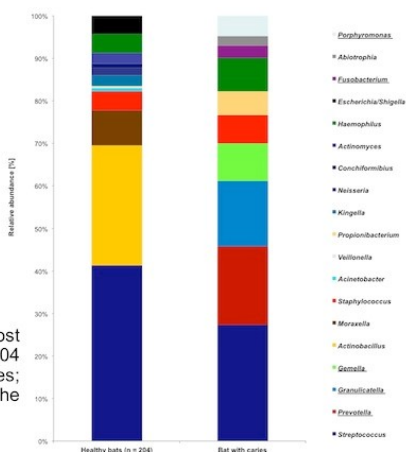


Fig. 5: Relative abundance of the most abundant bacterial genus in the saliva of 204 healthy bats and one bat with dental caries; underlined genus could only be verified in the saliva of the sick animal.

### Teeth structure of bats and humans

Teeth of bats and humans showed pronounced differences in morphology and surface structure. Bat teeth had a thinner enamel layer. That was surprising because due to its higher resistance the enamel acts like a protection layer for the dentin. Therefore we suspected specific surface characteristics that lead to the protection. Analysis of the surface structure via different microscopic techniques indicated interesting differences. The surface structure of human teeth appear striated. In contrast the bats' enamel micro- and nanostructure looks alike a double structure, which could impede the adhesion of bacteria and therefore the formation of plaque (Fig 4). Therefore, we suggest that it's the specialized surface structure of the frugivorous bats' teeth that protects *A. jamaicensis* from dental caries.

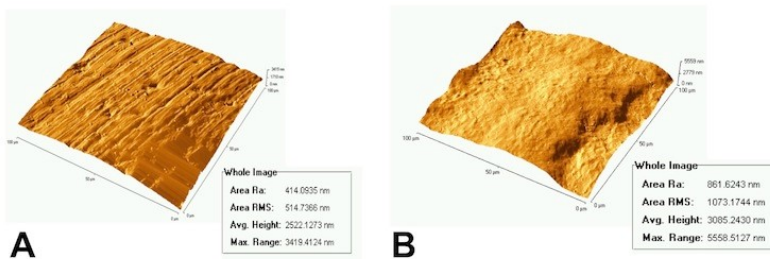


Fig. 4: Comparison of the enamel surface between human teeth [A] and teeth of *A. jamaicensis* via atomic force microscopy (AFM).