

Narrative 9: Tooth wear in mammalian herbivores

From early during my career I was interested in the effect of captivity on tooth wear

starting with a small grant CL 182/1-1 of the German Research Foundation

Clauss et al. (2007) Tooth wear in captive giraffes (*Giraffa camelopardalis*): mesowear analysis classifies free-ranging specimens as browsers but captive ones as grazers. *J Zoo Wildl Med* 38: 433-445

Martin Jurado, Clauss, Hatt (2008) Irregular tooth wear and longevity in captive wild ruminants: a pilot survey of necropsy reports. *J Zoo Wildl Med* 39: 69-75

This work does not only have husbandry relevance, but also documents impressively the effect of different environments on wear

Kaiser, ..., Clauss M (2009) Tooth wear in captive wild ruminant species differs from that of free-ranging conspecifics. *Mammal Biol* 74: 425-437

This led to an invitation to participate in the Catalysis Meeting “Earth Surface Processes Contribute to the Evolution of Mammalian Tooth Shape”, National Evolutionary Synthesis Center (NESCent), Durham NC in 2011

with a resulting review publication based on literature datasets

Kaiser, ..., Clauss (2013) Hypsodonty and tooth facet development in relation to diet and habitat in herbivorous ungulates: implications for understanding tooth wear. *Mamm Rev* 43:34-46

We successfully applied for an International Incoming Marie Curie Fellowship for Carlo Meloro (Acronym W-Tooth), to be hosted at our clinic, in 2013; however, while waiting for the decision, Dr. Meloro had attained a tenured professorship so that we had to refuse the grant.

We explored mechanisms of tooth wear, on a theoretical basis

Kaiser, Clauss, Schulz-Kornas (2016) A set of hypotheses on tribology of mammalian herbivore teeth. *Surf Topogr Metrol Prop* 4:014003,

using faecal samples from wild animals

Hummel, ..., Clauss, Codron (2011) Another one bites the dust - faecal silica levels in large herbivores correlate with high-crowned teeth. *Proc R Soc Lond B* 278: 1742-1747,

(mentioned in NATURE April 7 2011, page 9 under 'Research Highlights of This Week')

using samples from an experiment designed for a very different reason that nevertheless allowed to challenge a long-standing hypothesis in dental wear theory

Schulz, ..., Clauss, et al. (2013) Dietary abrasiveness is associated with variability of microwear and dental surface texture in rabbits. *PLoS One* 8: e56167,

as well as performing controlled experiments with carefully designed diets *in vitro*

Karme, ..., Clauss, Fortelius (2016) Mechanical modelling of tooth wear. *J R Soc Interface* 13:20160399,

and *in vivo*

Müller, Clauss et al. (2014) Growth and wear of incisor and cheek teeth in domestic rabbits (*Oryctolagus cuniculus*) fed diets of different abrasiveness. *J Exp Zool A* 321:283-298.

Our results demonstrate that both internal (phytoliths) and external (grit) abrasives cause dental wear, which is an important contribution to the current discussion about the drivers of tooth wear.

Our work on tooth wear led to my participation in SNSF project 31003A_163300/1 (PI Jean-Michel Hatt) and in ERC Consolidator Grant ('Vertebrate Herbivory' to Thomas Tütken)

These projects spawned series of publications on various aspects of tooth wear based on empirical data from carefully designed experiments, e.g.

first empirical data for a long-suspected compensation mechanism

Ackermans, Clauss et al. (2019) Root growth compensates for molar wear in adult goats (*Capra aegagrus hircus*). *J Exp Zool A* 331: 139-148,

or the first empirical data for another long-suspected mechanism for enamel wear:

Martin, ... Clauss (2019) The way wear goes – phytolith-based wear on the dentine-enamel system in guinea pigs (*Cavia porcellus*). *Proc R Soc B* 286:20191921.

For her publication on tooth wear in guinea pigs, Louise Martin was awarded the Young Scientist Award of Vetsuisse Faculty of the University of Zurich, 2020.

as well as insights on the action of internal or external abrasives:

Winkler ..., Clauss, Tütken (2019) Forage silica and water content control dental surface texture in guinea pigs - implications for diet reconstruction. *PNAS* 116: 1325-1330.

Winkler, ..., Clauss (2020) Shape, size, and quantity of ingested external abrasives influence dental microwear texture formation in guinea pigs. *PNAS* 117: 22264-22273

and a basically novel, critical assessment of the interrelationships of various proxies of dental wear

Ackermans, ..., Clauss M (2021) Correlation of dietary wear proxies in a long term feeding experiment with sheep (*Ovis aries*). *J R Soc Interface* 18: 20210139

Our work on tooth wear led to an invited plenary talks at the 2019 Swiss Veterinarians Conference, Fribourg, Switzerland on *Dental health in rodents and rabbits*.

An important aspect of our work on tooth wear are species-specific adaptations that defy considering wear as a 'taxon-free' process. We are currently exploring new ways of assessing species- or taxon-specificity in dental biology

Fischer ..., Clauss et al. (2022) Species-specific enamel differences in hardness and abrasion resistance between the permanent incisors of cattle (*Bos primigenius taurus*) and the ever-growing incisors of nutria (*Myocastor coypus*). *PLoS One* 17: e0265237

For this work, Valentin Fischer was awarded the ***Semester Award 2022 of the University of Zurich.***

the relevance of tooth wear in production animals, as well as new ways to evaluate the functional relevance of tooth shape, using humans not as models but as test chewers.