Narrative 3: Digesta kinetics and separation mechanisms

Digesta does not move uniformly through the gut, but different components (fluids, small and large particles) may move in different ways, depending on separation mechanisms. Since the beginning of my career

Clauss, Lechner-Doll (**2001**) Differences in selective reticulo-ruminal particle retention as a key factor in ruminant diversification. ***Oecologia*** 129: 321-327,

Jürgen Hummel and me have been constantly expanding the knowledge on nondomestic ruminant species in this context, with a large set of recent additions

Przybyło, ..., **Clauss** (**2019**) Digesta passage in nondomestic ruminants: separation mechanisms in 'moose-type' and 'cattle-type' species, and seemingly atypical browsers. ***Comp Biochem Physiol A*** 235:180-192.

The predominance of 'digesta washing' - the washing of rumen contents by fluids that flush very fine particles, such as microbes, into the lower digestive tract at a faster rate than regular 'small' food particles - in a diversity of species emphasizes its relevance in ruminant evolution. We identified primates to be apparently constrained in this respect, representing the only large mammal group in which digesta washing has not evolved

Müller, ..., **Clauss** (**2011**) Phylogenetic constraints on digesta separation: variation in fluid throughput in the digestive tract in mammalian herbivores. ***Comp Biochem Physiol A*** 160: 207–220

The effect of digesta washing, and hence its adaptive values, most probably lies in enhancing microbial harvest and microbial growth efficiency

Clauss, Hummel (2017) Physiological adaptations of ruminants and their potential relevance for production systems. Rev Bras Zootec 46: 606-613.

Separation mechanisms also play a role in the form of 'sorting mechanisms', e.g. in the size-discriminating sorting in ruminating foregut fermenters

Clauss et al. (**2011**) The effect of size and density on the mean retention time of particles in the reticulorumen of cattle (*Bos primigenius* f. *taurus*), muskoxen (*Ovibos moschatus*) and moose (*Alces alces*). ***Br J Nutr*** 105: 634-644

Dittmann, ..., **Clauss** (**2015**) Digesta retention patterns of solutes and different-sized particles in camelids compared with ruminants and other foregut fermenters. ***J Comp Physiol B*** 185:559-573,

and in the colonic separation mechanism of small herbivores that is the prerogative for coprophagy in lagomorphs and many rodents

Hagen, ..., **Clauss** (**2018**) Digesta kinetics in two arvicoline rodents, the field vole (*Microtus agrestis*) and the steppe lemming (*Lagurus lagurus*). ***Mamm Biol*** 89: 71-78.

In this line of research, we refined methodological aspects of displaying and interpreting digesta retention data,

Clauss et al. (**2007**) Demonstrating coprophagy with passage markers? The example of the plains viscacha (*Lagostomus maximus*). ***Comp Biochem Physiol A*** 147: 453-459

Matsuda, ..., **Clauss** (**2015**) Excretion patterns of solute and different-sized particle passage markers in foregut-fermenting proboscis monkey (*Nasalis larvatus*) do not indicate an adaptation for rumination. ***Physiol Behav*** 149:45-52,

and we developed a simple *in vivo* method to assess the differential selection of large vs. small particles in animals that would chew different-sized markers into a homogenous mass

Hummel, ..., **Clauss** (**2018**) Comparative selective retention of particle size classes in the gastrointestinal tract of ponies and goats. ***J Anim Physiol Anim Nutr*** 102: 429-439,

and amassed evidence for a lack of digesta mixing in the whole primate order

Matsuda, ..., **Clauss** (**2019**) Retention marker excretion suggests incomplete digesta mixing across the order primates. ***Physiol Behav*** 208:112558

The experience with measuring retention of digesta led to the participation in the largest comparative collection of digesta passage data in mammals and birds to date

Abraham, ..., **Clauss**, et al. (**2020**) Improved estimation of gut passage time considerably affects trait-based dispersal models. ***Funct Ecol*** 35: 860-869

and our extensive collection of digesta kinetics patterns formed a core part of

an invited review paper for Philosophical Transactions of the Royal Society B

Clauss et al. (2023) Teeth and the gastrointestinal tract in mammals: when 1 + 1 = 3. ***Phil Trans R Soc B*** 378:20220544

We are constantly looking for opportunities to measure digesta kinetics in species for which no data exists.

Additionally, I hope to combine our wealth of detailed *in vivo* data with an *in vitro* study to synthesize the methodological aspects of retention time measurements and the influence of digestive tract anatomy.