



Digesta kinetics in mammalian herbivores: the logistics and the value of research with zoo animals



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**University of
Zurich** ^{UZH}



Clinic
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Why do research with zoo animals?



What kind of research is of interest?



**Developing
the research
potential of
zoos and aquaria**

The EAZA Research Strategy



What kind of research is of interest?



Conservation of biodiversity is set as a main driver

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What kind of research is of interest?

Identify research priorities

The scope for research is huge, and time and resources are always limited, so it is important to identify research priorities. There are several bases for this.

For example:

- > degree of threat, where threatened species are high priorities (e.g. IUCN www.redlist.org);
- > species that are endemic to biodiversity hotspots (e.g. www.unep-wcmc.org);
- > problems identified by EAZA Taxon Advisory Groups, EEP Species Committees and other EAZA Groups;
- > biological issues in individual collections;
- > specialities and facilities of associated university departments;
- > specialities and expertise of staff.



What kind of research is of interest?

**To the zoo /
zoo community**

**To many students /
researchers**



What kind of research is of interest?

To the zoo / zoo community

- conservation-related issues
- issues related to animal welfare (i.e., captivity)

To many students / researchers



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reproduction, diseases (diagnostics and intervention), management, biological characteristics, enrichment, nutrition

To many students / researchers

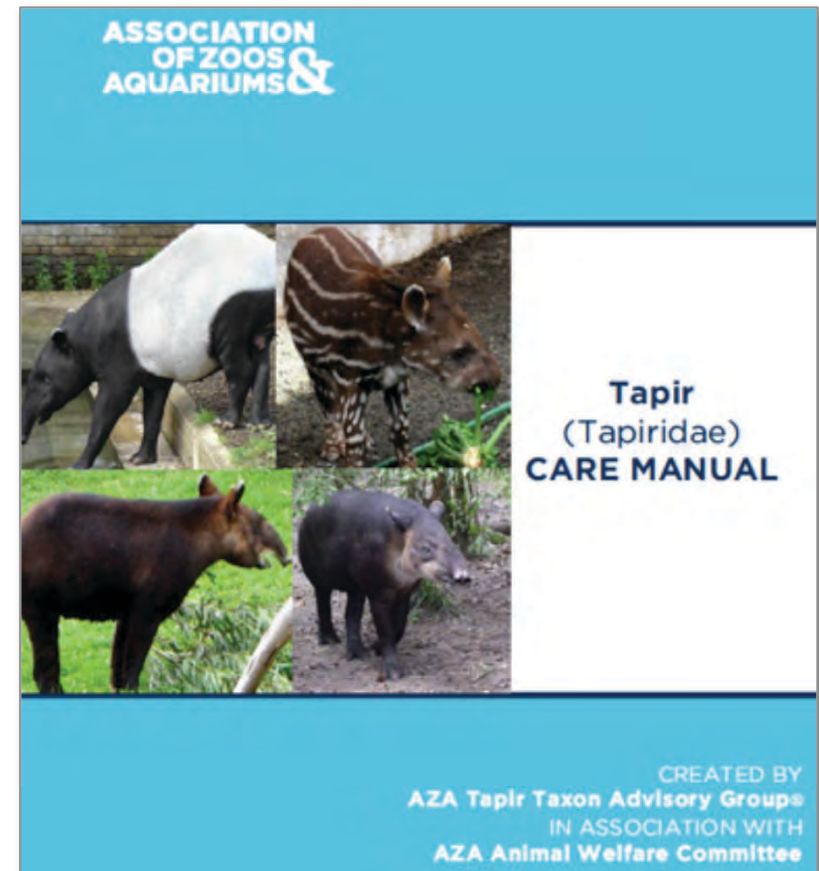


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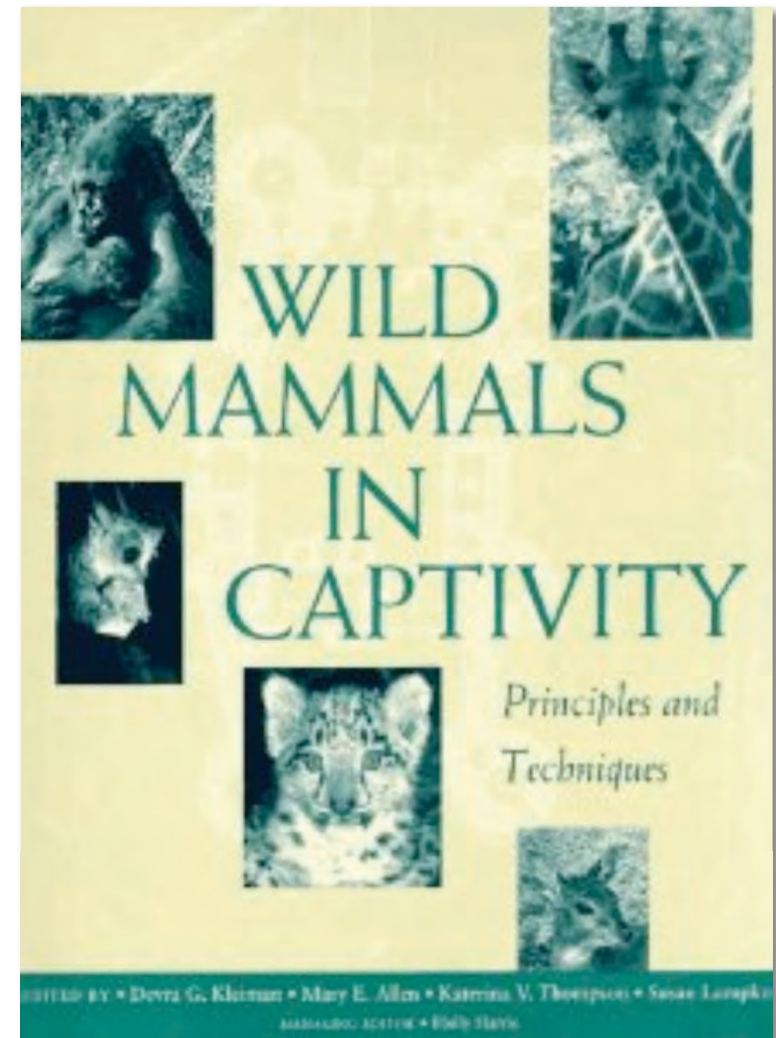


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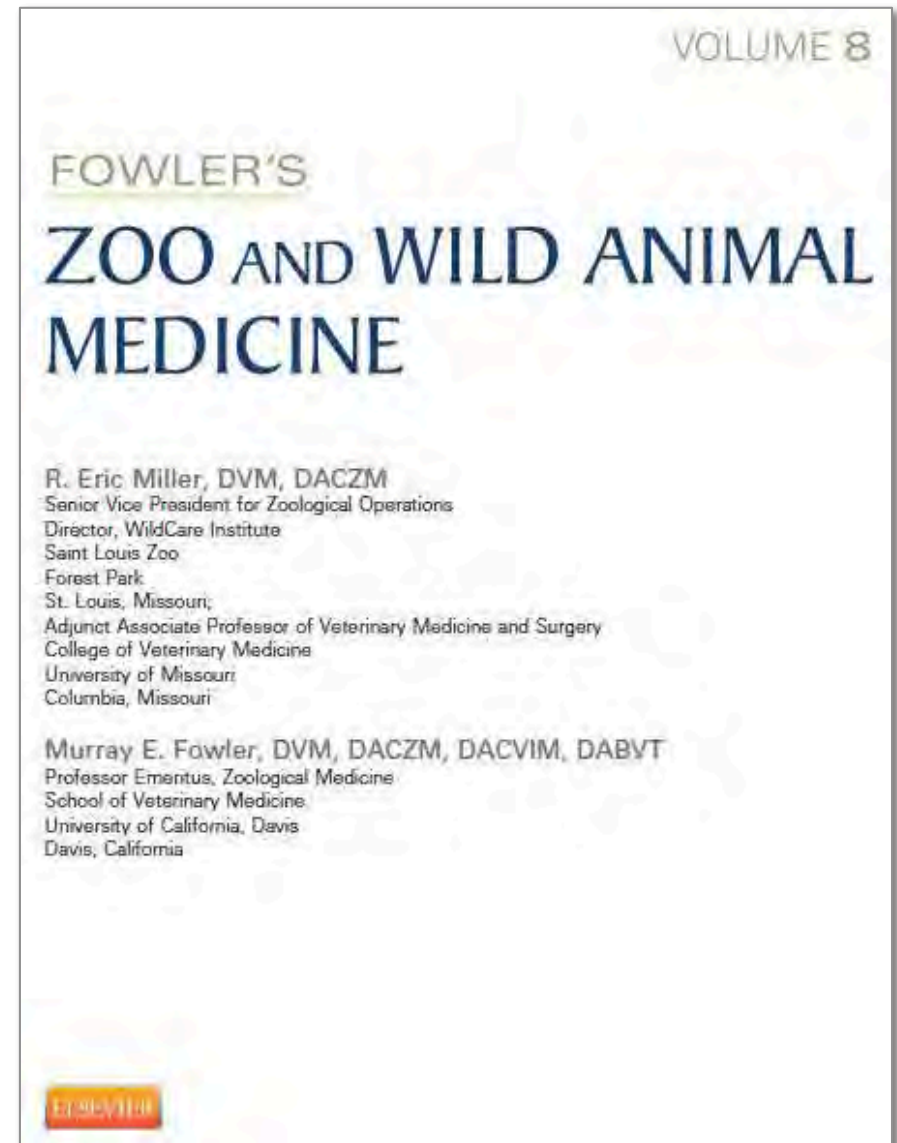


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- anything that allows work with zoo animals
- high 'adventure' factor
- pioneer situation
 - easy way to expertise position
 - perception of low failure risk
- automatic justification (at first)



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Justifications?

**To the zoo /
zoo community**

**To many students /
researchers**



- conservation-related issues

- issues related to animal welfare (i.e., captivity)

reproduction, diseases (diagnostics and intervention), management, biological characteristics, enrichment, nutrition

anything that allows work with zoo animals

XYZ is a highly endangered species ...

... more knowledge is essential for the management of this endangered species ...

• high 'adventurous' factor
• pioneer situation

- easy way to expertise position
- perception of low failure risk

• automatic justification



What kind of research is of interest?



Wider needs and benefits As well as underpinning practical or applied science, zoo research can make a general, perhaps major contribution to fundamental or theoretical knowledge.

**Developing
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The EAZA Research Strategy



Practical problems

- sample size
- permits (CITES, internal and official animal welfare committees)
- logistics of physically attaining the sample
- logistics of sample storage and transport





Case example: digesta retention studies



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What are the minimum conditions you need to perform reasonable studies on digestive physiology?



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What are the minimum conditions you need to perform reasonable studies on digestive physiology?



from Lechner et al. (2010)



Case example: digesta retention studies

What are the minimum conditions you need to perform reasonable studies on digestive physiology?



from Munn et al. (2015)



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from Dittmann et al. (2015)



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from Clauss et al. (2013)



Case example: digestion studies

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Case example: digesta retention studies

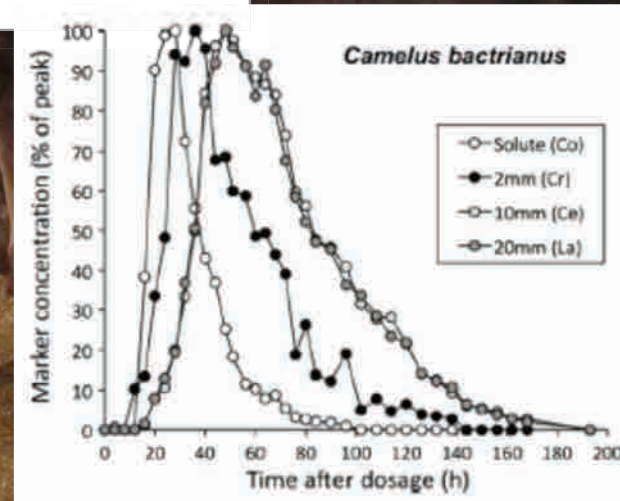
What are the minimum conditions you need to perform reasonable studies on digestive physiology?

J Comp Physiol B (2015) 185:559–573
DOI 10.1007/s00360-015-0904-x

ORIGINAL PAPER

Digesta retention patterns of solute and different-sized particles in camelids compared with ruminants and other foregut fermenters

Marie T. Dittmann^{1,2} · Ullrich Runge³ · Sylvia Ortmann⁴ · Richard A. Lang⁵ ·
Dario Moser⁶ · Cordula Galeffi⁷ · Angela Schwarm² · Michael Kreuzer² ·
Marcus Clauss¹

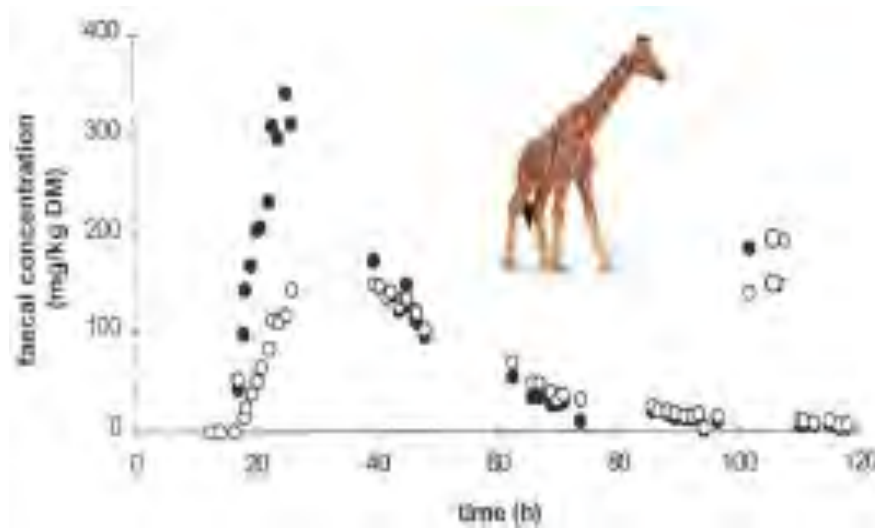




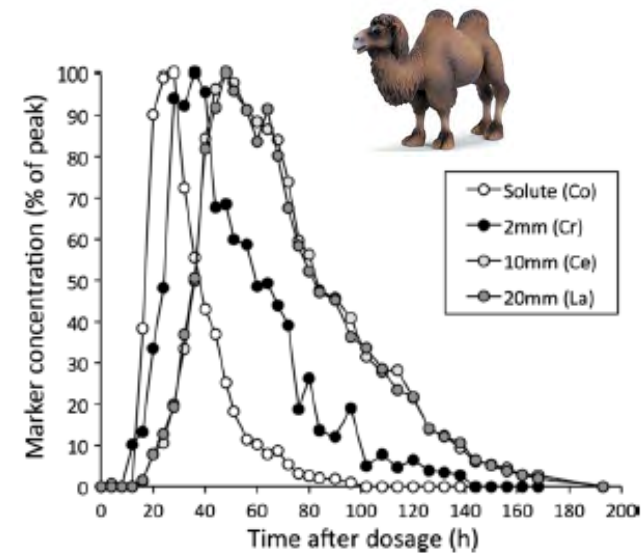
Case example: digesta retention studies

What are the minimum conditions you need to perform reasonable studies on digestive physiology?

Sampling frequency test



giraffe study



camel study

=> how much are you allowed and are you prepared to work?



Digesta retention allometry

Comparative Biochemistry and Physiology, Part A 164 (2013) 129–140



Contents lists available at [SciVerse ScienceDirect](#)

Comparative Biochemistry and Physiology, Part A

journal homepage: www.elsevier.com/locate/cbpa



Assessing the Jarman–Bell Principle: Scaling of intake, digestibility, retention time and gut fill with body mass in mammalian herbivores

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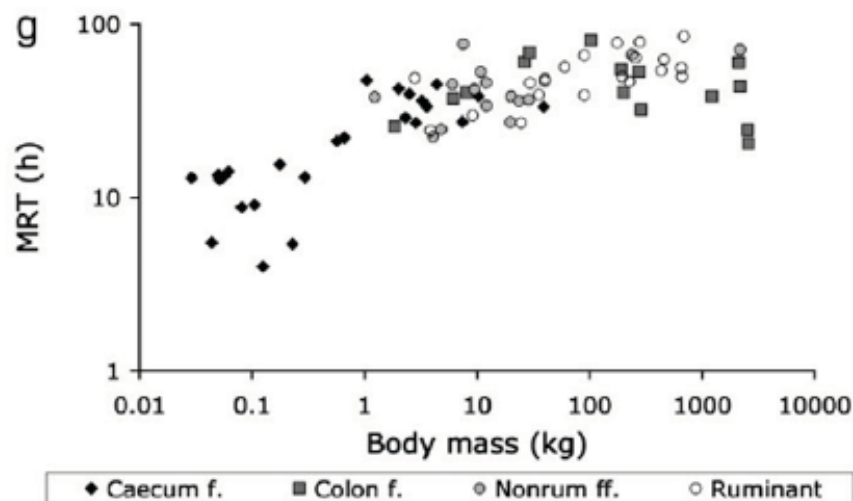
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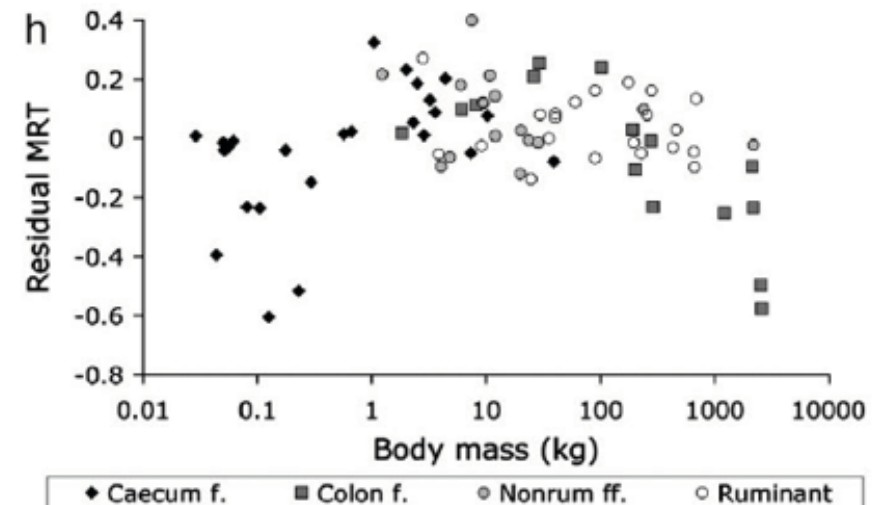
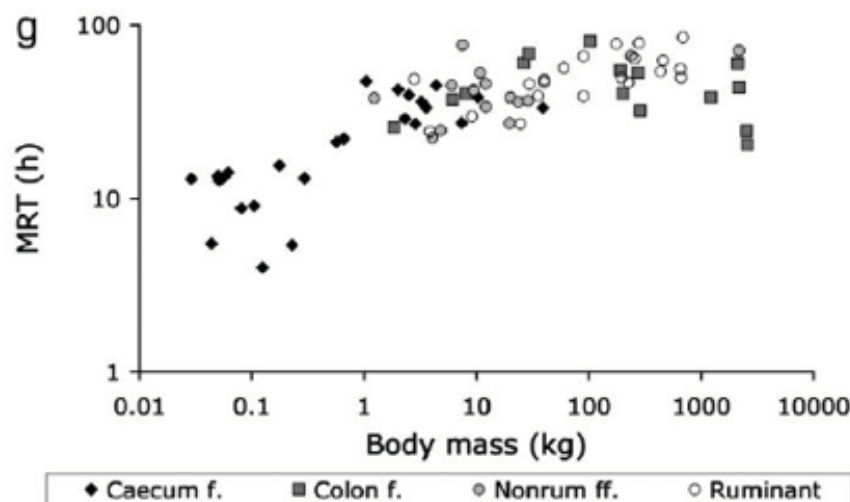
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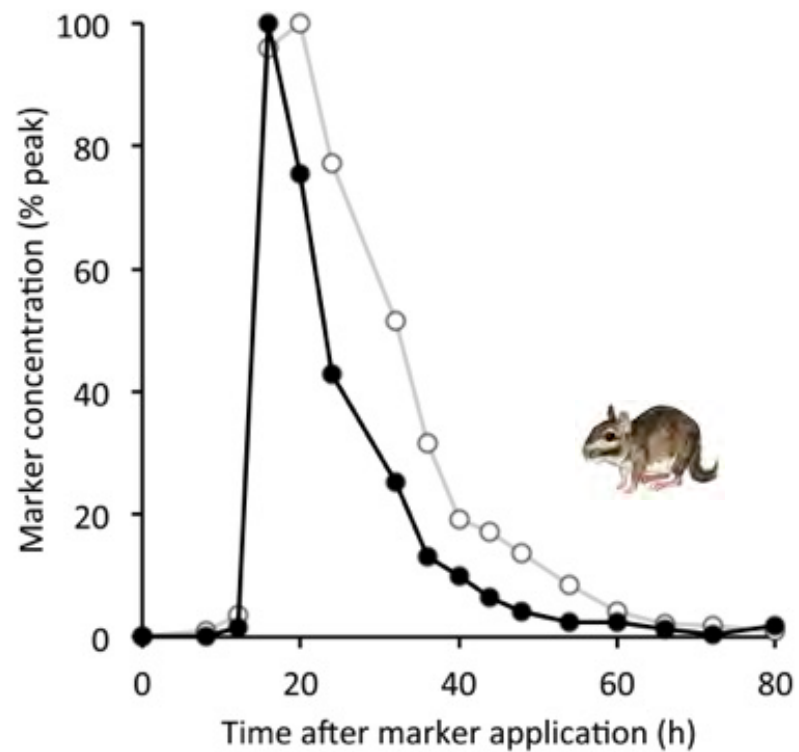
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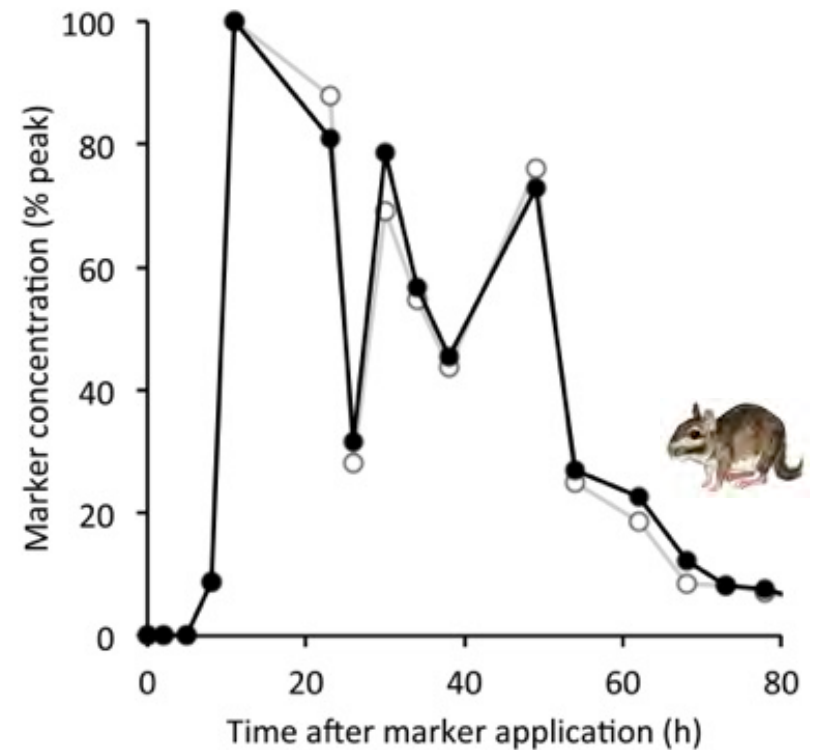
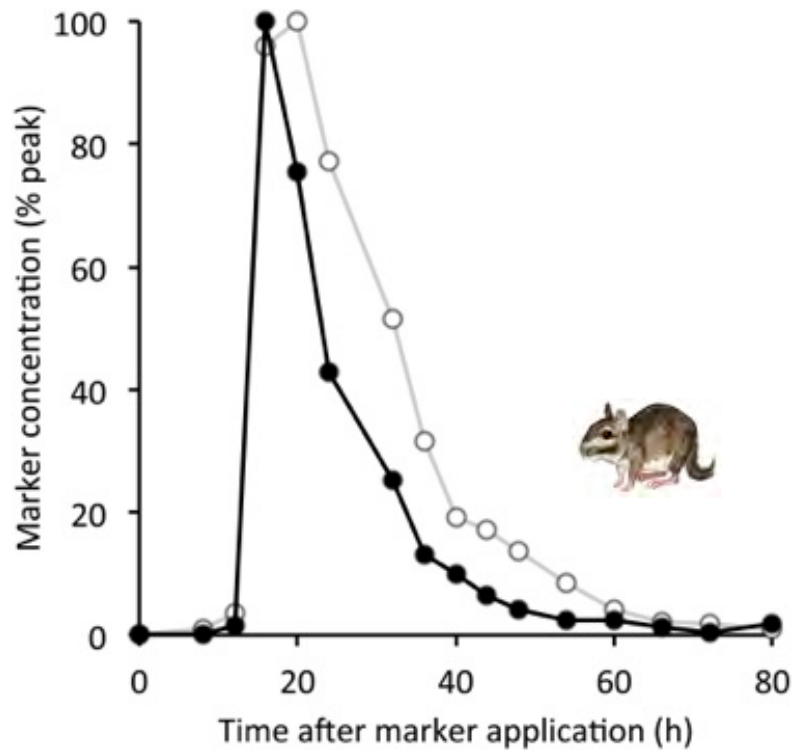


Patterns: secondary marker peaks





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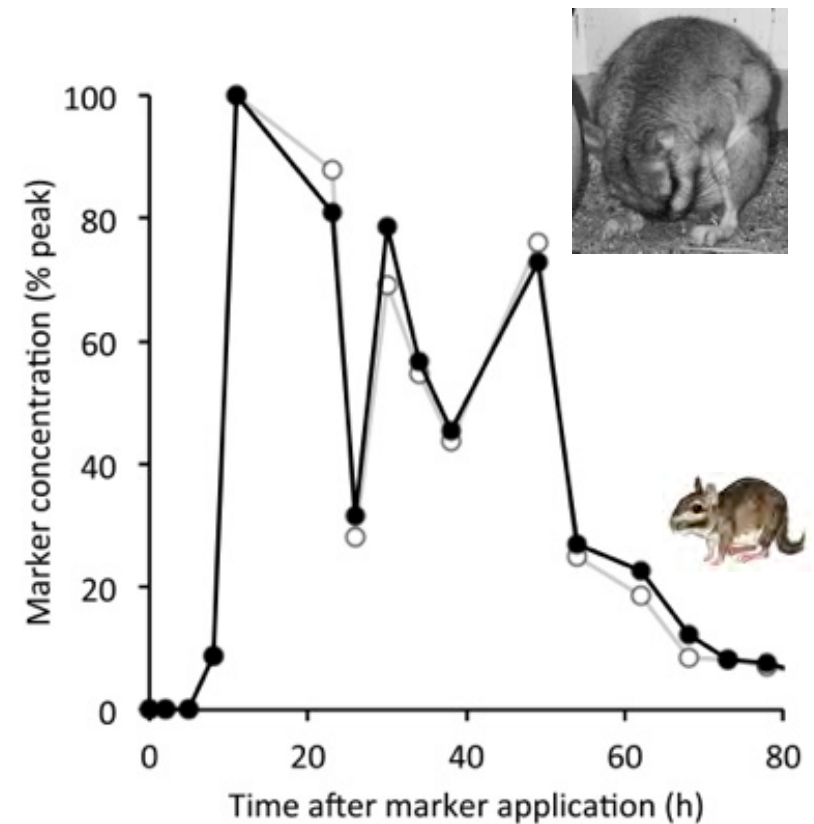
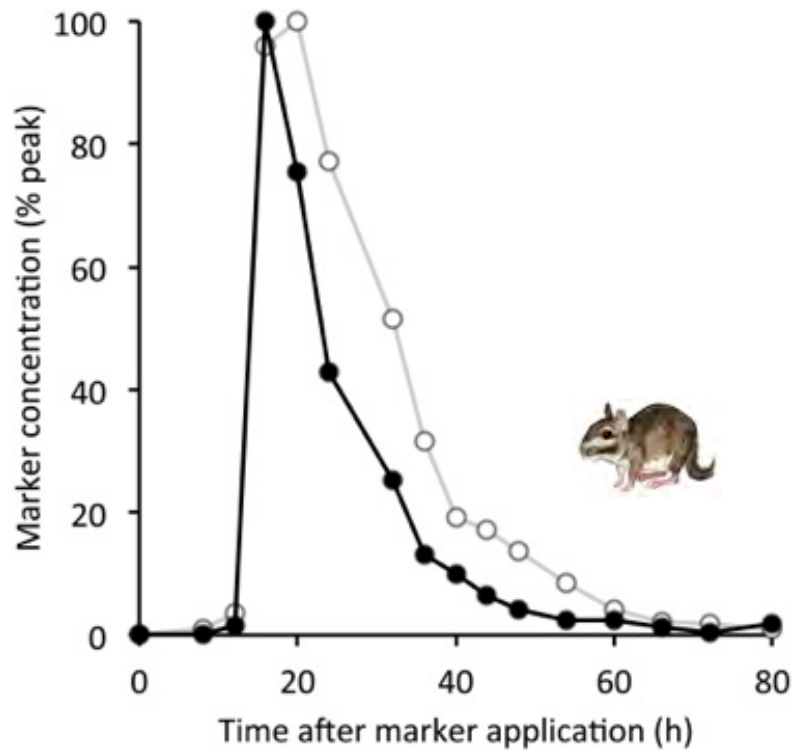


from Hagen et al. (2015)



Patterns: secondary marker peaks

Indication for coprophagy

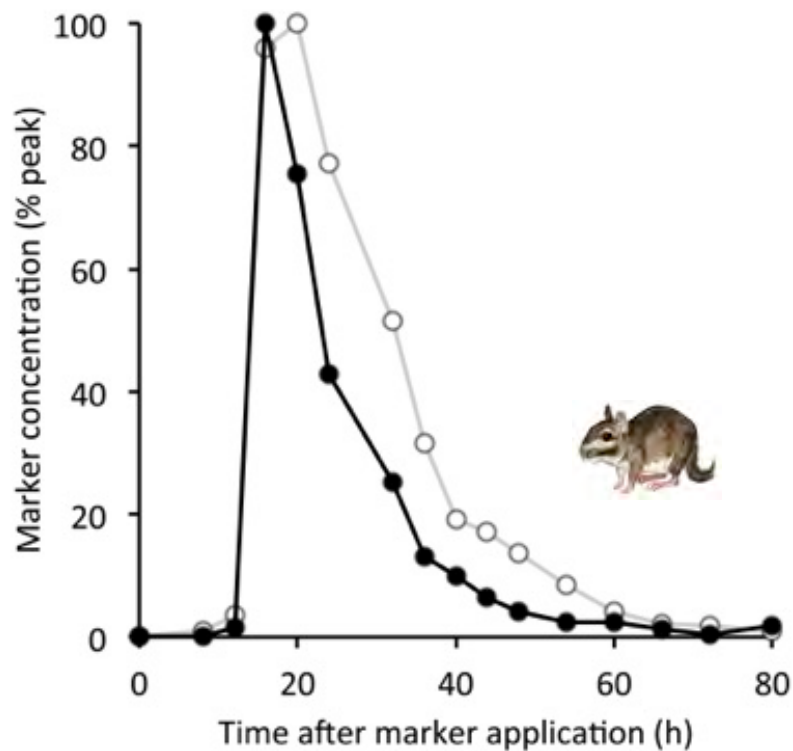


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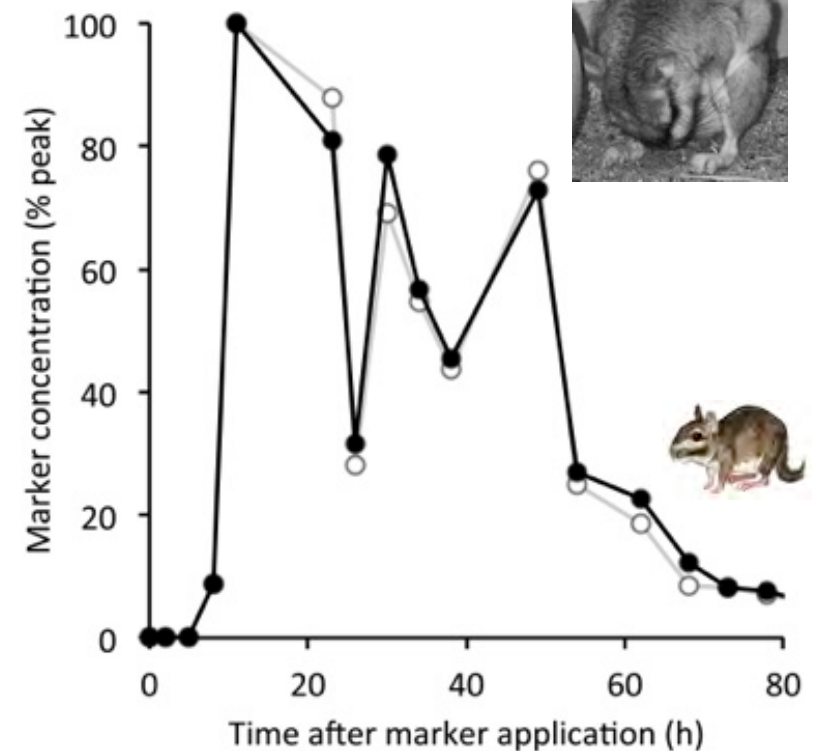


Patterns: secondary marker peaks

Indication for coprophagy



high-protein diet



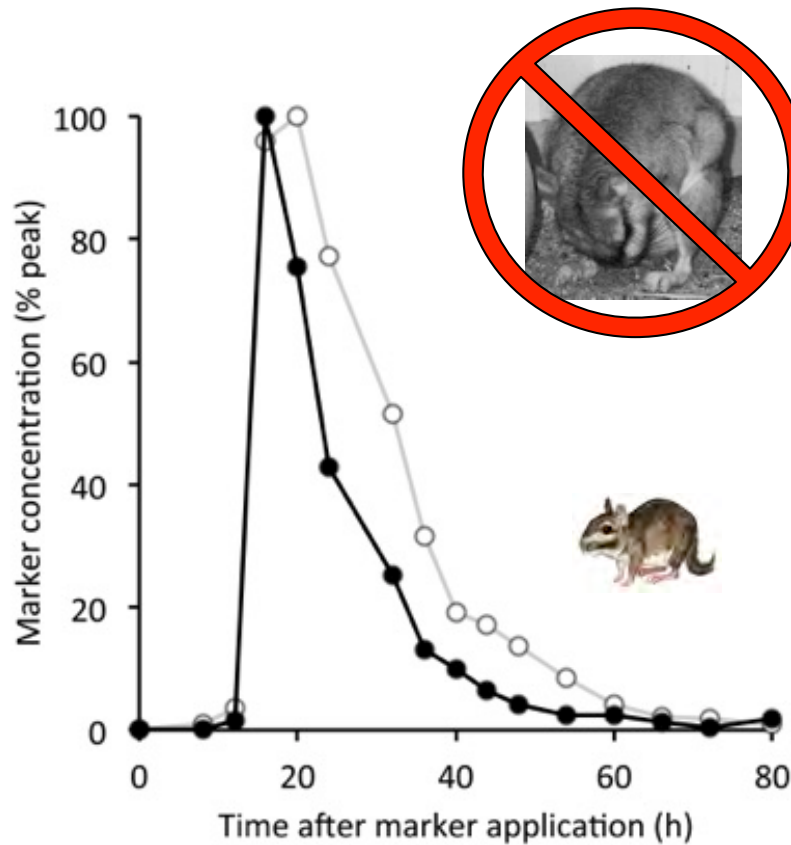
low-protein diet

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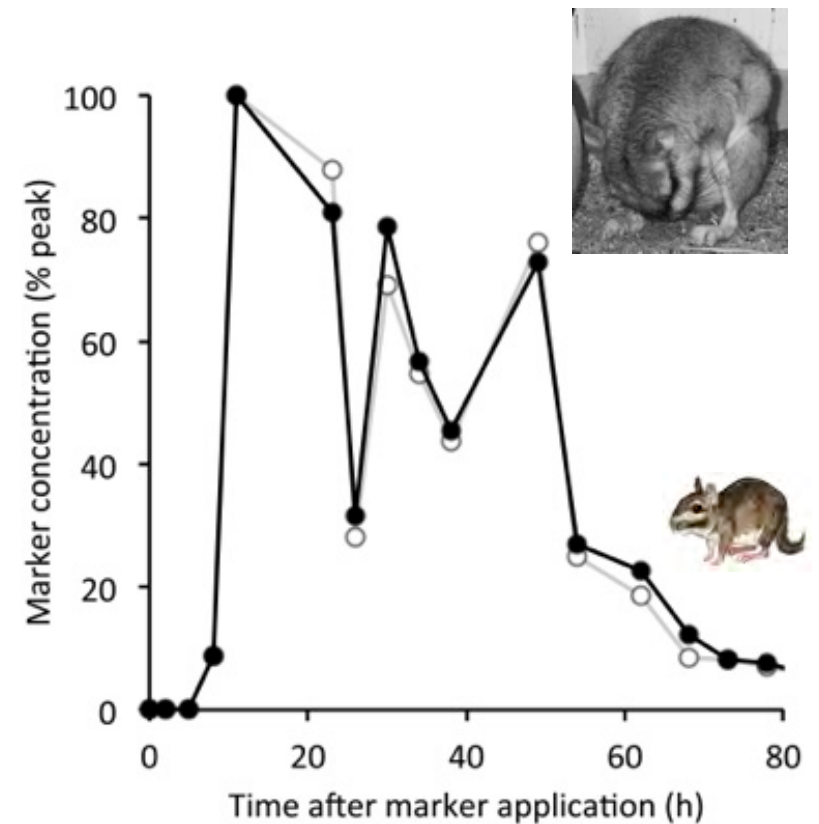


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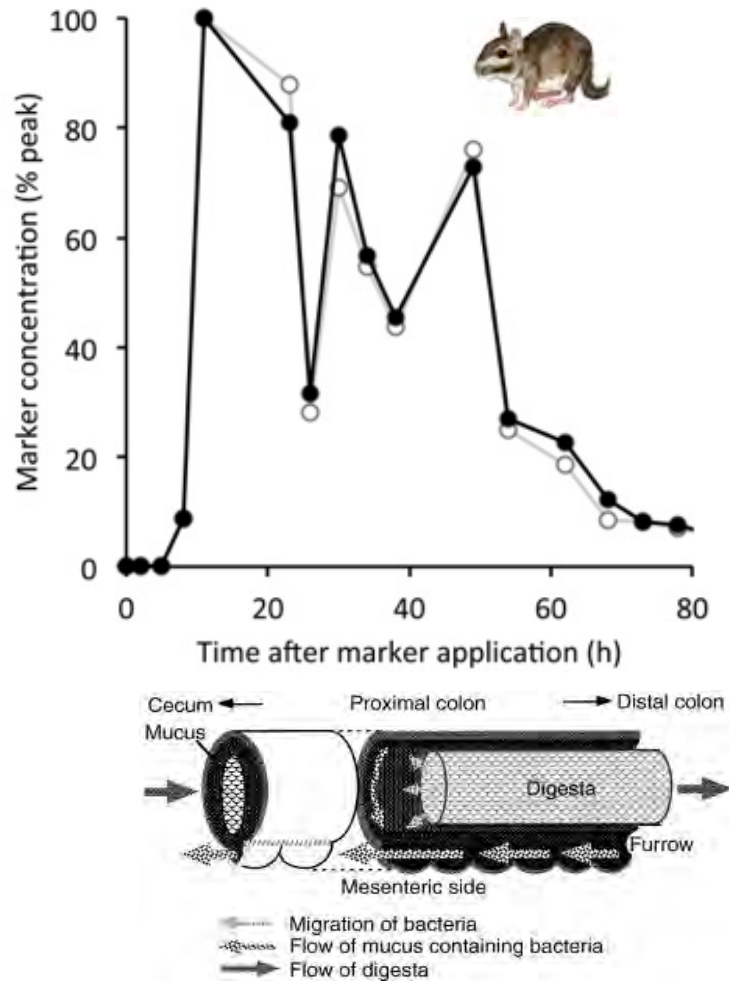
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Sorting of ingesta for caecotroph formation

Mucus trap mechanism (Hystricomorph rodents)

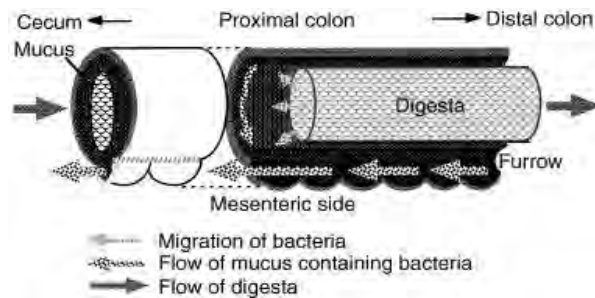
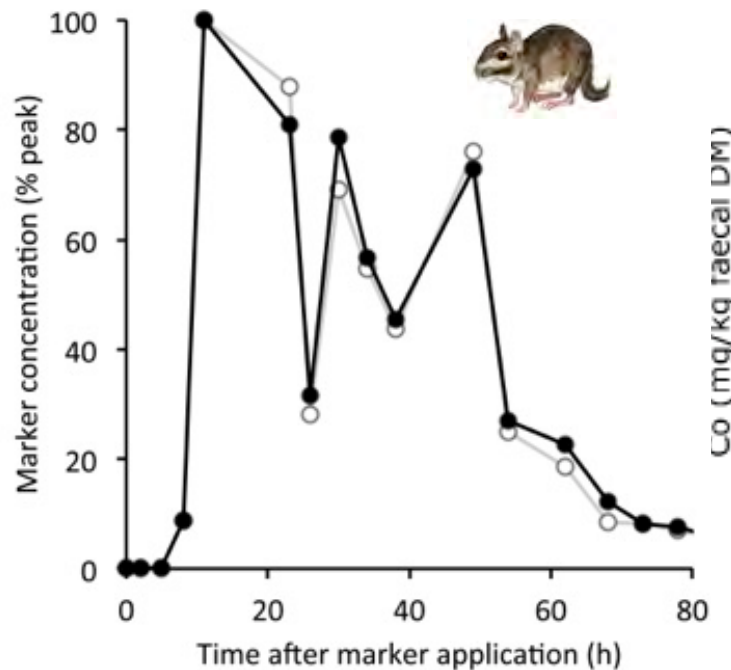


from Hagen et al. (2015), Sakaguchi & Hume (1991)

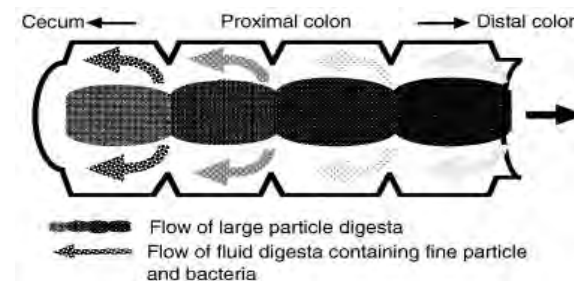
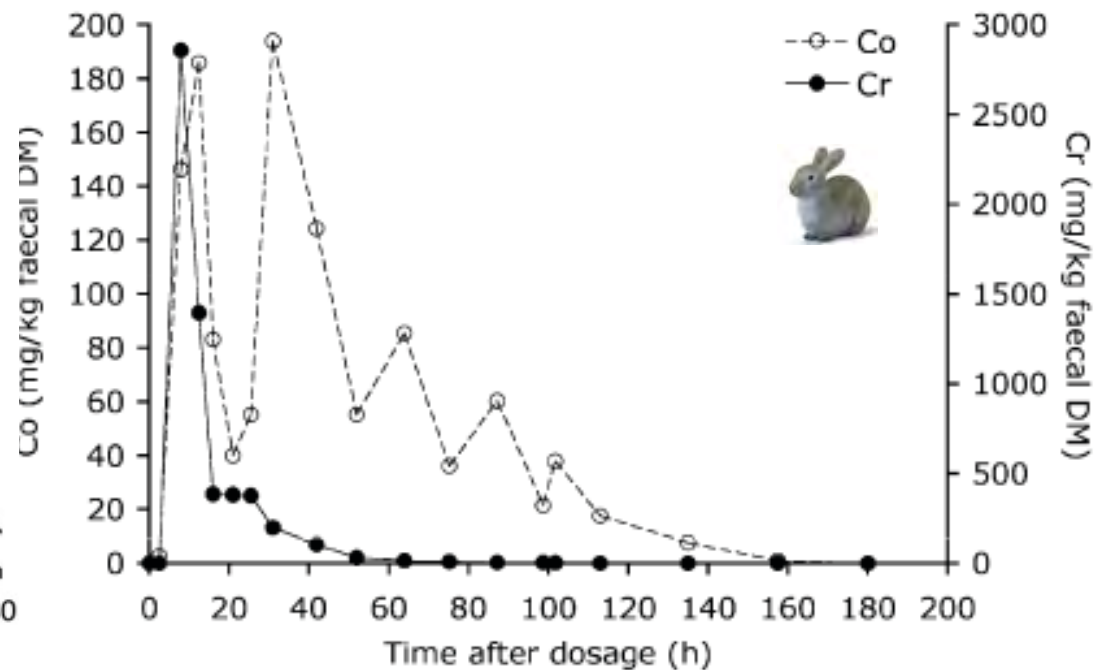


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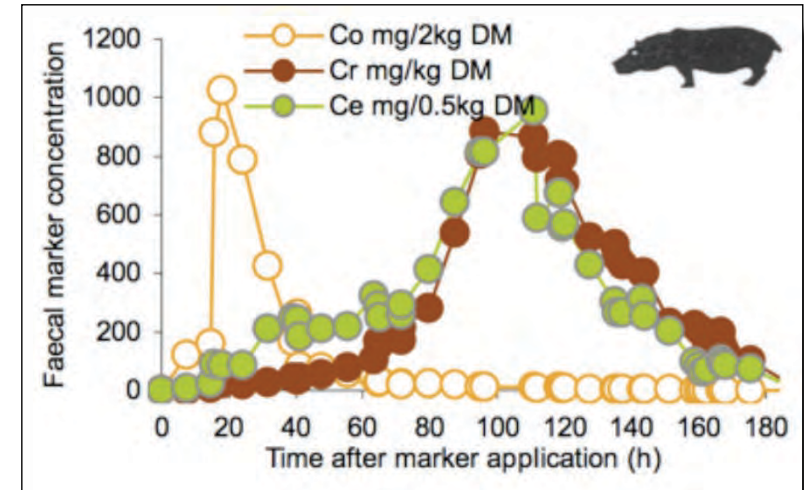
Wash back mechanism (Lagomorphs)



from Hagen et al. (2015), Sakaguchi & Hume (1991), Franz et al. (2011)



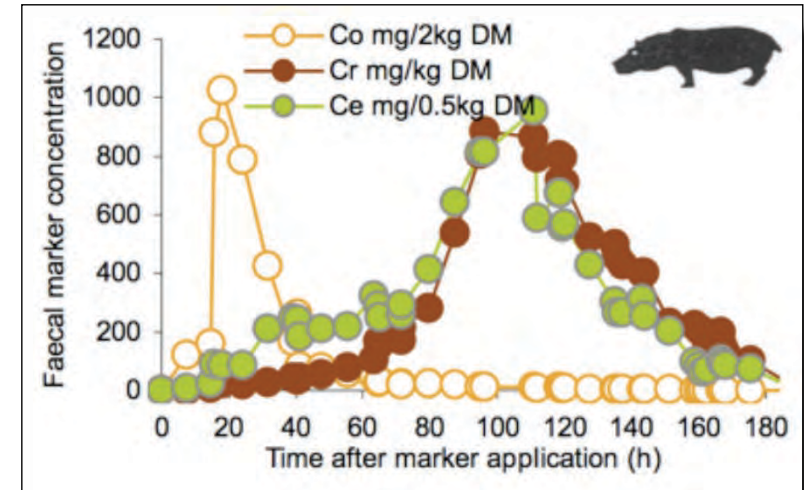
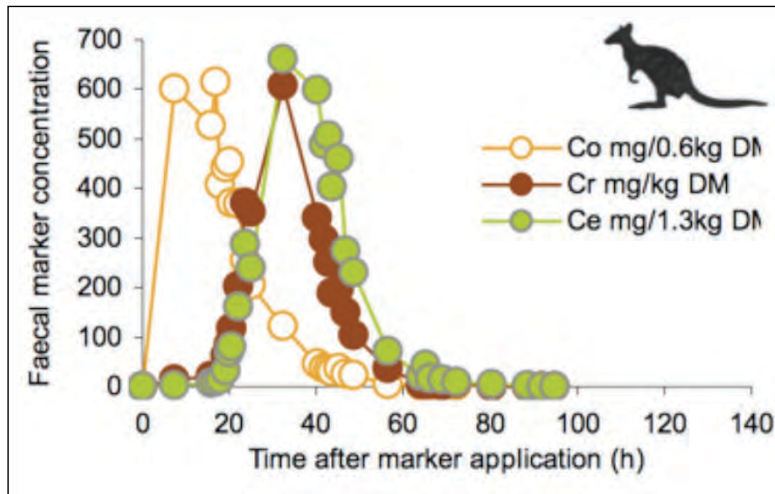
Ruminant vs. Nonruminant Foregut Fermentation



Schwarm et al. (2008)



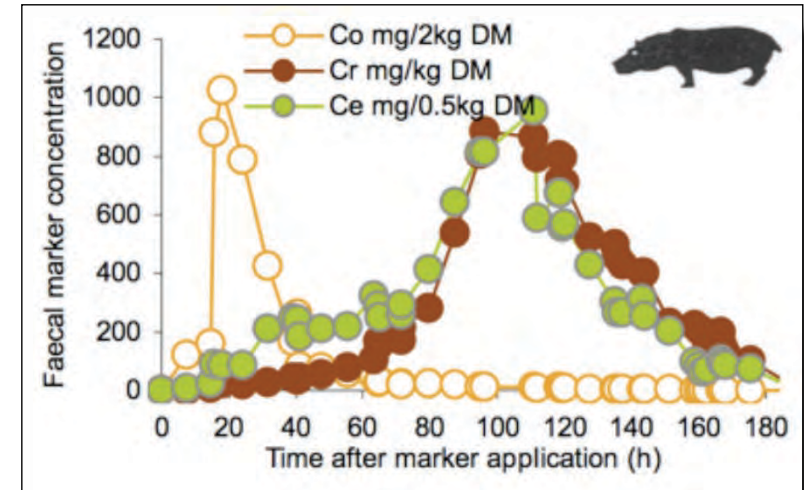
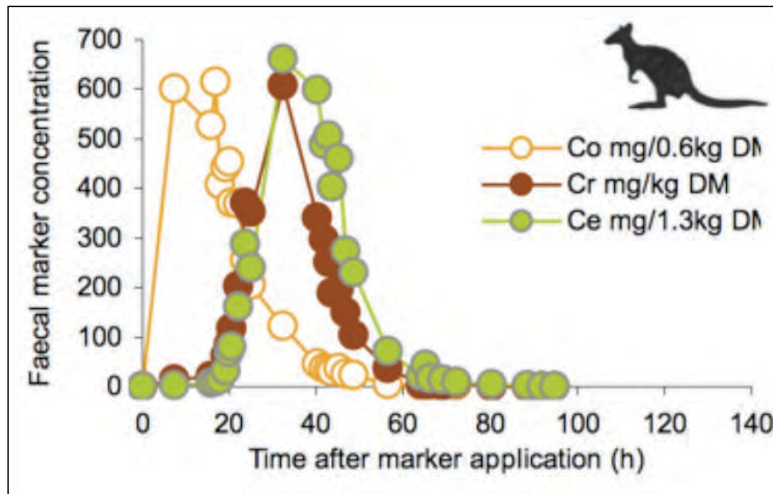
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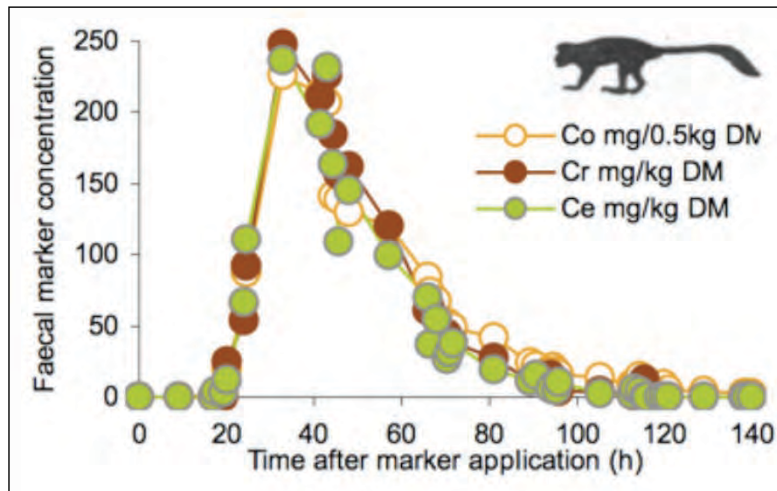
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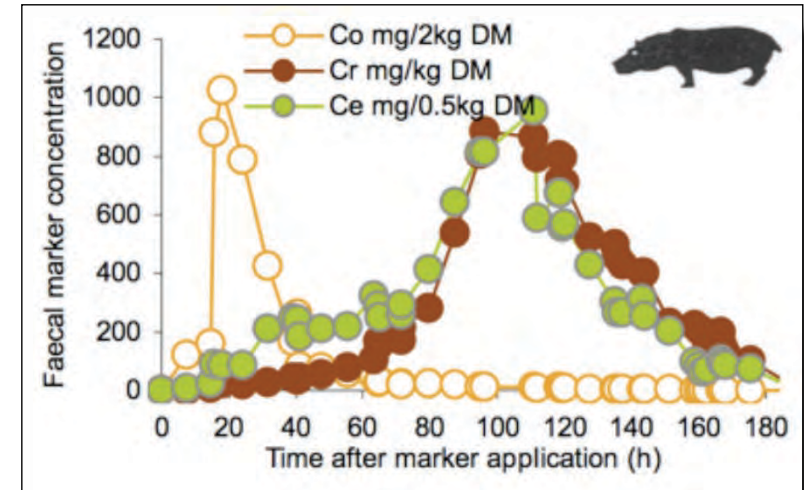
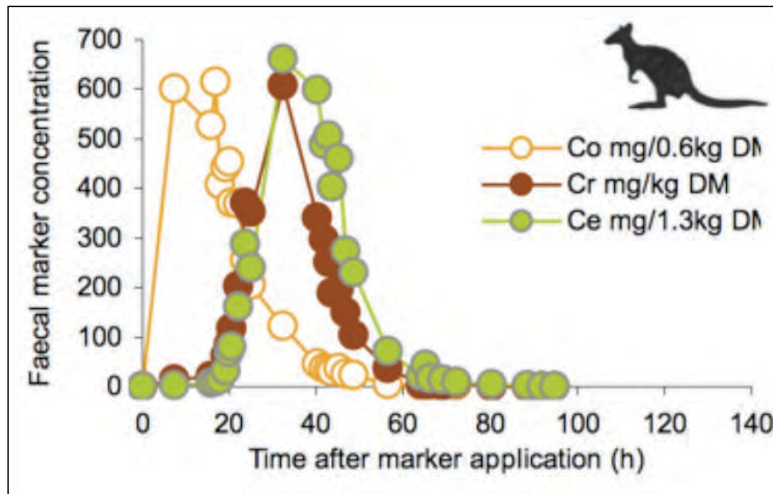


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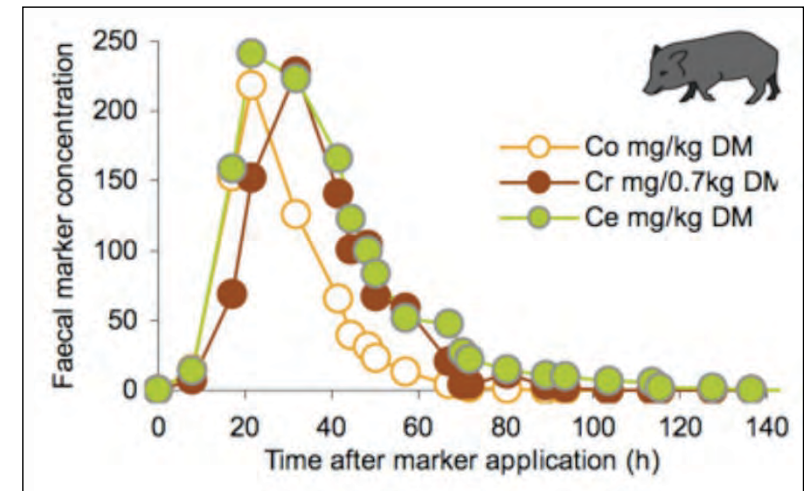
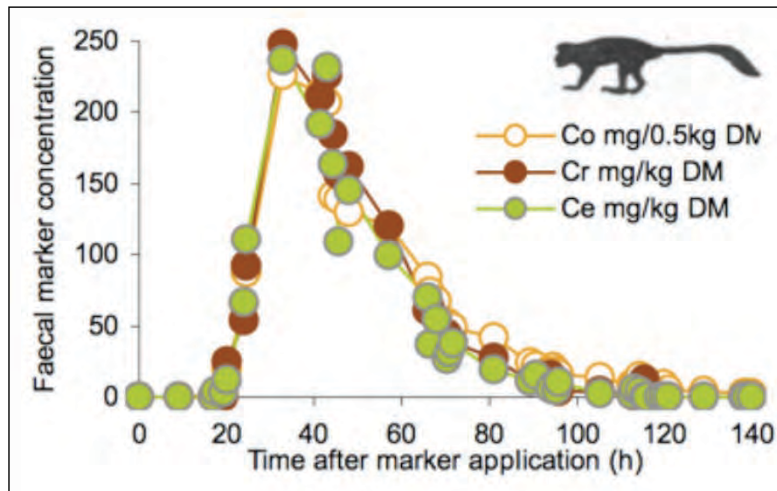




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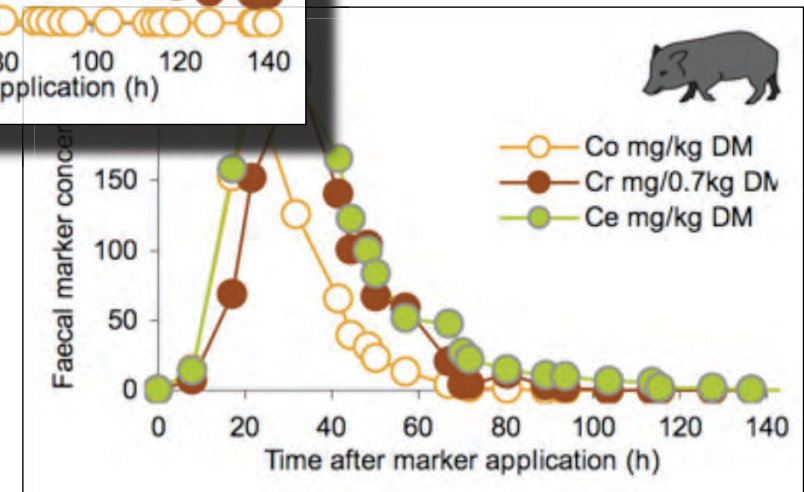
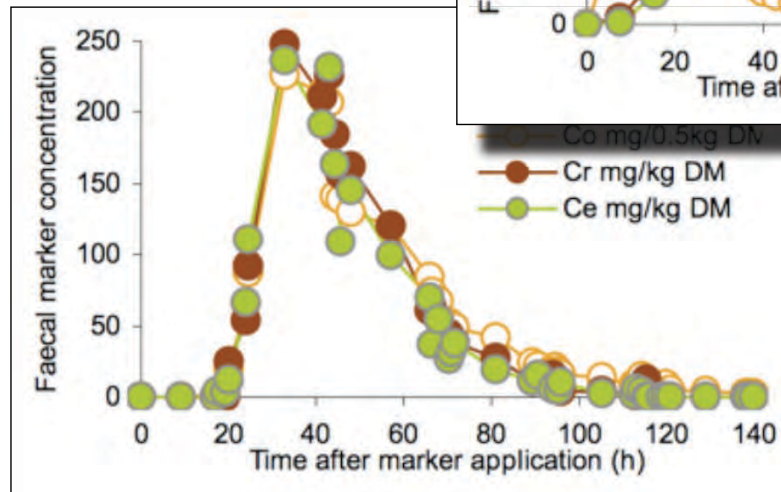
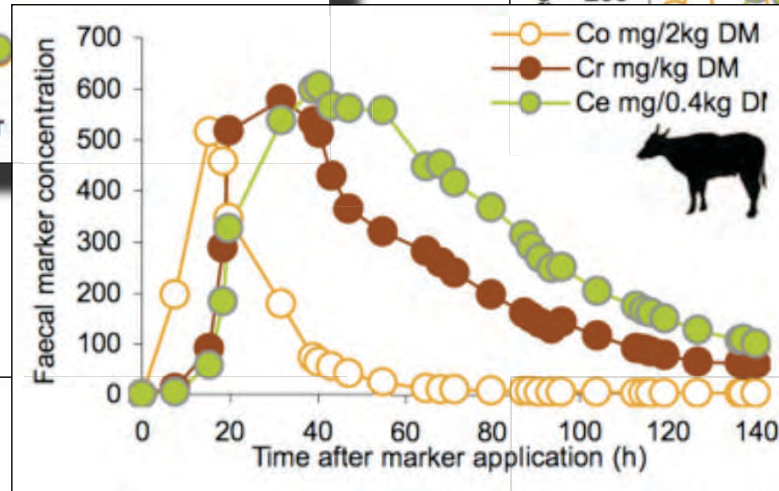
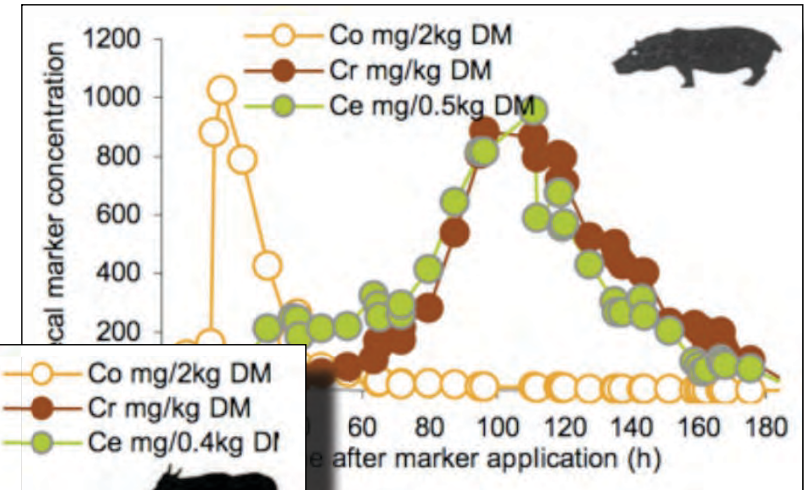
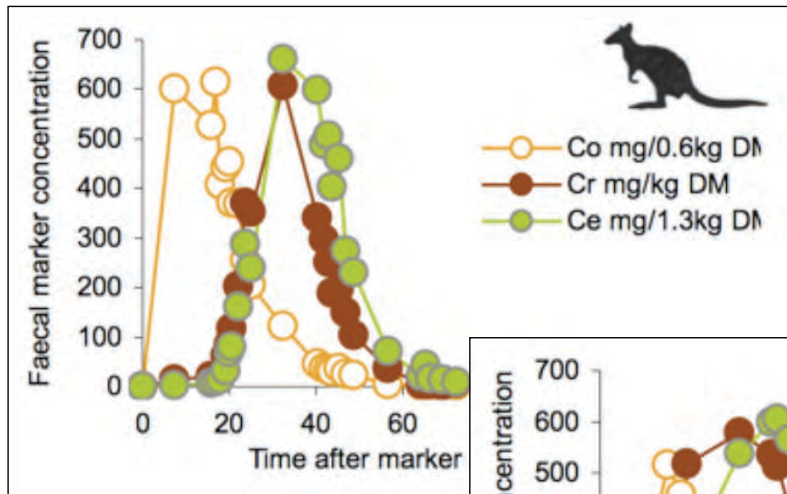


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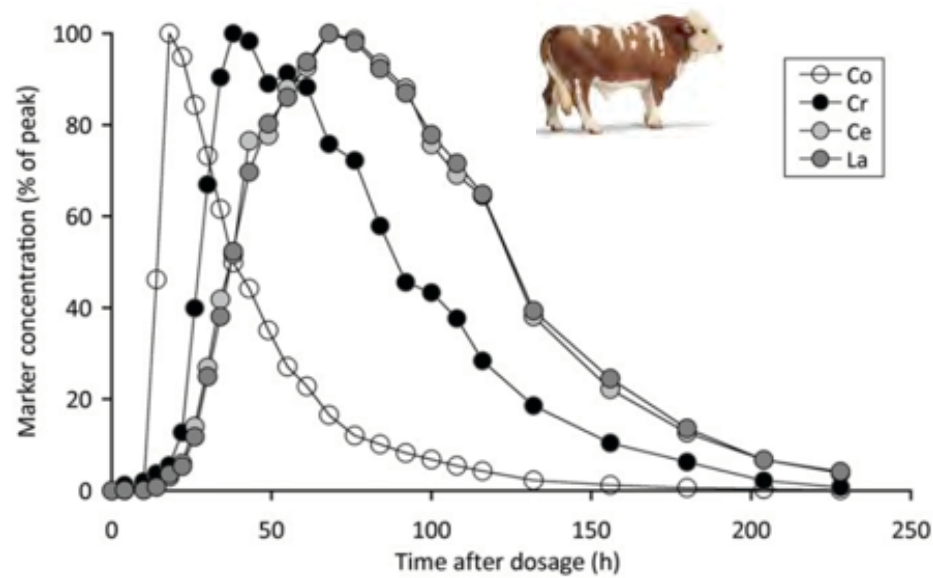
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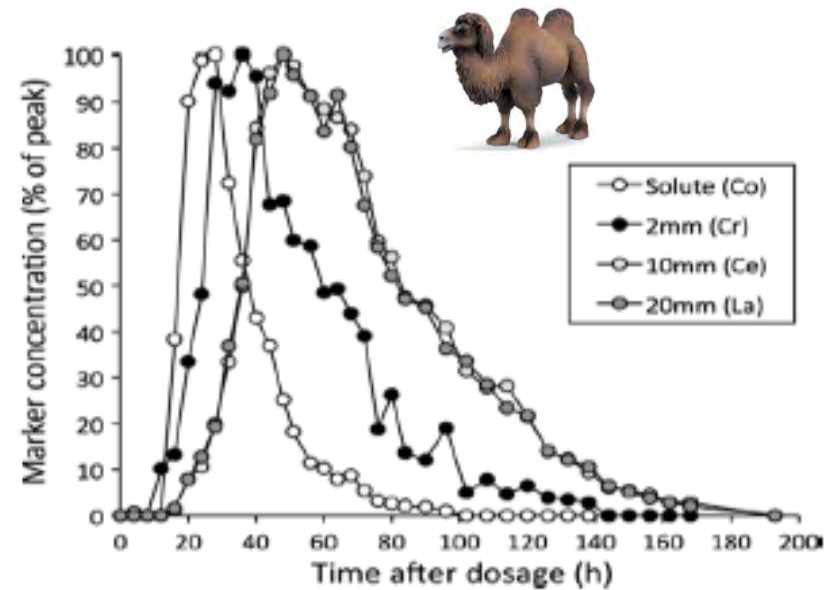
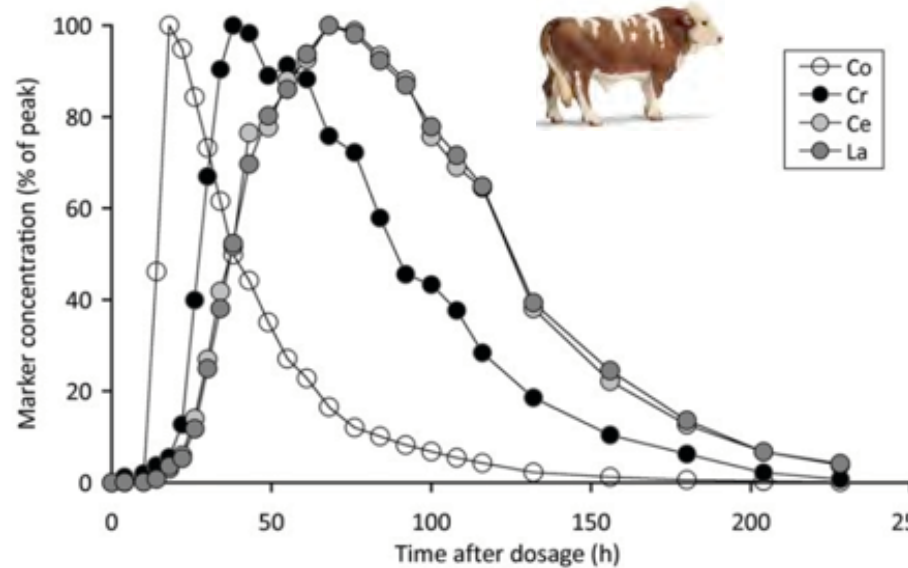


Rumination I: convergence



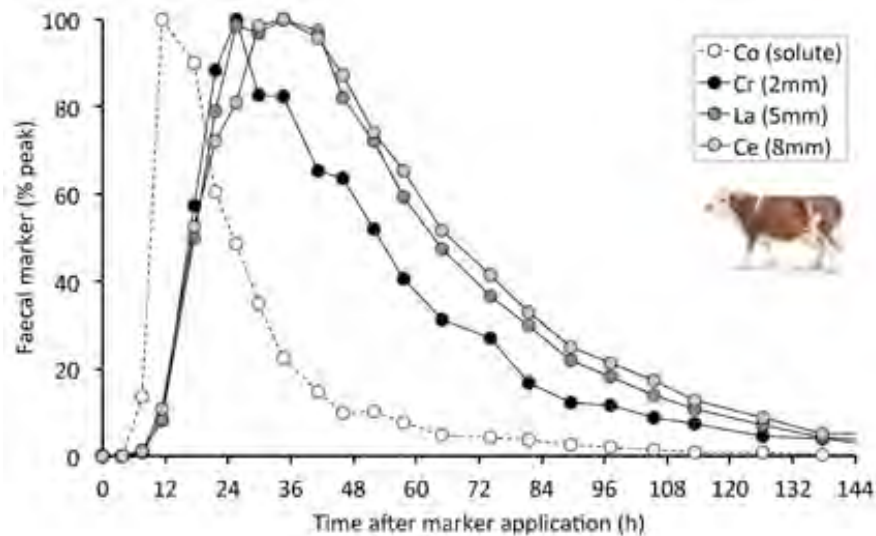


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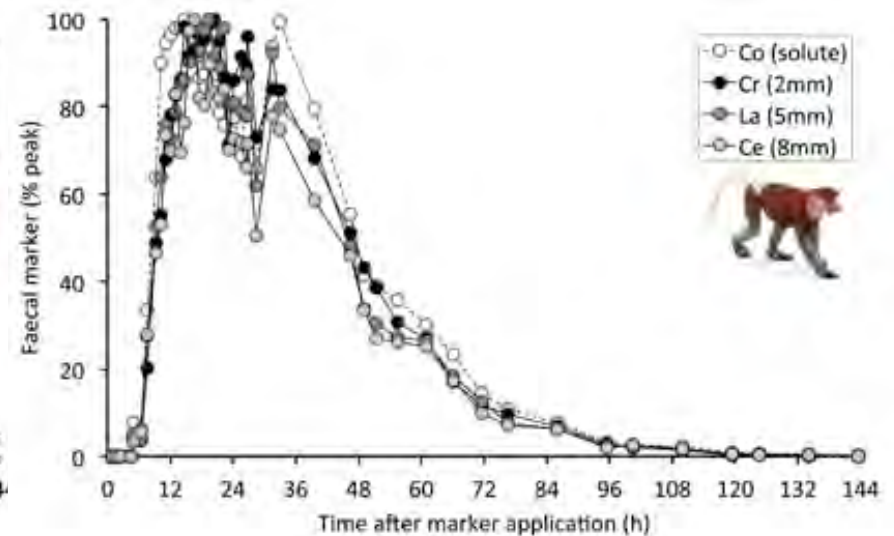
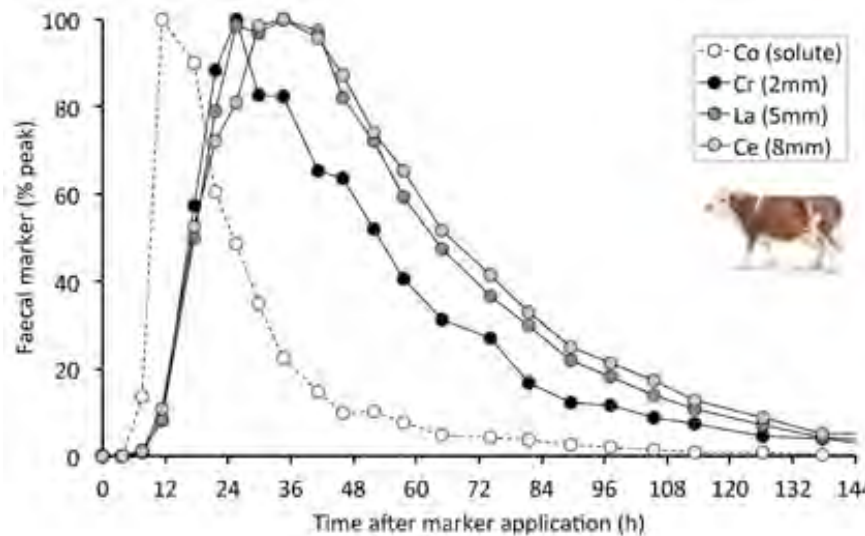


Rumination II: no convergence



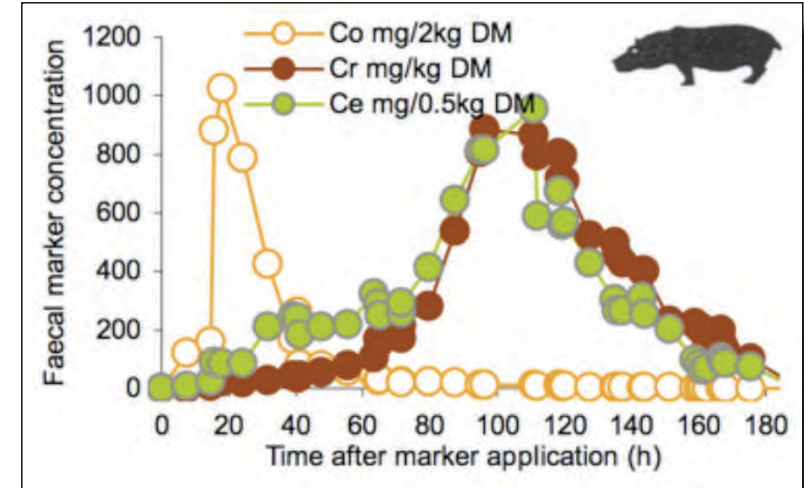
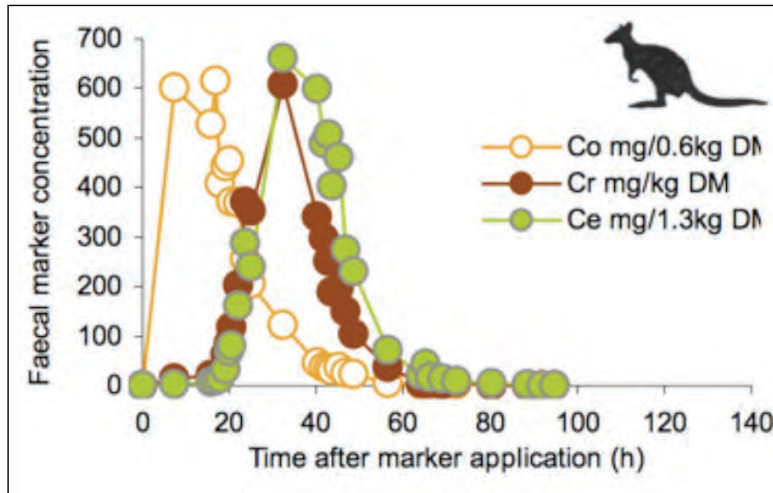


Rumination II: no convergence

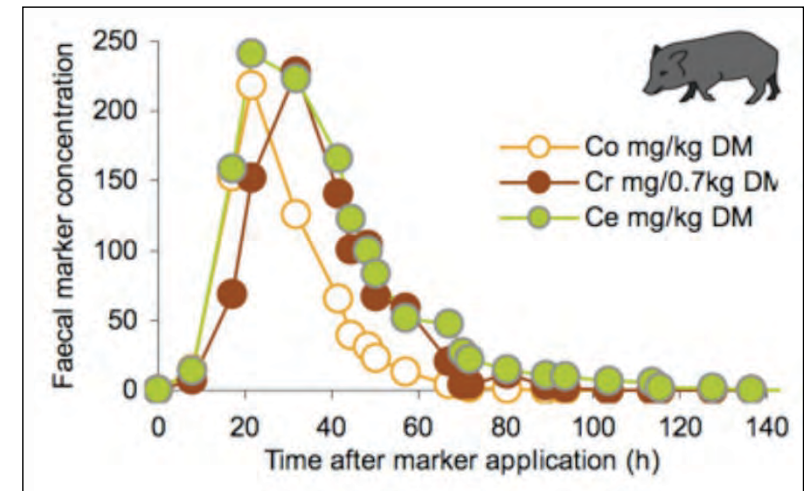
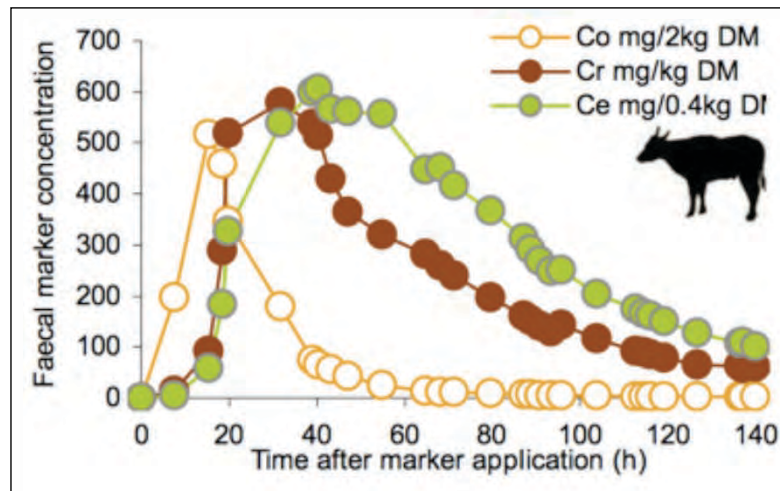




Fluid vs. particle retention

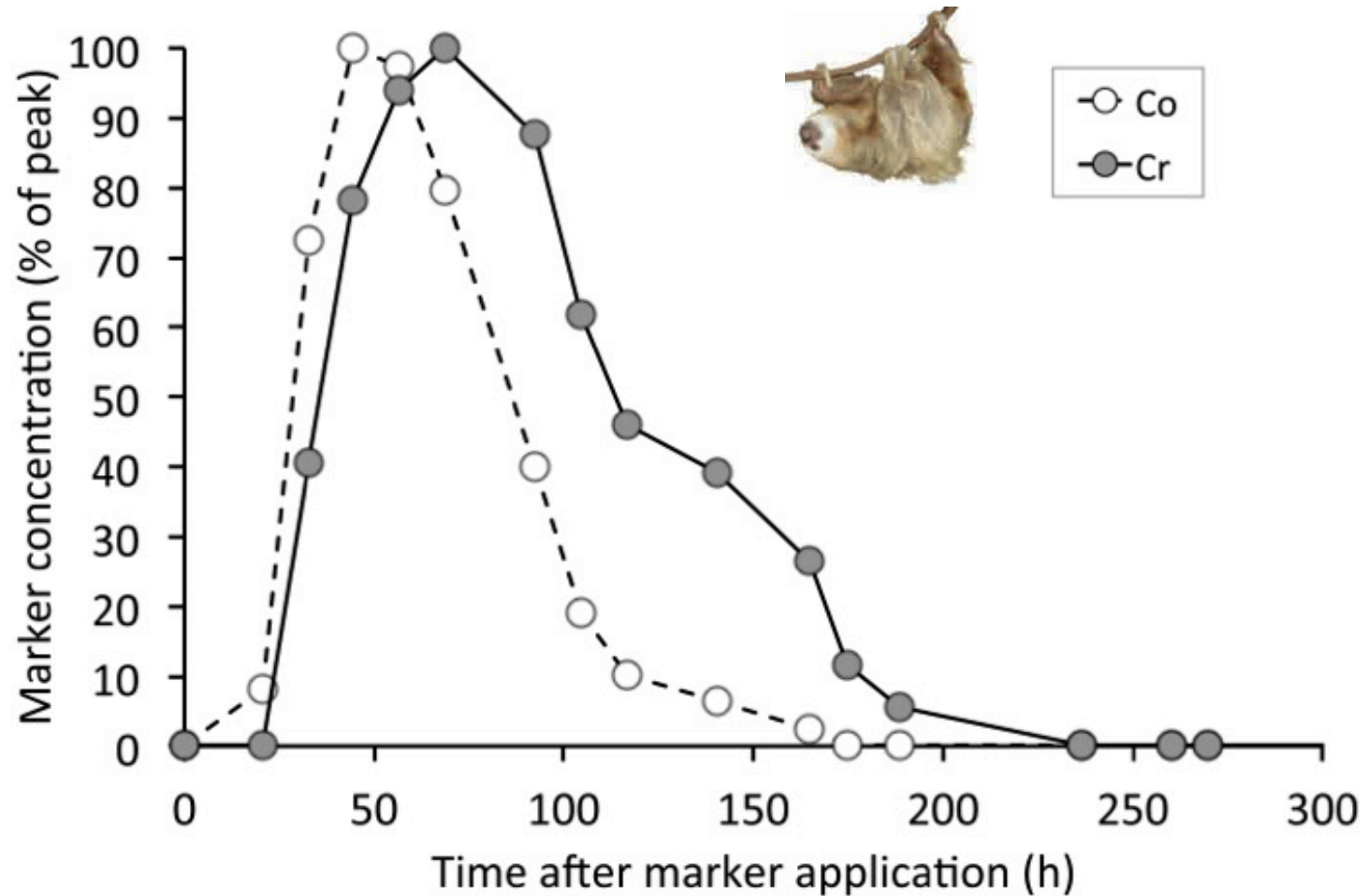


Schwarm et al. (2008,2009)





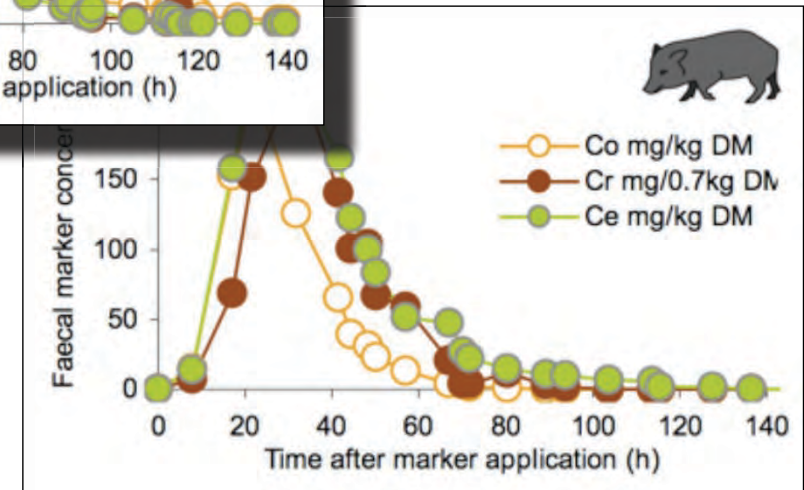
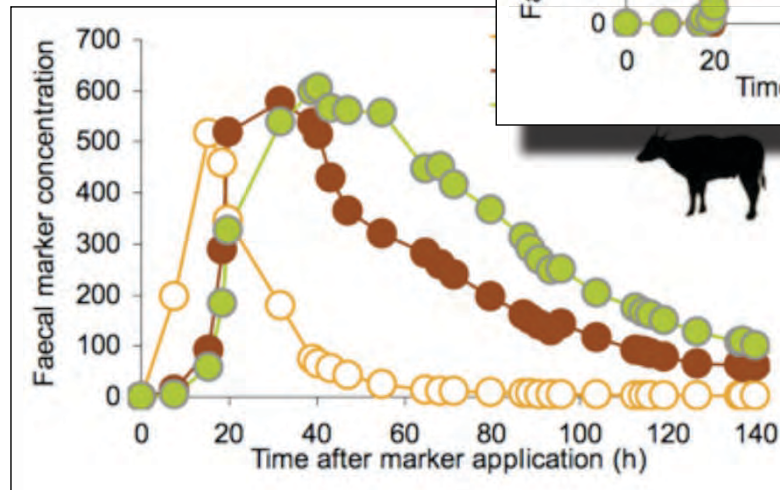
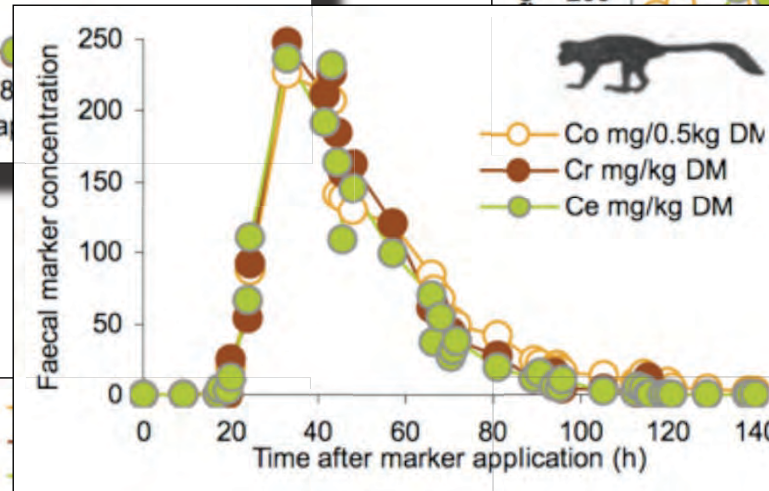
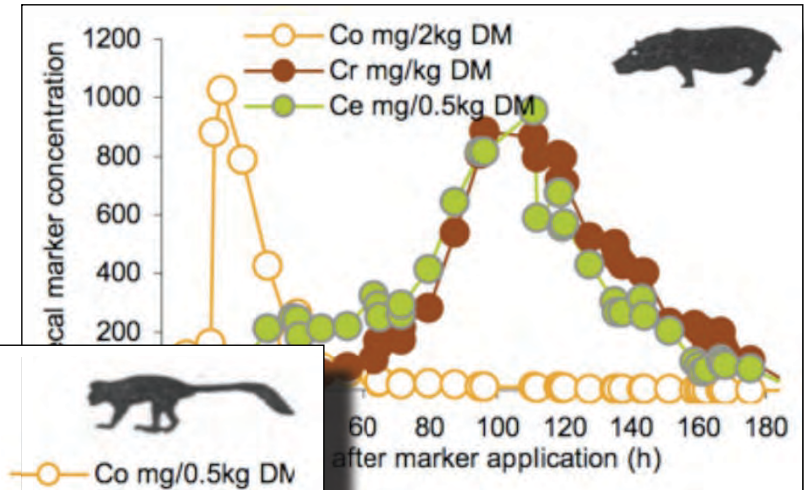
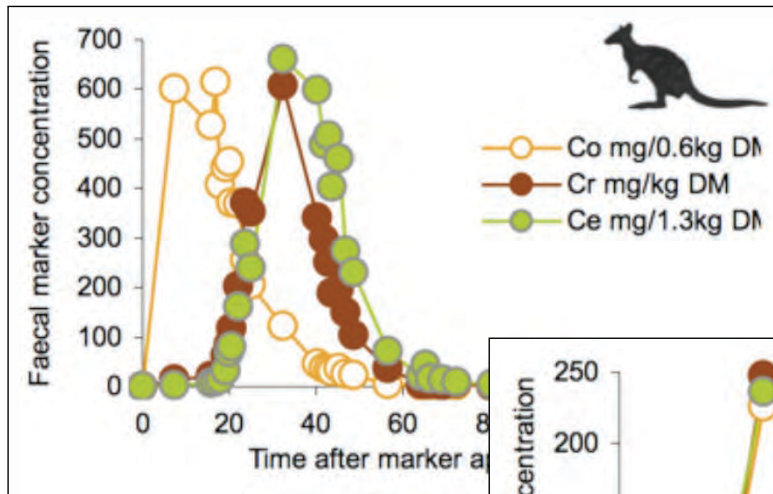
Fluid vs. particle retention



from Vendl et
al. (2015)



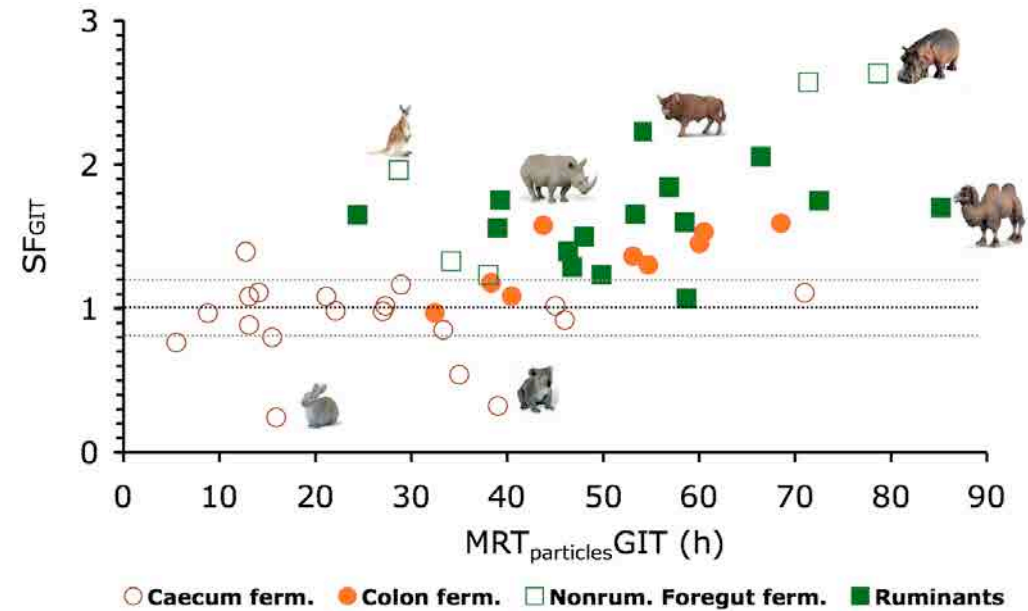
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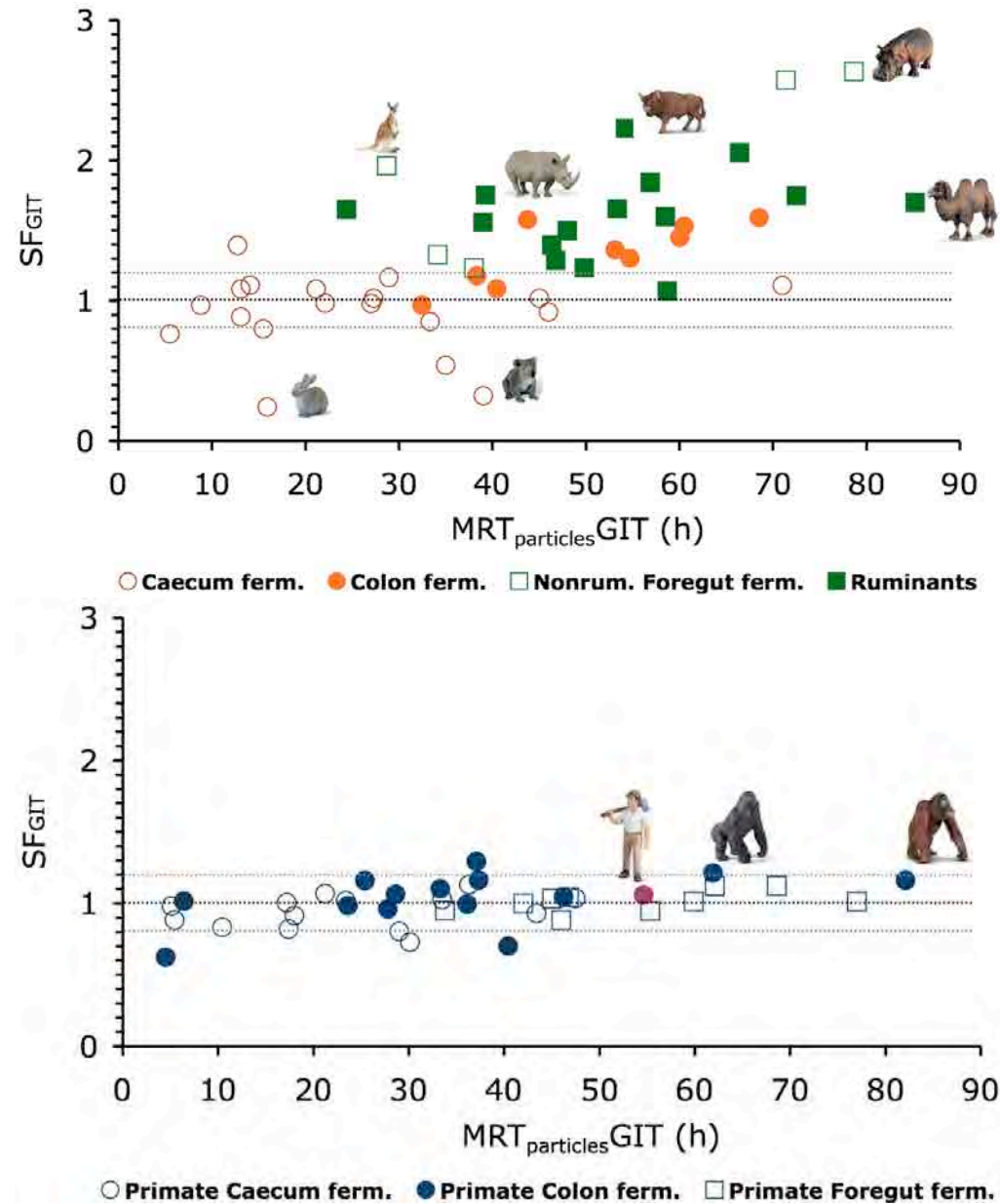


Fluid vs. particle retention





Fluid vs. particle retention



from Müller et al. (2011)



By granting access to their animals, and providing expert care support, zoos can facilitate basic research on physiological mechanisms that broaden our understanding of life, and hence our fascination for it.



Thanks to the large number of zoos who share the enthusiasm in the exploration of animal physiology.