Diet, feeding and dental health in herbivores – a review

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EAZA Acadmey Arnhem 2015

University of Zurich[UZH]

Clinic of Zoo Animals, Exotic Pets and Wildlife

Dental health in captivity

Coyler (1936) primates in captivity have much more tooth problems than free-ranging primates (e.g. caries)

Hungerford et al. (1999) higher incidence of periodontosis and caries in raccoons from a city park than from the wild

Wenker et al. (1999) more dental calculus in captive than in free-ranging bears, and more leasions due to bar chewing in zoo bears

Crossley (2001) captive chinchillas much more cheek tooth overgrowth than free-ranging ones

Dental health in captivity

... a lot of work suggesting that the dental health of captive wild animals is not ideal ...

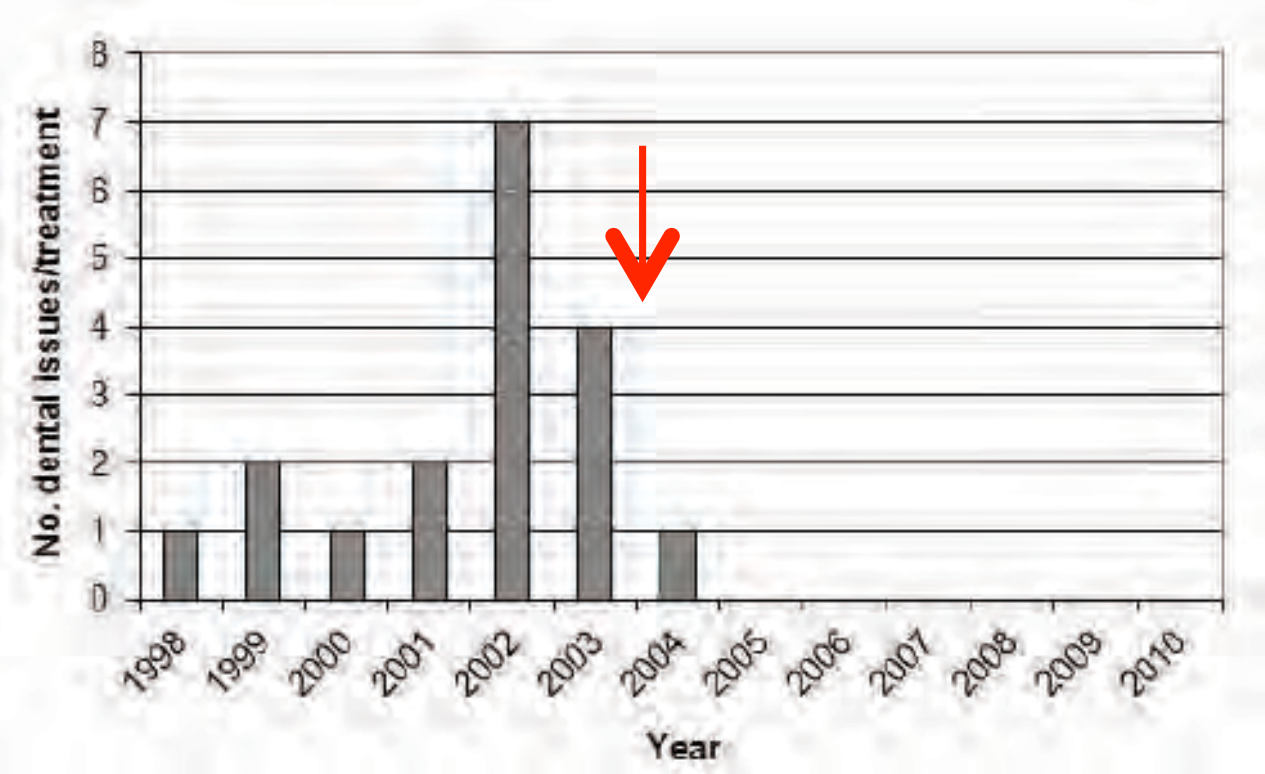
... due to sugars (caries), texture (calculus), behavioural abnormalities (bar chewing) or genetics (malformed teeth)

JZAR JOURNAL OF ZOO AND AQUARIUM RESEARCH
www.jzar.org
Journal of Zoo and Aquarium Research 1(2) 2013

Research article

Diet review and change for monkeys at Paignton Zoo Environmental Park

Amy Plowman



Dental health in captivity

... a lot of work suggesting that the dental health of captive wild animals is not ideal ...

... due to sugars (caries), texture (calculus), behavioural abnormalities (bar chewing) or genetics (malformed teeth)

... what about tooth wear (the loss of dental tissue for physical reasons)?

What wears down dental tissue?

- ~~*diet 'hardness' (common perception: branches, twigs, sometimes even dry bread)*~~

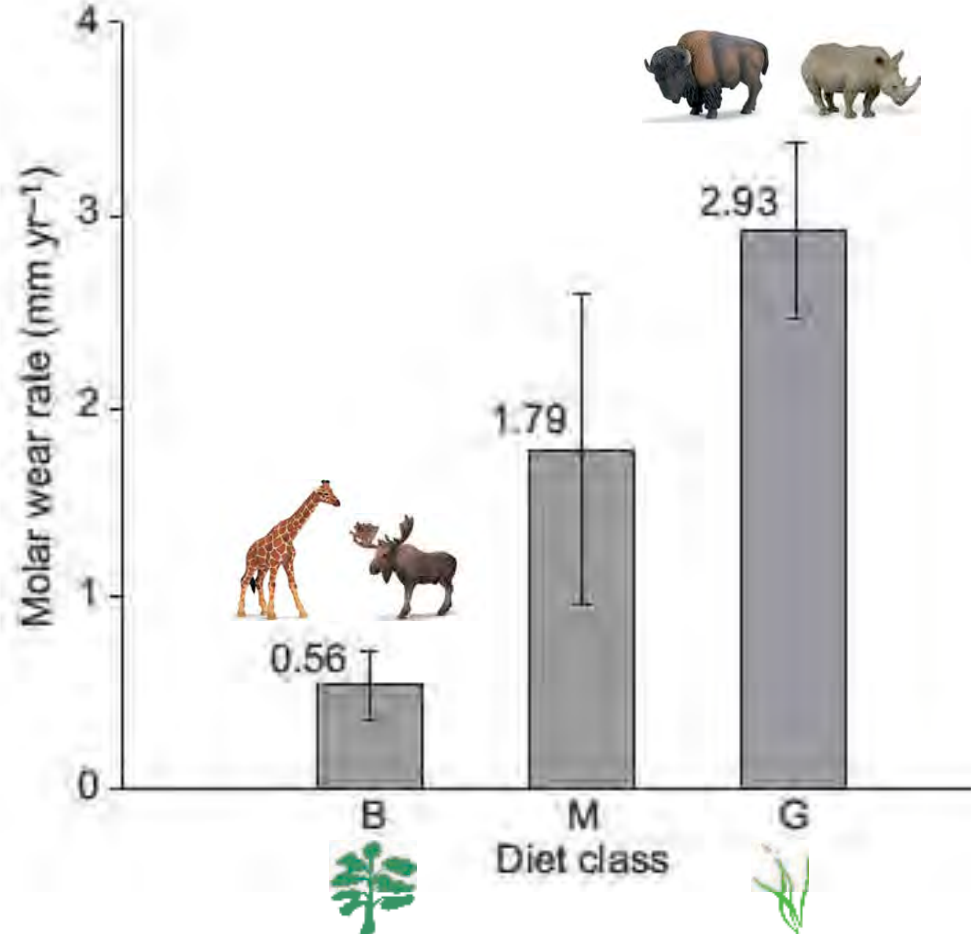
- *diet abrasiveness*

- *tooth-to-tooth contact => chewing!*

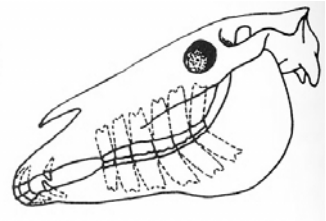
A comparison of observed molar wear rates in extant herbivorous mammals

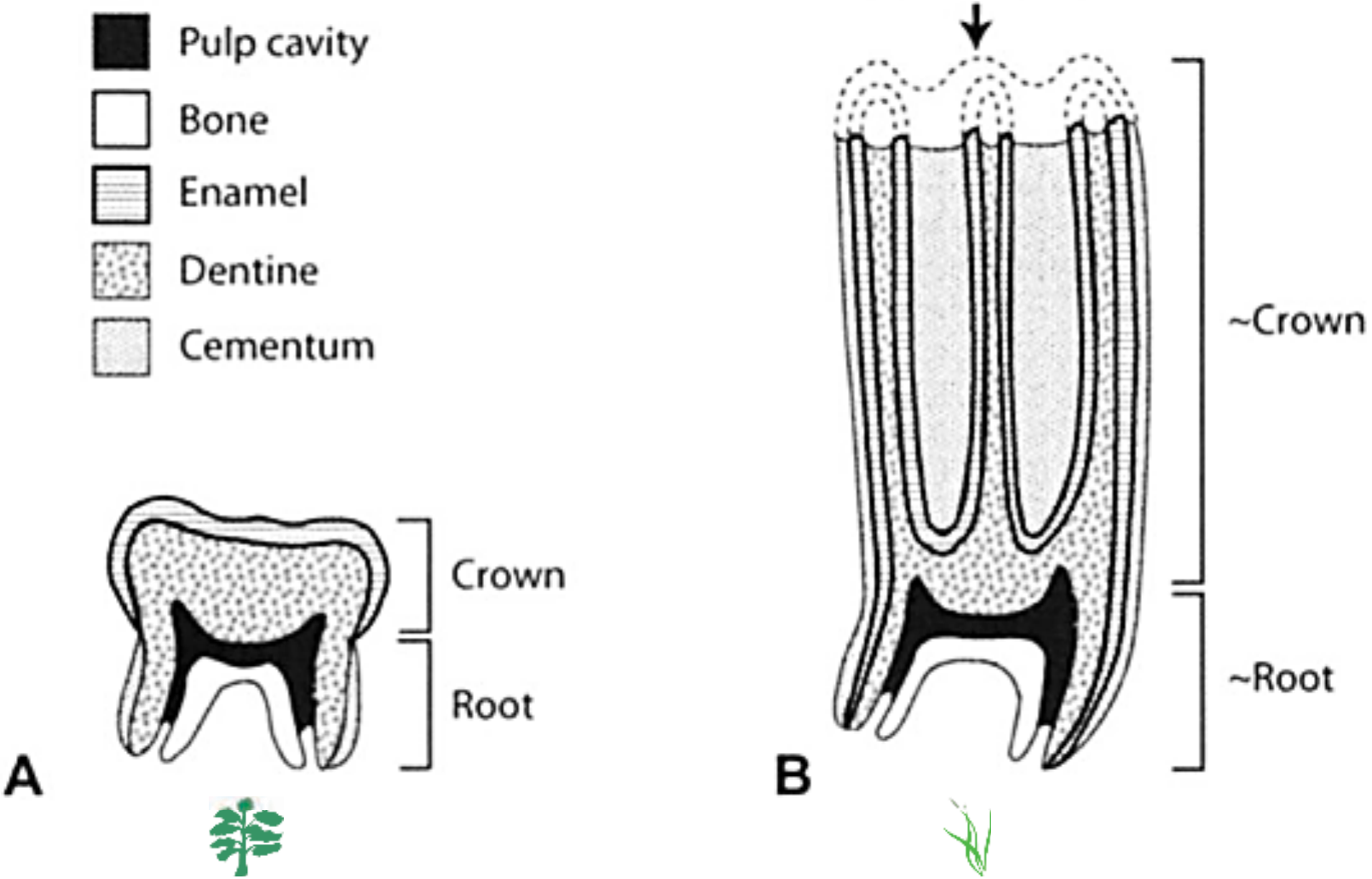
John Damuth[1] & Christine M. Janis[2]

Ann. Zool. Fennici 51: 188–200
Helsinki 7 April 2014



Hypsodonty

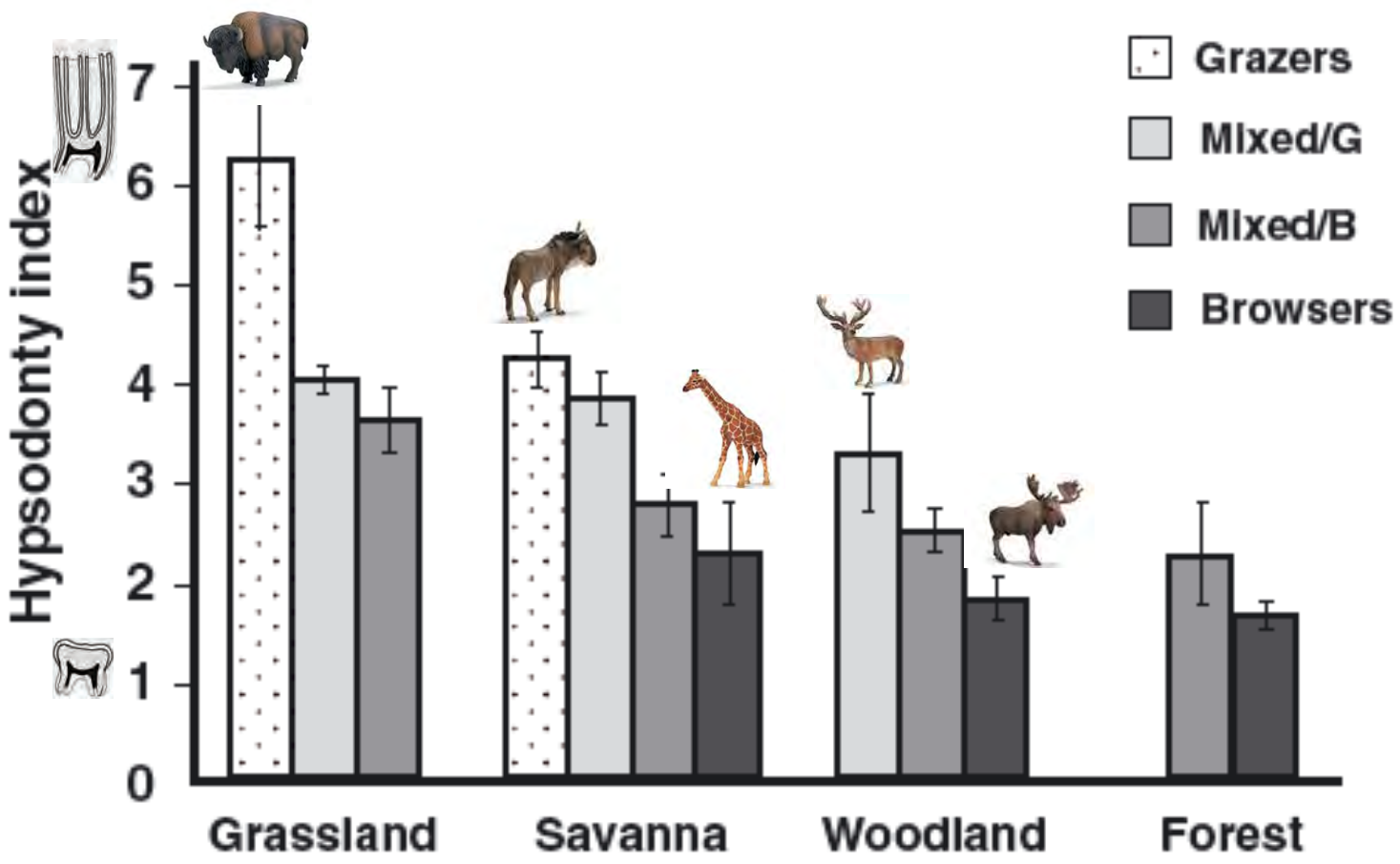



Occlusal surface
Pulp cavity
Bone
Enamel
Dentine
Cementum
Crown
Root
A
~Crown
~Root
B

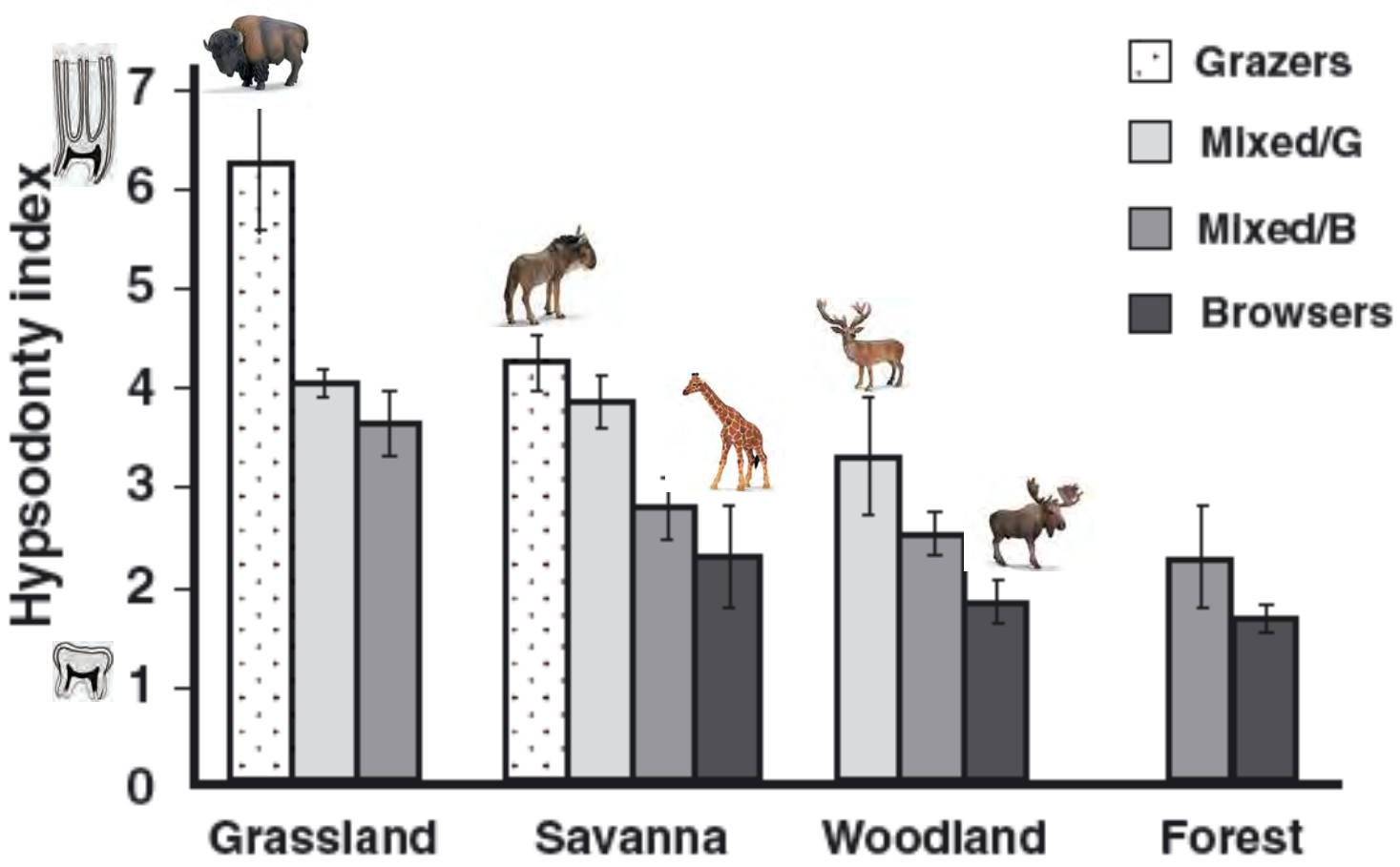
On the relationship between hypsodonty and feeding ecology in ungulate mammals, and its utility in palaeoecology

John Damuth[1]* and Christine M. Janis[2]

Biol. Rev. (2011),



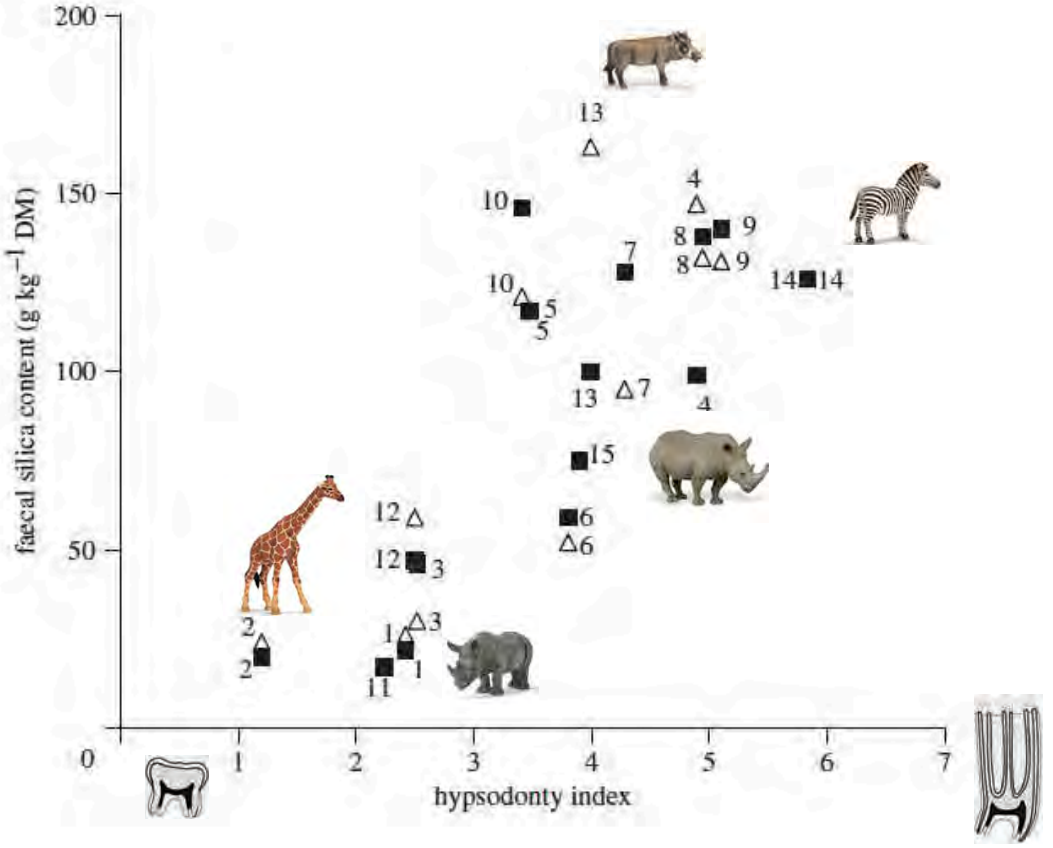
What does hypsodonty relate to?



Another one bites the dust: faecal silica levels in large herbivores correlate with high-crowned teeth

Jürgen Hummel[1,*], Eva Findeisen[1], Karl-Heinz Südekum[1], Irina Ruf[2], Thomas M. Kaiser[3], Martin Bucher[4], Marcus Clauss[5] and Daryl Codron[5]

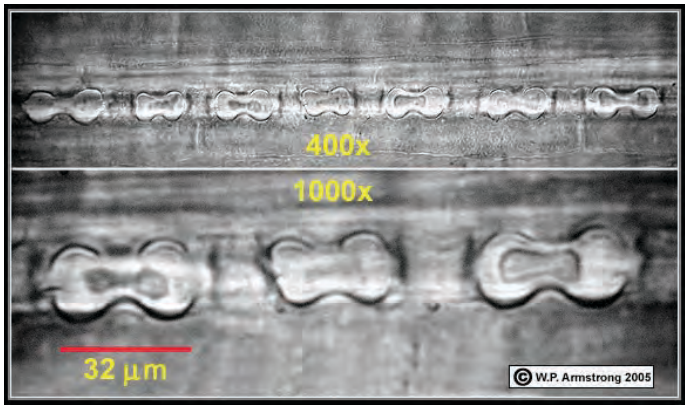
Proc. R. Soc. B (2011) 278, 1742–1747



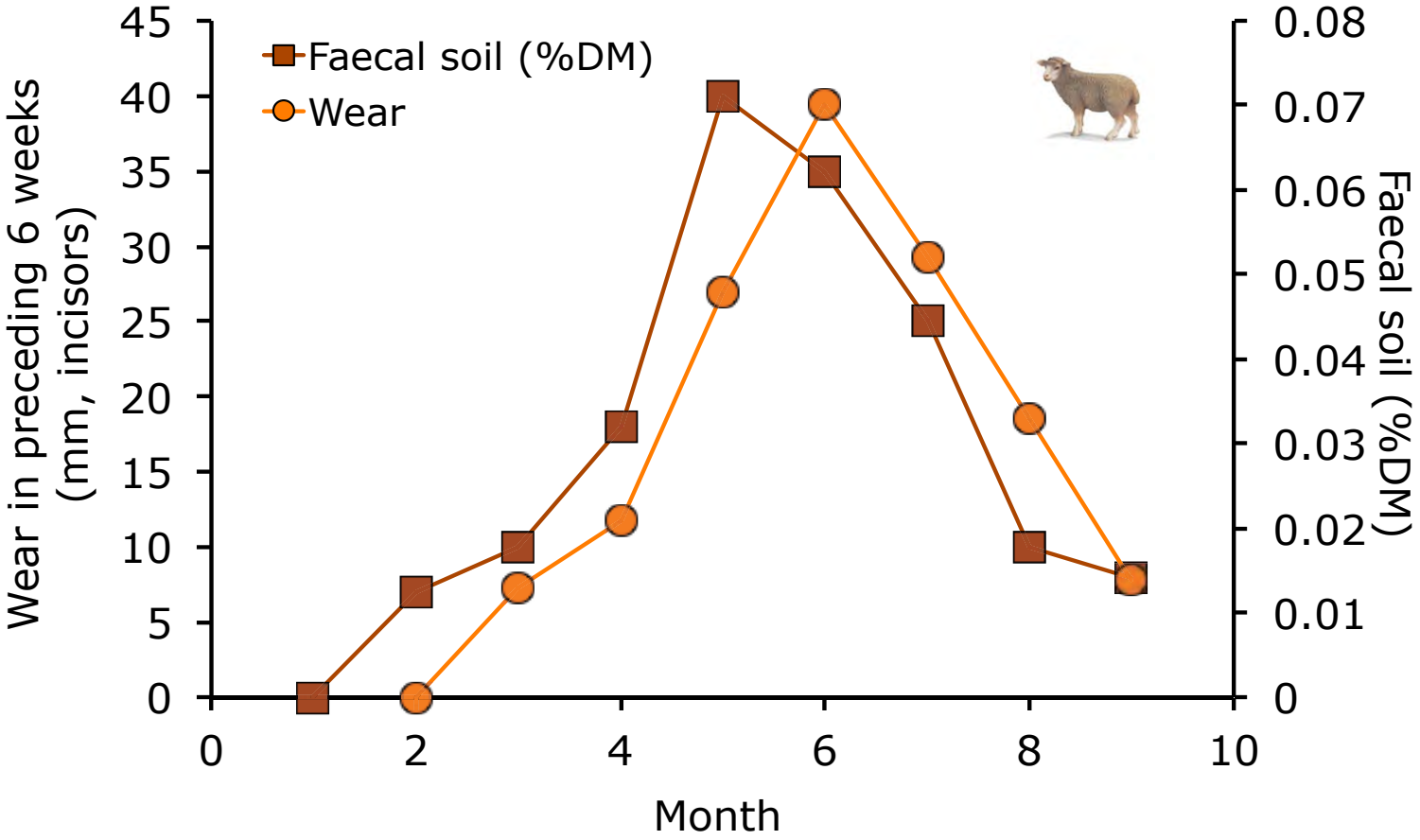
Where does the silica come from?

- *grit/dust (external abrasives)?*

- *phytoliths (internal abrasives)?*



Soil ingestion and wear

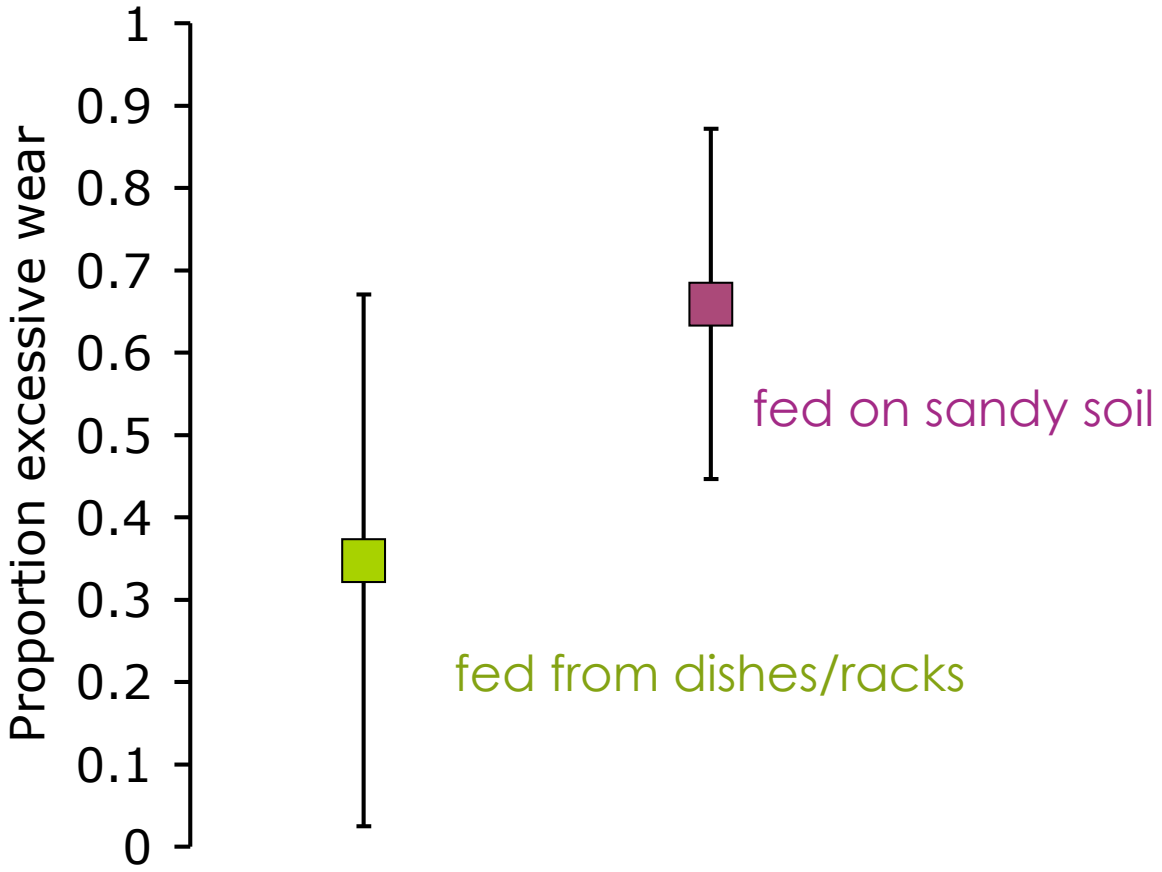


from Healey et al. (1966)

Journal of Zoo and Wildlife Medicine 39(1): 69–75, 2008

IRREGULAR TOOTH WEAR AND LONGEVITY IN CAPTIVE WILD RUMINANTS: A PILOT SURVEY OF NECROPSY REPORTS

Olga Martin Jurado, med.vet., Marcus Clauss, M.Sc., Dr.med.vet., Dipl. E.C.V.C.N., W. Jürgen Streich, Dr.rer.nat., and Jean-Michel Hatt, M.Sc., Prof. Dr.med.vet., Dipl. E.C.A.M.S., Dipl. A.C.Z.M.



Are phytoliths not abrasive?

ELSEVIER

Journal of Archaeological Science 34 (2007) 526–531

Journal of Archaeological SCIENCE

http://www.elsevier.com/locate/jas

Do silica phytoliths really wear mammalian teeth?

Gordon D. Sanson [a,*], Stuart A. Kerr [a], Karlis A. Gross [b]

JOURNAL OF THE ROYAL SOCIETY Interface

2013

rsif.royalsocietypublishing.org

J R Soc Interface 10: 20120923.

Mechanisms and causes of wear in tooth enamel: implications for hominin diets

Peter W. Lucas[1], Ridwaan Omar[2], Khaled Al-Fadhalah[3], Abdulwahab S. Almusallam[4], Amanda G. Henry[6], Shaji Michael[5], Lidia Arockia Thai[5], Jörg Watzke[6], David S. Strait[7] and Anthony G. Atkins[8]

RESEARCH ARTICLE

Growth and Wear of Incisor and Cheek Teeth in Domestic Rabbits (*Oryctolagus cuniculus*) Fed Diets of Different Abrasiveness

JACQUELINE MÜLLER[1], MARCUS CLAUSS[1]*, DARYL CODRON[1,2], ELLEN SCHULZ[3], JÜRGEN HUMMEL[4], MIKAEL FORTELIUS[5], PATRICK KIRCHER[6], AND JEAN-MICHEL HATT[1]

JEZ JOURNAL OF EXPERIMENTAL ZOOLOGY PART A ECOLOGICAL GENETICS AND PHYSIOLOGY
A Journal of Integrative Biology

J. Exp. Zool. 321A:283–298, 2014

Journal of Animal Physiology and Animal Nutrition

Journal of Animal Physiology and Animal Nutrition © 2014 DOI: 10.1111/jpn.12226

ORIGINAL ARTICLE

Tooth length and incisal wear and growth in guinea pigs (*Cavia porcellus*) fed diets of different abrasiveness

J. Müller[1], M. Clauss[1], D. Codron[1,2], E. Schulz[3,4], J. Hummel[5], P. Kircher[6] and J.-M. Hatt[1]

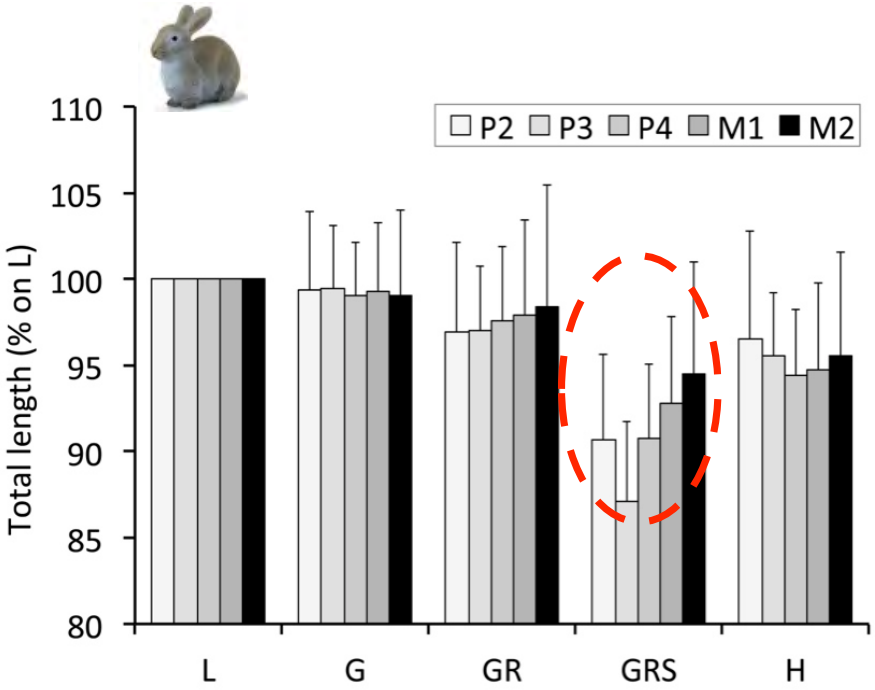
Diet design

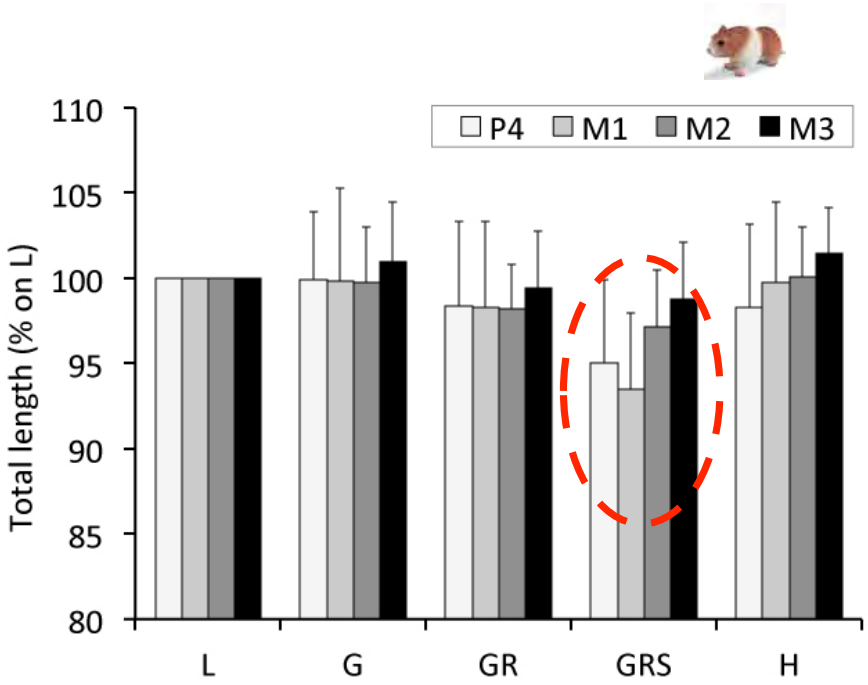
Table 1. Composition of different complete pelleted diets (lucerne L, grass G, grass and rice hulls GR, grass and rice hulls and sands GRS) and grass hay (H).

	L	G	GR	GRS	H
Ingredients					
Lucerne meal (%)	60.0	–	–	–	–
Grass meal (%)	–	60.0	64.8	64.8	–
Rice hulls (%)	–	–	20.0	20.0	–
Sand[a] (%)	–	–	–	5.0	–
Pure lignocellulose (%)	33.8	27.4	5.0	–	–
Soybean meal (%)	–	7.0	5.0	5.0	–
Molasses (%)	3.0	3.0	3.0	3.0	–
Lignobond (%)	2.0	2.0	2.0	2.0	–
Soy oil (%)	1.0	0.4	–	–	–
Mineral/vitamin premix (%)	0.2	0.2	0.2	0.2	–
Dry matter (% as fed)	91.4	91.9	91.8	92.2	90.8
Nutrient composition (g/kg DM)					
Total ash	79	64	75	130	104
Crude protein	102	90	97	85	109
aNDFom[b]	578	600	487	459	579
ADFom[c]	434	403	322	299	354
ADL[d]	131	110	74	65	52
Dry matter digestibility (%)	39.7 ± 9.3	34.3 ± 8.1	41.2 ± 5.7	40.7 ± 11.1	45.1 ± 4.1

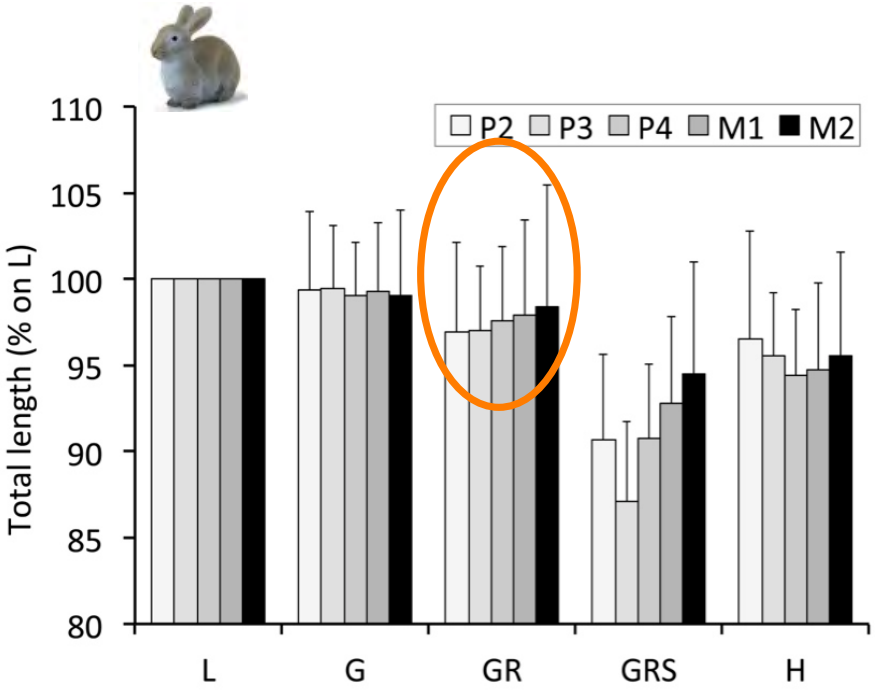
[a]Sand for playgrounds, grain size 0–1 mm, REDSUN garden products B.V., Heijen, Denmark; mean particle size measured by sieve analysis as dMEAN (Fritz et al., 2012) of 0.233 mm.
[b]aNDFom neutral detergent fiber, determined using amylase and ash corrected.
[c]ADFom acid detergent fiber, ash corrected.
[d]ADL acid detergent lignin ash corrected.
[e]ADIA acid detergent insoluble ash (a measure for abrasives).

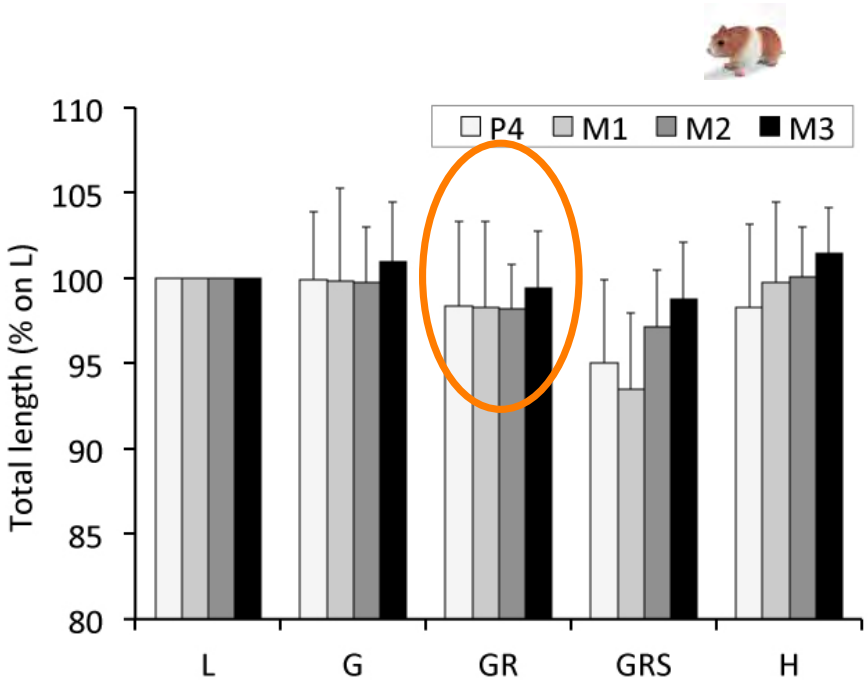
Sand abrades





Phytoliths also abrade!





Does it matter for zoos?

Food item	*n*	AIA (%DM) Mean	AIA (%DM) Range	Source
Temperate browse	1	0.0	—	Clauss et al.[6]
	6	0.2	0.0–0.4	Castell[4]
Alfalfa hay	1	0.2	—	Baer et al.[1]
	1	0.2	—	Clauss et al.[6]
	9	0.3	0.0–0.7	Castell[4]
Alfalfa meal pellet	1	0.5	—	Castell[4]
Grass hay	13	2.0	0.3–5.1	Castell[4]
Fresh grass	2	2.0	1.8–2.2	Castell[4]
Grass meal pellet[a]	1	6.4	—	Castell[4]
Pelleted compound feed	2	0.9	0.2–1.5	Baer et al.[1]
	3	0.8	0.7–1.0	Clauss et al.[6]
	24	1.5	0.5–3.1	Castell[4]

[a] Young grass cut low, dried artificially, ground and pelleted.

animals adapted to browse but eating grass products should experience more wear than they are naturally adapted to

Journal of Zoo and Wildlife Medicine 38(3): 433–445, 2007

TOOTH WEAR IN CAPTIVE GIRAFFES (*GIRAFFA CAMELOPARDALIS*): MESOWEAR ANALYSIS CLASSIFIES FREE-RANGING SPECIMENS AS BROWSERS BUT CAPTIVE ONES AS GRAZERS

Marcus Clauss, M.Sc., Dr. Med. Vet., Dipl. E.C.V.C.N., Tamara A. Franz-Odendaal, Ph.D., Juliane Brasch, Johanna C. Castell, Dr. Med. Vet., and Thomas Kaiser, P.D. Dr. Rer. Nat.

Tooth wear in captive wild ruminant species differs from that of free-ranging conspecifics

Thomas M. Kaiser[a,*], Juliane Brasch[b], Johanna C. Castell[c], Ellen Schulz[a], Marcus Clauss[d]

Mamm. biol. 74 (2009) 425–437

Contributions to Zoology, 83 (2) 107-117 (2014)

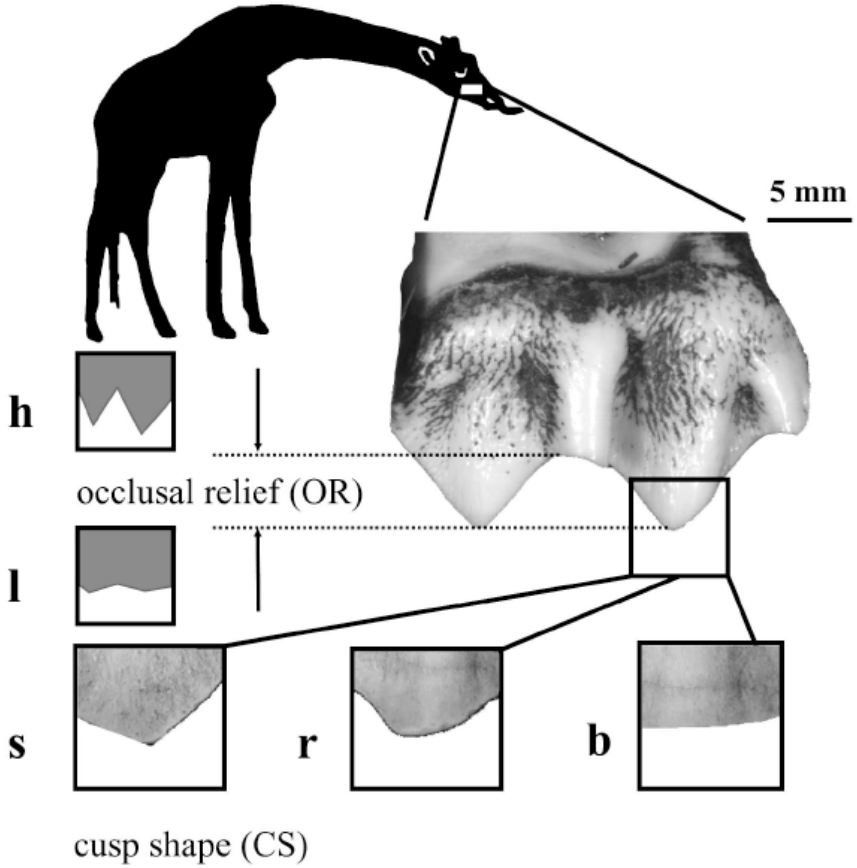
Tooth wear in captive rhinoceroses (*Diceros*, *Rhinoceros*, *Ceratotherium*: Perissodactyla) differs from that of free-ranging conspecifics

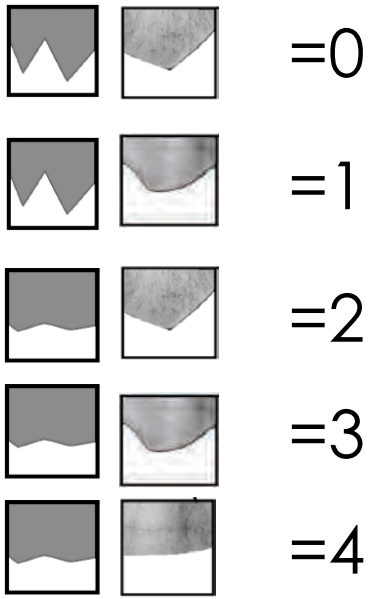
Lucy A. Taylor[1,2], Dennis W.H. Müller[3,4], Christoph Schwitzer[1], Thomas M. Kaiser[5], Daryl Codron[3,6], Ellen Schulz[5], Marcus Clauss[3,7]

Equine Veterinary Journal ISSN 0425-1644
DOI: 10.1111/evj.12408

Comparative analyses of tooth wear in free-ranging and captive wild equids

L. A. TAYLOR[†‡], D. W. H. MÜLLER[§#], C. SCHWITZER[†], T. M. KAISER[¶], J. CASTELL[¥], M. CLAUSS[§] and E. SCHULZ-KORNAS[*¶††]

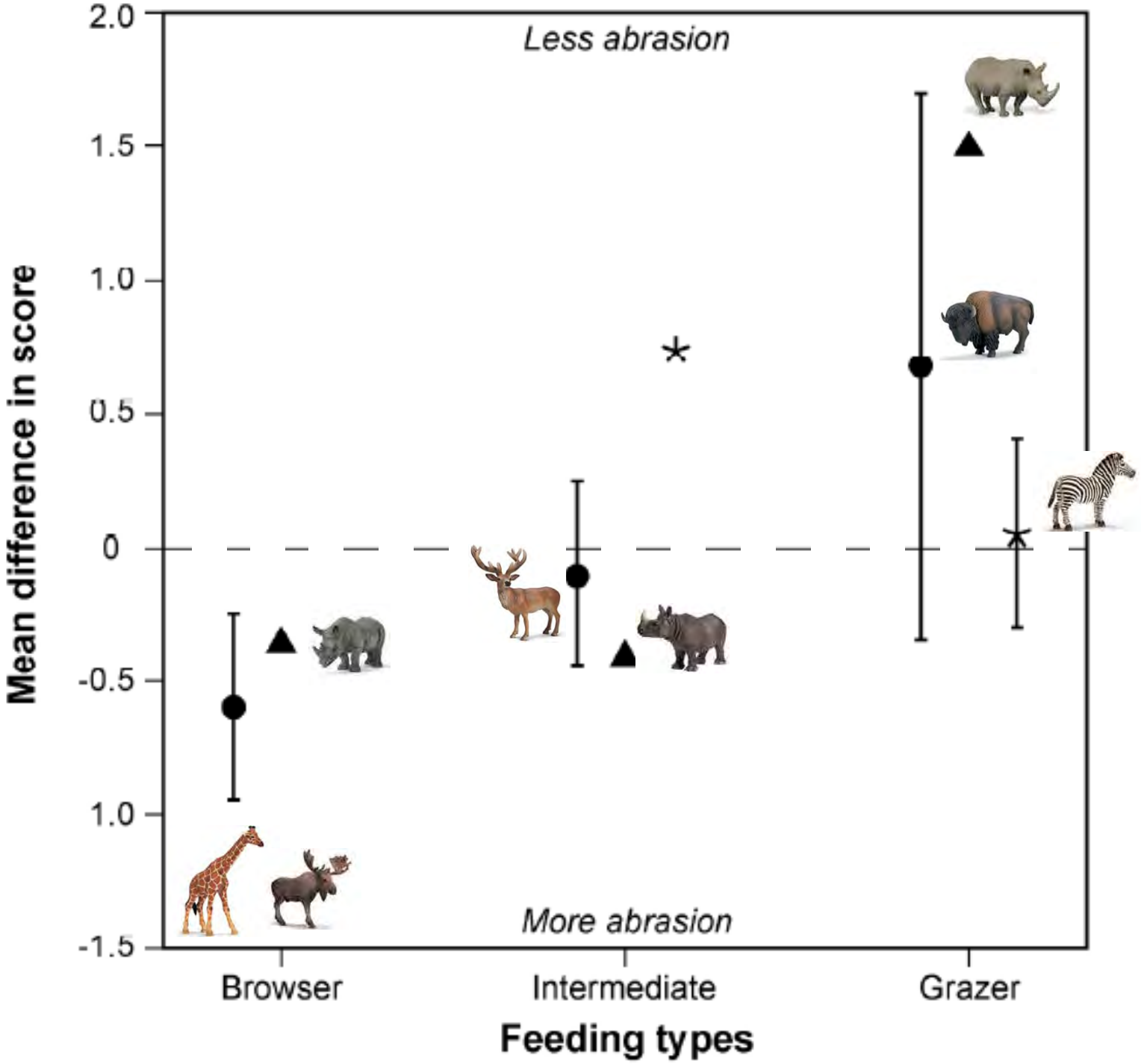




Fotos: Johanna Castell,

Free-ranging vs. captive giraffes

from Clauss et al. (2007)


2.0
1.5
1.0
0.5
0
-0.5
1.0
-1.5
Less abrasion
More abrasion
Mean difference in score
Browser
Intermediate
Grazer
Feeding types

Feeding position?

Wild

Zoo

from Taylor et al. (2015)

Summary

Differences in wear patterns exist between zoos and the wild, indicating

- less abrasion in grazers — due to feeding hygiene?
- more abrasion in browsers — due to the use of abrasive feeds (incl. phytoliths)?

Summary

Less abrasion in grazers: only a problem in uneven wear => feeding position

Summary

Less abrasion in grazers: only a problem in uneven wear => feeding position

More abrasion in browsers: contributing to lower lifespan?; is it possible to avoid abrasive elements in both forages (dicot = lucerne) and pellets (no monocot products)?