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

Taylor, L A ; Müller, Dennis W H ; Schwitzer, C ; Kaiser, T ; Codron, Daryl ; Schulz, E ; Clauss, Marcus

Abstract: Tooth wear can affect body condition, reproductive success and life expectancy. Poor dental health is frequently reported in the zoo literature, and abrasion-dominated tooth wear, which is typical for grazers, has been reported in captive browsing ruminants. The aim of this study was to test if a similar effect is evident in captive rhinoceros species. Dental casts of maxillary cheek teeth of museum specimens of captive black (Diceros bicornis; browser), greater one-horned (Rhinoceros unicornis; intermediate feeder) and white rhinoceroses (Ceratotherium simum; grazer) were analysed using the recently developed extended mesowear method for rhinoceroses. Captive D. bicornis exhibited significantly more abrasion-dominated tooth wear than their free-ranging conspecifics ($p<0.001$), whereas captive C. simum exhibited significantly less abrasion-dominated tooth wear, particularly in the posterior cusp of the second molar ($p=0.005$). In R. unicornis, fewer differences were exhibited between free-ranging and captive animals, but tooth wear was highly variable in this species. In both free-ranging and captive D. bicornis, anterior cusps were significantly more abrasion-dominated than posterior cusps ($p<0.05$), which indicates morphological differences between cusps that may represent functional adaptations. By contrast, tooth wear gradients between free-ranging and captive animals differed, which indicates ingesta-specific influences responsible for inter-tooth wear differences. Captive D. bicornis exhibited more homogenous tooth wear than their free-ranging conspecifics, which may be caused by an increase in the absolute dietary abrasiveness and a decrease in relative environmental abrasiveness compared to their free-ranging conspecifics. The opposite occurred in C. simum. The results of this study suggest that diets fed to captive browsers are too abrasive, which could result in the premature loss of tooth functionality, leading to reduced food acquisition and processing ability and, consequently, malnourishment.

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S1. Museum and specimen information.

Museum Abbreviation	Museum Name	Specimen identification	
		Free-ranging	Captive
AMNH	American Museum of Natural History New York	54454, 54455, 51854, 146718	
IZW	Institute for Zoo and Wildlife Research Berlin		371/2003, 0175, 538, 2001, 835/93
MHN	Museum National d'Histoire Naturelle Paris	A2277	1944-278, 1961-195, 1974-124, 1960-59, 1967-101, 2005-297
NHB	Naturhistorisches Museum Bern	1021034	10594, n.N.082
NHM	Natural History Museum London	1874.11.2.2, 1876.2.15.5, 19.7.15.511, 1907.2.26.1, 1948.1.28.6, 1962.7.6.1, 1962.7.6.5, 1962.7.6.6, 1967.7.6.4, 1976.9.26.6, 2.11.18.7, 1951.11.30.2, 72.12.30.1, 72.739, 84.1.22.1+2, 1967.8.31.4, 25.5.23.1, 52.12.9.1, 75.2384	1961.5.10.1
NHS	Staatliches Museum für Naturkunde Stuttgart	32018, 7564, 1218	
NMAB	Naturmuseum Augsburg		01, 02
NMB	Naturhistorisches Museum Basel	7351, C.1798	n.N.007
NMP	National Museum Prague		165, 2007, 25963, 25964, 47655, 48347, 489, 1/188, 2006, 47145
NMS	National Museums Scotland Edinburgh		200.369, 2008 unreg, 2003.5, 2008.124, 2000.33, 2004.75, 2005.129.2, 2008.127, 2009.10
NMW	Naturhistorisches Museum Wien	4279, 4291	55210
NRM	Naturhistoriska Riksmuseet Stockholm	A591324, A591596	
OUM	Oxford University Museum of Natural History	7118, 3827	
PMJ	Phyletisches Museum Jena	651	
SMF	Forschungsinstitut und Naturmuseum Senckenberg Frankfurt am Main	22660, 699, 664	15934, 40543
Zoo Basel	Zoo Basel		Zoo Basel
ZFMK	Zoologisches Forschungsmuseum Alexander Koenig Bonn		88.16
ZMB	Museum für Naturkunde Berlin	35744, 40053, 41480, 46166, 83230, 83232	
ZMH	Zoologisches Museum Hamburg	35744, 40053, 41480, 46166, 83230, 83232, 2551, 2552	8405, 9328, 8385, 10060
ZMZ	Zoologisches Museum Zürich	83226, 10806, 10927	18129, 19660, 20165, 20273
ZSSM	Zoologische Staatssammlung München	1963/160, AM416, 1912/4199, 1912/4202	2001/33