

Paleobiology - Supplement

Gizzard vs. Teeth, it's a tie: food-processing efficiency in herbivorous birds and mammals and implications for dinosaur feeding strategies

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Appendix 1

Body mass (BM; weighted, estimated or taken from literature) in kg and mean fecal particle size (MPS) in mm \pm standard deviation (SD) respectively in non-ruminating mammals (* = foregut fermenter, other species are hindgut fermenters); n = number of fecal samples analyzed (gs = group sample pooled from a group of animals).

Species			n	BM \pm SD		MPS \pm SD	
				kg		mm	
<i>Monodelphis domestica</i>	Didelphimorphia	Didelphidae	2 (gs)	0.100	-	0.331	\pm 0.184
<i>Phascolarctus cinereus</i>	Diprodontia	Phascolarctidae	5	6.188	\pm 1.128	0.293	\pm 0.047
<i>Vombatus ursinus</i>	Diprodontia	Macropodidae	3	40.000	-	0.432	\pm 0.072
<i>Bettongia penicillata</i> *	Diprodontia	Macropodidae	2 (gs)	1.250	\pm 0.354	0.492	\pm 0.518
<i>Dendrolagus matschiei</i> *	Diprodontia	Macropodidae	3	13.000	-	0.881	\pm 0.409
<i>Macropus agiles</i> *	Diprodontia	Macropodidae	2	15.000	-	0.630	\pm 0.106
<i>Macropus fuliginosus</i> *	Diprodontia	Macropodidae	1	50.000	-	0.888	-
<i>Macropus giganteus</i> *	Diprodontia	Macropodidae	3	60.000	\pm 25.000	0.572	\pm 0.436
<i>Macropus parma</i> *	Diprodontia	Macropodidae	2 (gs)	6.000	-	0.283	\pm 0.088
<i>Macropus rufogriseus</i> *	Diprodontia	Macropodidae	3	16.500	\pm 0.866	0.831	\pm 0.087
<i>Macropus rufus</i> *	Diprodontia	Macropodidae	2	62.500	\pm 31.820	1.441	\pm 0.302
<i>Wallabia bicolor</i> *	Diprodontia	Macropodidae	2	15.000	-	0.646	\pm 0.211
<i>Hapalemur griseus</i>	Primates	Lemuridae	1	1.200	-	1.608	-
<i>Lemur catta</i>	Primates	Lemuridae	3	3.333	\pm 0.289	2.246	\pm 0.773
<i>Varecia variegata</i>	Primates	Lemuridae	4	4.000	-	2.387	\pm 1.247
<i>Alouatta palliata</i>	Primates	Cebidae	1	7.000	-	3.190	-
<i>Lagothrix lagotricha</i>	Primates	Cebidae	2	7.500	\pm 4.243	2.333	\pm 1.861
<i>Pithecia pithecia</i>	Primates	Cebidae	2	1.800	\pm 0.283	0.381	\pm 0.068
<i>Cercopithecus pygerythrus</i>	Primates	Cercopithecidae	1	5.500	-	0.527	-
<i>Macaca sylvanus</i>	Primates	Cercopithecidae	1	24.000	-	0.688	-
<i>Mandrillus sphinx</i>	Primates	Cercopithecidae	2	27.500	\pm 0.707	1.249	\pm 0.374
<i>Presbytis obscurus</i> *	Primates	Cercopithecidae	1	7.000	-	0.706	-
<i>Presbytis entellus</i> *	Primates	Cercopithecidae	2 (gs)	20.000	\pm 1.414	0.848	\pm 0.179
<i>Presbytis cristata</i> *	Primates	Cercopithecidae	3 (gs)	13.167	\pm 2.021	0.762	\pm 0.173
<i>Pygathrix nemaesus</i> *	Primates	Cercopithecidae	5	9.000	\pm 1.414	0.598	\pm 0.103
<i>Theropithecus gelada</i>	Primates	Cercopithecidae	6	17.500	-	2.221	\pm 0.757
<i>Hylobates lar</i>	Primates	Hylobatidae	2	5.500	-	2.545	\pm 0.055
<i>Hylobates lar moloch</i>	Primates	Hylobatidae	2	5.500	\pm 0.707	1.122	\pm 0.012
<i>Hylobates syndactylus</i>	Primates	Hylobatidae	4	12.500	\pm 1.683	4.786	\pm 4.041
<i>Gorilla gorilla</i>	Primates	Pongidae	8	97.563	\pm 55.537	3.896	\pm 1.941
<i>Pan paniscus</i>	Primates	Pongidae	5	39.120	\pm 9.366	3.207	\pm 0.761
<i>Pan troglodytes</i>	Primates	Pongidae	5	52.220	\pm 26.187	1.942	\pm 0.938
<i>Pongo pygmaeus</i>	Primates	Pongidae	5	60.000	\pm 37.495	2.142	\pm 1.305

<i>Choloepus didactylus</i> *	Xenarthra	Megalonychidae	5	10.000	± 1.414	0.419	± 0.119
<i>Lepus europaeus</i>	Lagomorpha	Leporidae	5	4.500	-	0.346	± 0.083
<i>Cynomys ludovicianus</i>	Lagomorpha	Leporidae	1 (gs)	1.150	-	0.673	-
<i>Oryctolagus cuniculus</i>	Rodentia	Sciuridae	5	4.000	-	0.379	± 0.040
<i>Marmota bobac</i>	Rodentia	Sciuridae	1	5.000	-	0.197	-
<i>Marmota marmota</i>	Rodentia	Sciuridae	1	5.000	-	0.950	-
<i>Sciurus carolinensis</i>	Rodentia	Sciuridae	1	0.450	-	0.271	-
<i>Sciurus variegatoides</i>	Rodentia	Sciuridae	1	0.550	-	0.319	-
<i>Xerus inauris</i>	Rodentia	Sciuridae	1 (gs)	0.750	-	0.568	-
<i>Castor canadensis</i>	Rodentia	Castoridae	2	30.000	-	2.517	± 0.437
<i>Castor fiber</i>	Rodentia	Castoridae	3	30.000	-	3.121	± 1.094
<i>Pedetes capensis</i>	Rodentia	Pedetidae	1 (gs)	3.500	-	0.211	-
<i>Jaculus jaculus</i>	Rodentia	Dipodidae	1 (gs)	0.055	-	0.247	-
<i>Acomys russatus</i>	Rodentia	Muridae	2 (gs)	0.045	-	0.396	± 0.070
<i>Lemniscomys barbarus</i>	Rodentia	Muridae	1 (gs)	0.040	-	0.318	-
<i>Mastomys natalensis</i>	Rodentia	Muridae	1 (gs)	0.065	-	0.417	-
<i>Micromys minutus</i>	Rodentia	Muridae	2 (gs)	0.006	-	0.213	± 0.014
<i>Mus musculus</i>	Rodentia	Muridae	1	0.020	-	0.231	-
<i>Cricetomys emini</i>	Rodentia	Cricetidae	1 (gs)	1.250	-	0.413	-
<i>Cricetulus griseus</i>	Rodentia	Cricetidae	1 (gs)	0.040	-	0.323	-
<i>Gerbillus perpallidus</i>	Rodentia	Cricetidae	2 (gs)	0.040	-	0.293	± 0.011
<i>Graphiurus murinus</i>	Rodentia	Cricetidae	1 (gs)	0.025	-	0.436	-
<i>Hypogeomys antimena</i>	Rodentia	Cricetidae	2	1.350	-	0.508	± 0.207
<i>Microtus brandti</i>	Rodentia	Cricetidae	1 (gs)	0.045	-	0.136	-
<i>Microtus fortis</i>	Rodentia	Cricetidae	1 (gs)	0.045	-	0.149	-
<i>Phodopus roborovskii</i>	Rodentia	Cricetidae	2 (gs)	0.030	-	0.299	± 0.045
<i>Phodopus sungorus</i>	Rodentia	Cricetidae	3 (gs)	0.040	-	0.287	-
<i>Seketamys calurus</i>	Rodentia	Cricetidae	1 (gs)	0.060	-	0.406	-
<i>Ctenodactyles gundi</i>	Rodentia	Ctenodactylidae	1	0.250	-	0.235	-
<i>Atherurus africanus</i>	Rodentia	Hystricidae	1 (gs)	1.750	-	0.303	-
<i>Hystrix africae australis</i>	Rodentia	Hystricidae	1 (gs)	20.000	-	1.560	-
<i>Hystrix cristata</i>	Rodentia	Hystricidae	5 (gs)	20.000	-	1.908	± 0.726
<i>Hystrix indica</i>	Rodentia	Hystricidae	2 (gs)	20.000	-	1.110	± 0.199
<i>Petromus typicus</i>	Rodentia	Petromuridae	1	0.200	-	0.281	-
<i>Heterocephalus glaber</i>	Rodentia	Bathyergidae	2 (gs)	0.052	-	0.531	± 0.053
<i>Chinchilla chinchilla</i>	Rodentia	Chinchillidae	3 (gs)	0.550	± 0.050	0.154	± 0.068
<i>Lagostomus maximus</i>	Rodentia	Chinchillidae	5	4.130	± 0.790	0.176	± 0.012
<i>Cavia aperea</i>	Rodentia	Caviidae	3 (gs)	0.625	-	0.109	± 0.026
<i>Cavia aperea f. porcellus</i>	Rodentia	Caviidae	6 (gs)	0.783	± 0.075	0.172	± 0.158
<i>Dolichotis patagonum</i>	Rodentia	Caviidae	5 (gs)	7.500	± 0.354	0.273	± 0.060
<i>Galea musteloides</i>	Rodentia	Caviidae	1 (gs)	0.450	-	0.104	-

<i>Kerodon rupestris</i>	Rodentia	Caviidae	1	0.750	-	0.160	-
<i>Hydrochaerus hydrochaeris</i>	Rodentia	Hydrochaeridae	3	40.000	-	0.401	± 0.084
<i>Dasyprocta azarae</i>	Rodentia	Dasyproctidae	1 (gs)	3.000	-	0.697	-
<i>Dasyprocta leporina</i>	Rodentia	Dasyproctidae	2 (gs)	3.250	-	0.544	± 0.432
<i>Octodon degus</i>	Rodentia	Octodontidae	2 (gs)	0.230	-	0.168	± 0.008
<i>Spalacopus cyanus</i>	Rodentia	Octodontidae	1	0.090	-	0.235	-
<i>Capromys pilorides</i>	Rodentia	Capromyidae	3	5.000	± 0.500	0.118	± 0.024
<i>Myocastor coypus</i>	Rodentia	Myocastoridae	5 (gs)	7.600	± 0.894	0.762	± 0.245
<i>Procavia capensis</i>	Hyracoidae	Procaviidae	2 (gs)	3.075	± 0.106	1.177	± 0.856
<i>Elephas maximus</i>	Proboscidae	Elephantidae	18	3183.672	± 821.540	7.086	± 4.192
<i>Loxodonta africana</i>	Proboscidae	Elephantidae	12	2733.333	± 1053.206	6.177	± 1.725
<i>Trichechus manatus</i>	Sirenia	Trichechidae	4	850.000	± 57.735	5.113	± 1.990
<i>Equus africanus f. asinus</i>	Perissodactyla	Equidae	11	216.364	± 0.545	1.096	± 0.545
<i>Equus africanus somalicus</i>	Perissodactyla	Equidae	4	268.750	23.936	1.479	± 0.509
<i>Equus grevyi</i>	Perissodactyla	Equidae	5	342.000	± 10.954	1.652	± 0.800
<i>Equus hemionus kiang</i>	Perissodactyla	Equidae	6	245.000	5.477	0.516	± 0.090
<i>Equus hemionus kulan</i>	Perissodactyla	Equidae	5	250.000	-	0.779	± 0.207
<i>Equus hemionus onager</i>	Perissodactyla	Equidae	2	250.000	-	0.900	± 0.024
<i>Equus przewalskii</i>	Perissodactyla	Equidae	5	292.000	± 40.866	0.533	± 0.070
<i>Equus przewalskii f. caballus</i>	Perissodactyla	Equidae	37	460.000	± 223.709	1.224	± 0.537
<i>Equus quagga antiquorum</i>	Perissodactyla	Equidae	3	216.667	± 28.868	1.378	± 0.551
<i>Equus quagga boehmi</i>	Perissodactyla	Equidae	6	275.000	± 27.386	2.153	± 1.069
<i>Equus quagga burchelli</i>	Perissodactyla	Equidae	2	215.000	± 21.213	1.309	± 0.005
<i>Equus quagga chapmani</i>	Perissodactyla	Equidae	5	290.000	± 22.361	1.441	± 0.918
<i>Equus zebra hartmannae</i>	Perissodactyla	Equidae	5	314.000	± 21.909	1.335	± 0.499
<i>Ceratotherium simun</i>	Perissodactyla	Rhinocerotidae	8	1938.750	± 370.769	9.782	± 3.003
<i>Diceros bicornis</i>	Perissodactyla	Rhinocerotidae	12	985.000	± 200.839	9.276	± 3.348
<i>Rhinoceros unicornis</i>	Perissodactyla	Rhinocerotidae	6	2150.000	± 151.658	4.161	± 1.239
<i>Tapirus indicus</i>	Perissodactyla	Tapiridae	5	275.000	± 17.678	3.555	± 1.261
<i>Tapirus terrestris</i>	Perissodactyla	Tapiridae	10	195.500	± 17.552	2.887	± 1.064
<i>Ailuropoda melanoleuca</i>	Carnivora	Ailuridae	8	98.750	± 9.910	8.267	± 4.296
<i>Ailurus fulgens</i>	Carnivora	Ailuridae	5 (gs)	5.000	-	1.084	± 0.343
<i>Babyrousa babyrussa*</i>	Cetartiodactyla	Suidae	3	60.000	-	3.082	± 1.172
<i>Phacochoerus aethiopicus</i>	Cetartiodactyla	Suidae	5	85.000	-	2.182	± 0.242
<i>Tayassu tajacu</i>	Cetartiodactyla	Tayassuidae	5	23.000	-	0.567	± 0.083
<i>Hippopotamus amphibius*</i>	Cetartiodactyla	Hippopotamidae	6	2333.333	± 302.765	13.758	± 6.578
<i>Choeropsis liberiensis*</i>	Cetartiodactyla	Hippopotamidae	4	250.000	-	7.163	± 2.035

Note that the MPS was calculated on the basis of a sieve analysis with nine sieves (in contrast to the data presented in Fritz et al. 2009).

Appendix 2

Body mass (BM) and mean fecal particle size (MPS) in herbivorous reptiles.
n = number of fecal samples analyzed.

Species	<i>n</i>	BM ± SD		MPS ± SD	
		kg		mm	
<i>Iguana iguana</i>	8	2.711	± 0.432	8.025	± 8.172
<i>Cyclura cornuta</i>	5	4.500*	± 1.118	10.614	± 14.781
<i>Corucia zebrata</i>	10	0.423	± 0.123	10.128	± 4.024
<i>Dipsochelys dussumieri</i>	6	102.500*	± 86.125	23.712	± 10.087
<i>Testudo gigantea</i>	5	158.000*	± 31.937	26.247	± 3.814
<i>Geochelone nigra</i>	7	104.286*	± 21.492	16.170	± 6.605
<i>Testudo radiata</i>	3	10.000*	-	8.187	± 1.515
<i>Testudo pardalis</i>	4	30.000*	-	19.161	± 14.068
<i>Testudo sulcata</i>	3	90.000*	-	9.921	± 8.196
<i>Testudo horsfieldii</i>	1	1.200	-	7.114	-
<i>Testudo hermanni</i>	14	0.808	± 0.464	5.103	± 3.726
<i>Testudo graeca</i>	13	1.545	± 0.884	6.755	± 5.911

Note that the MPS was calculated on the basis of a sieve analysis with nine sieves (in contrast to the data presented in Fritz et al. 2009).