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Online Supplement for

Body cavity volume reconstruction in terrestrial tetrapods

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Basal synapsids/ mammal-like reptiles

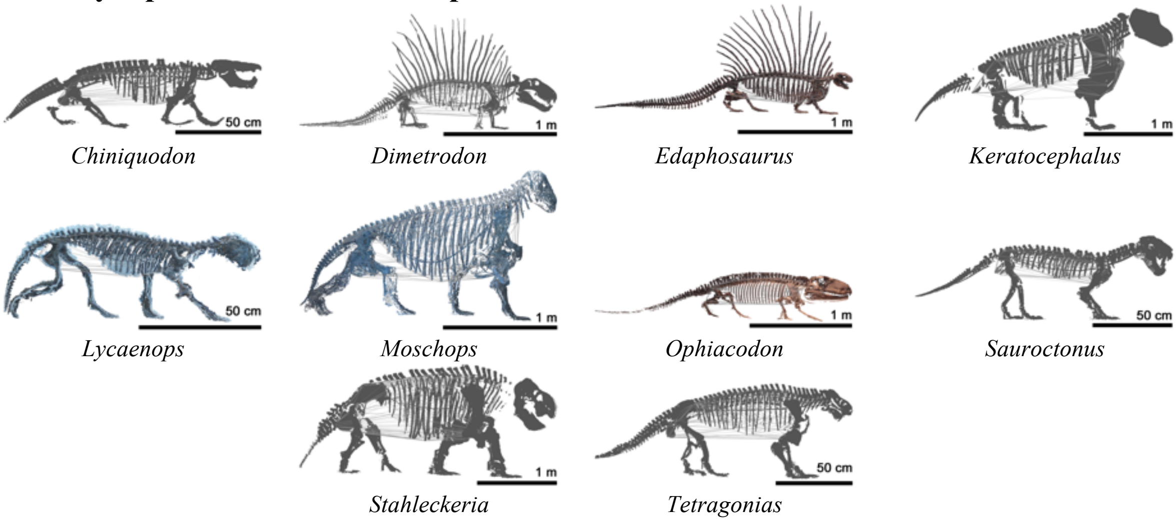
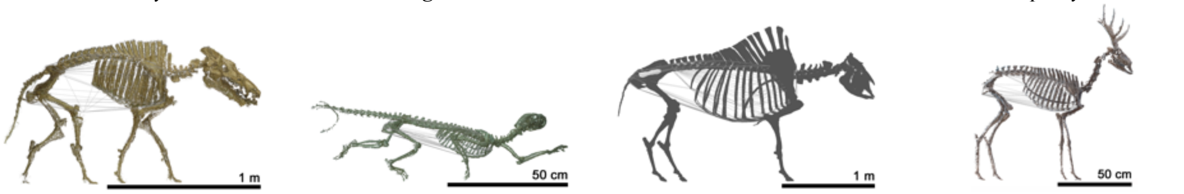


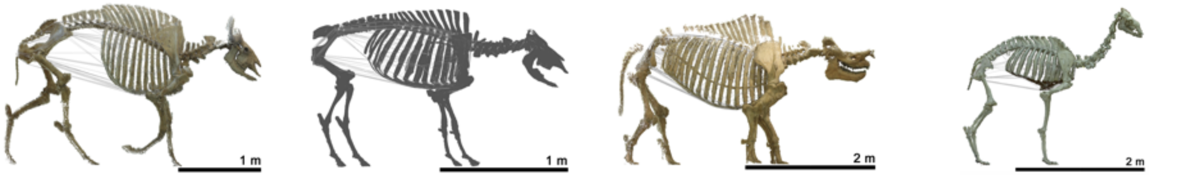
Figure S1. 3D skeleton reconstructions of early synapsids (incl. indications of the convex hull of the body cavity).

Mammals

Acinonyx *Agouti* *Ailurus* *Amphicyon*

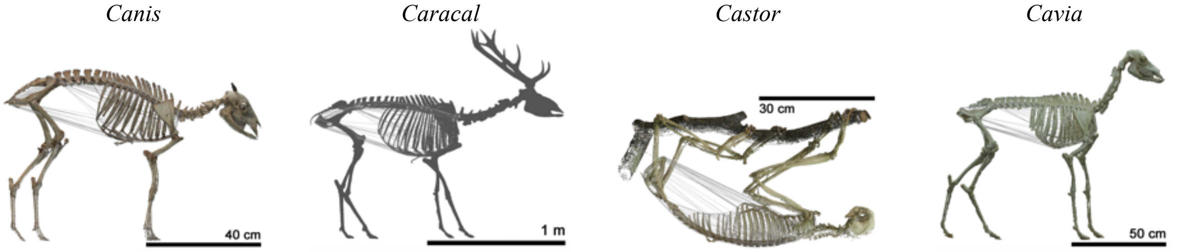


Archaeotherium *Arctitis* *Bison** *Blastocerus*



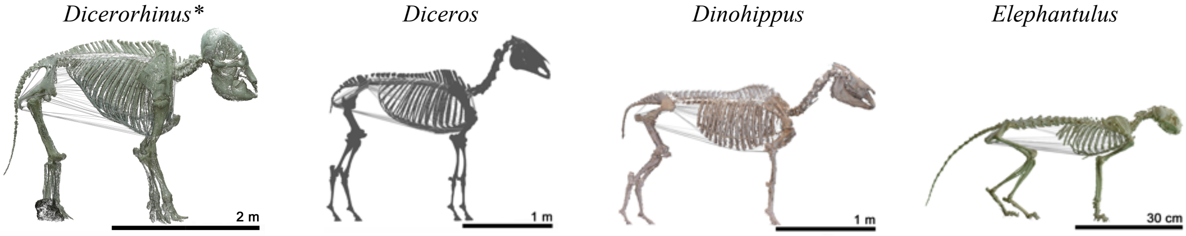
Bos gaurus *Bos taurus** *Brontops* *Camelus*

Canis *Caracal* *Castor* *Cavia*

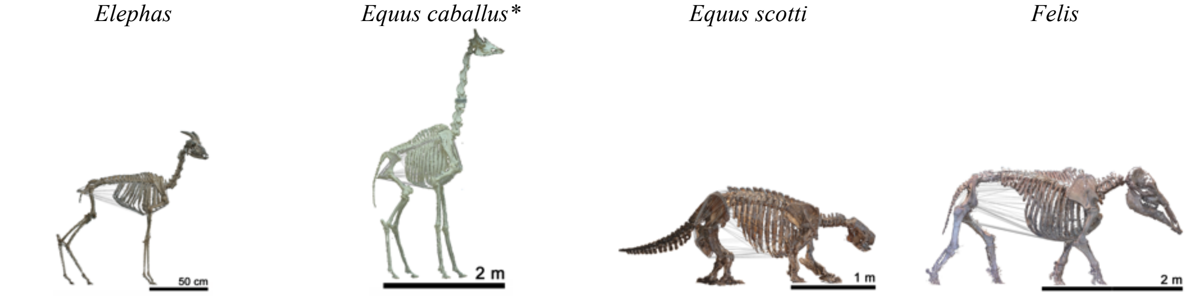


Cephalophus *Cervus** *Choloepus* *Dama*

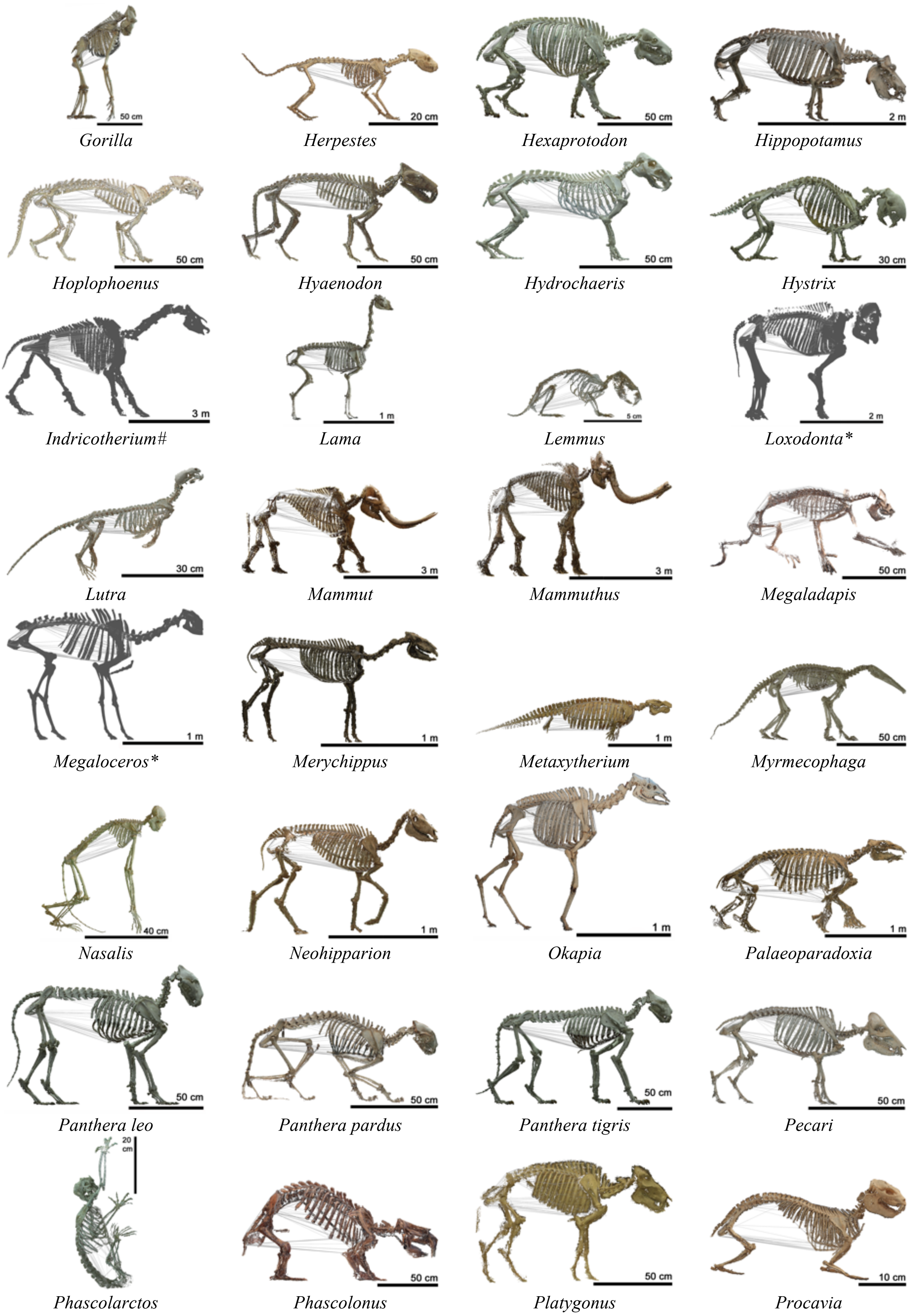
*Dicerorhinus** *Diceros* *Dinohippus* *Elephantulus*



Elephas *Equus caballus** *Equus scotti* *Felis*



Gazella *Giraffa* *Glossotherium* *Gomphotherium*


50 cm
Gorilla
20 cm
Herpestes
50 cm
Hexaprotodon
2 m
Hippopotamus
50 cm
Hoplophoenus
50 cm
Hyaenodon
50 cm
Hydrochaeris
30 cm
Hystrix
3 m
Indricotherium#
1 m
Lama
5 cm
Lemmus
2 m
*Loxodonta**
30 cm
Lutra
3 m
Mammut
3 m
Mammuthus
50 cm
Megaladapis
1 m
*Megaloceros**
1 m
Merychippus
1 m
Metaxytherium
50 cm
Myrmecophaga
40 cm
Nasalis
1 m
Neohipparion
1 m
Okapia
1 m
Palaeoparadoxia
50 cm
Panthera leo
50 cm
Panthera pardus
50 cm
Panthera tigris
50 cm
Pecari
20 cm
Phascolarctos
50 cm
Phascolonus
50 cm
Platygonus
10 cm
Procavia

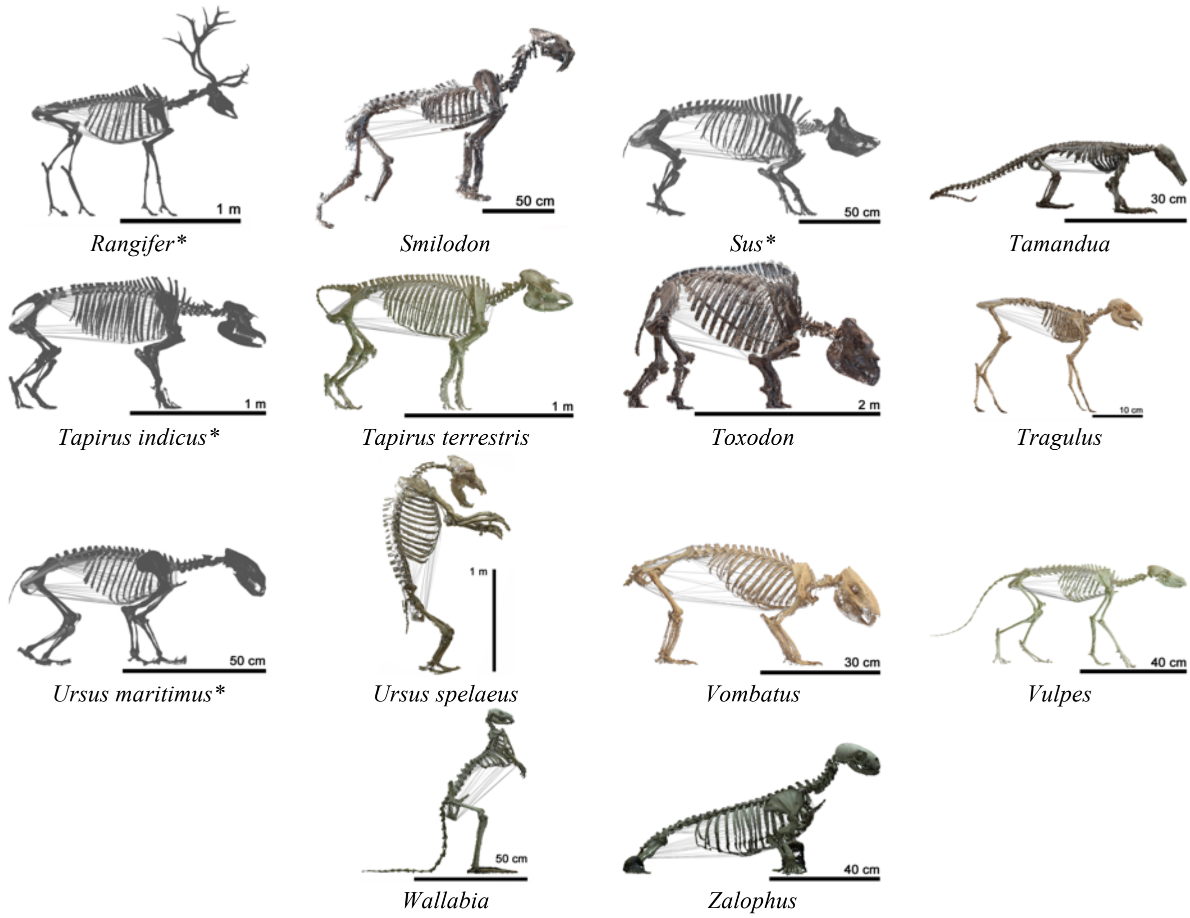


Figure S2. 3D skeleton reconstructions of mammals (incl. indications of the convex hull of the body cavity). Reconstructions from this study, except *(from Sellers et al., 2012) and #(from Stoinski et al., 2011).

Birds

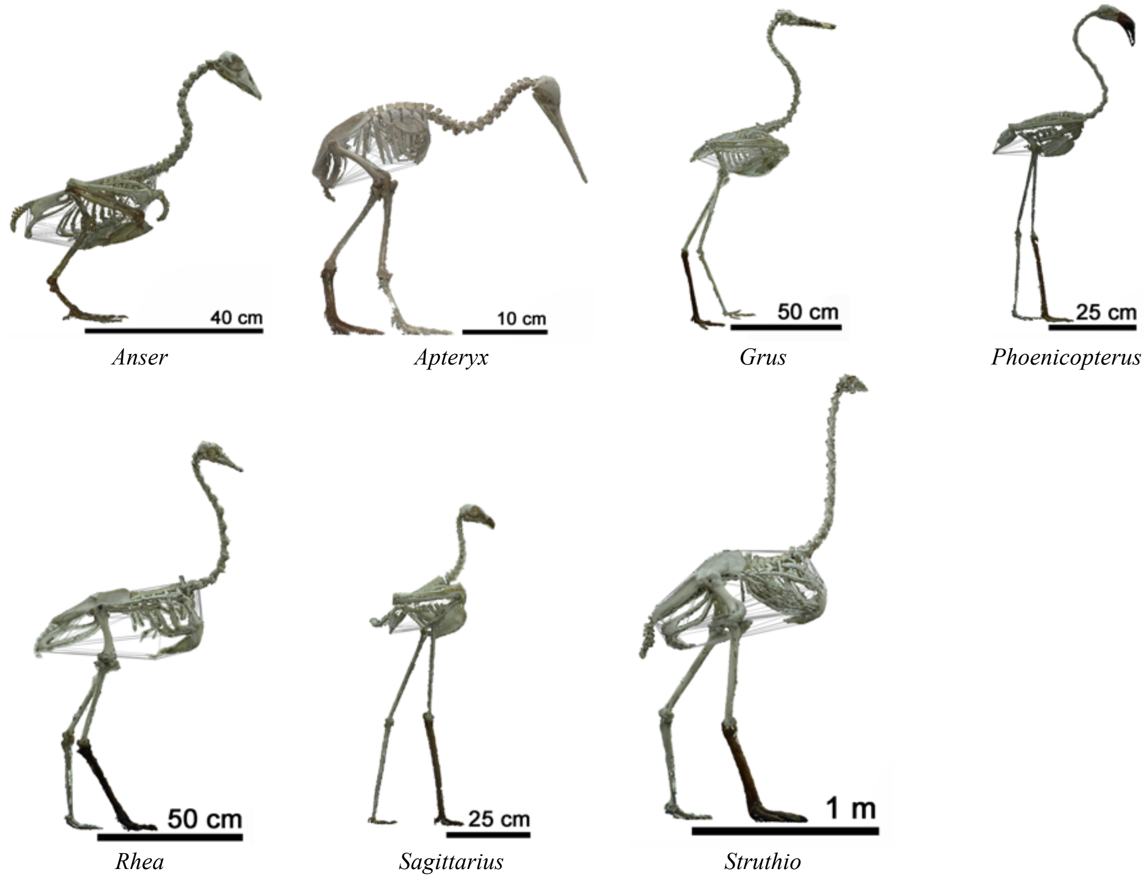


Figure S3. 3D skeleton reconstructions of birds (incl. indications of the convex hull of the body cavity).

Non-avian dinosaurs

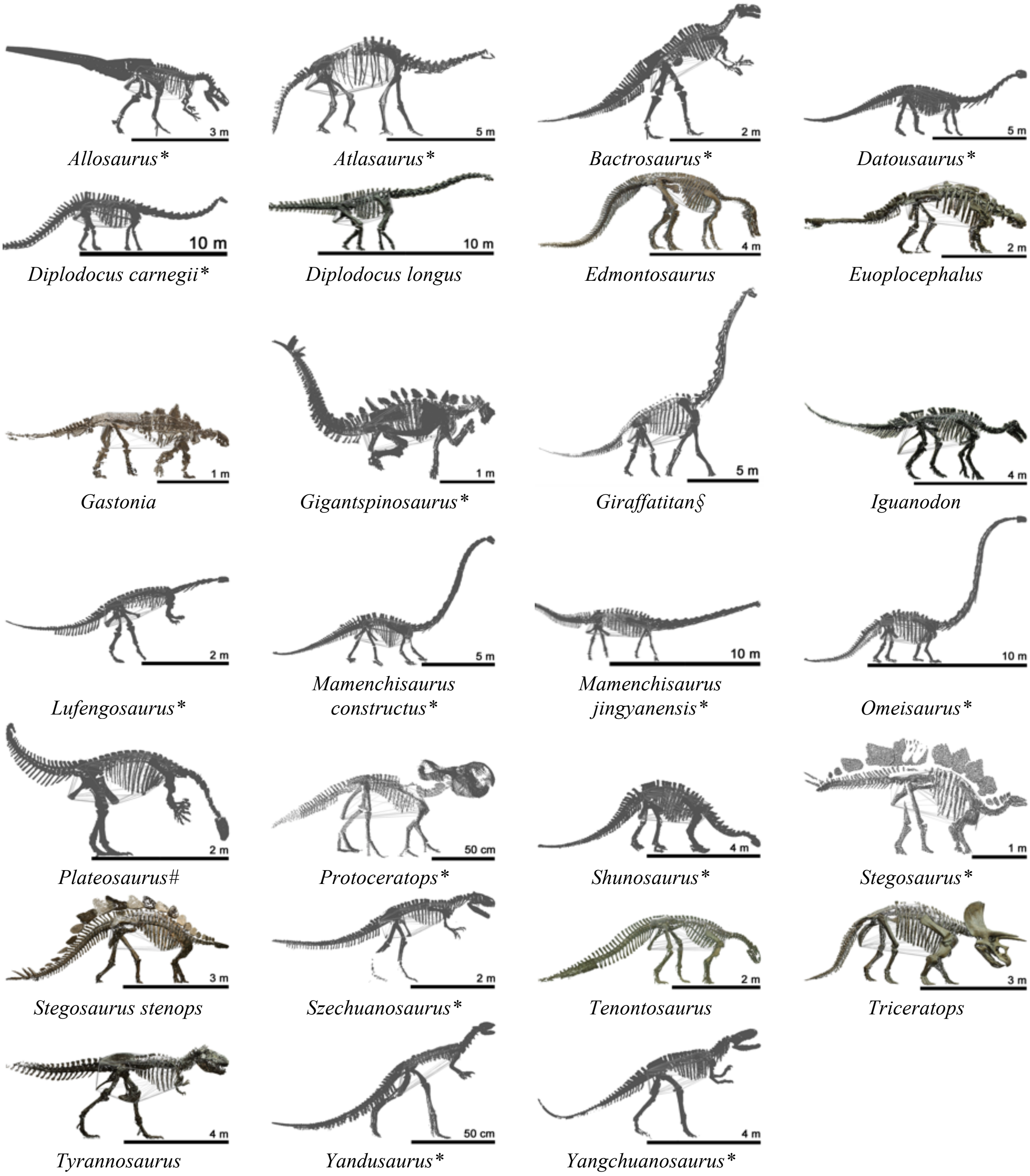
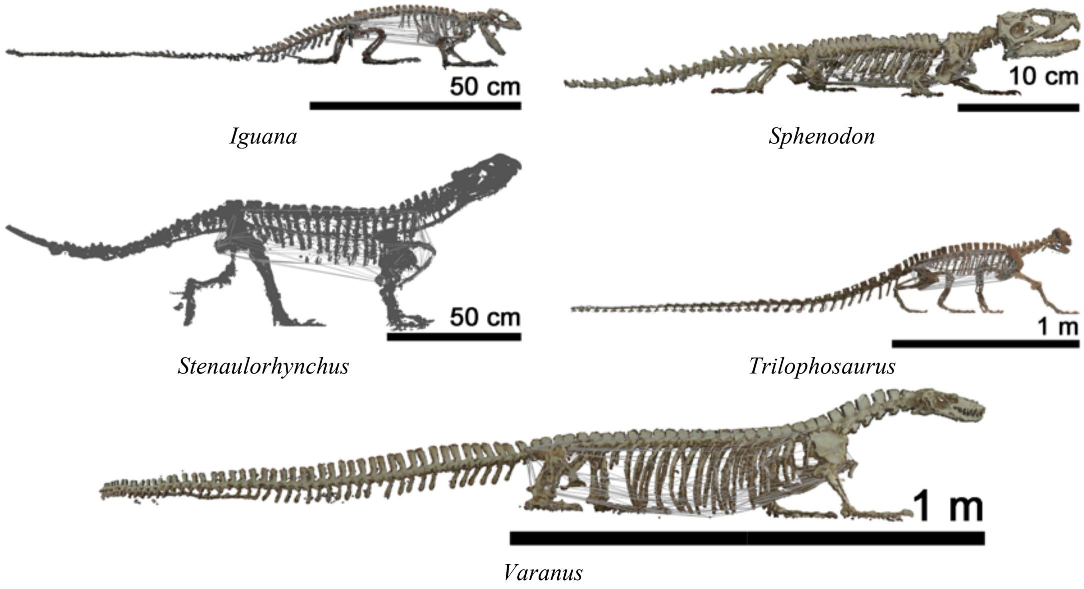


Figure S4. 3D skeleton reconstructions of non-avian dinosaurs (incl. indications of the convex hull of the body cavity). Reconstructions from this study, except #(from Gunga et al., 2007), §(from Gunga et al., 2008), *(from Stoinski et al., 2011).

Reptiles



Amphibia

Figure S5. 3D skeleton reconstructions of reptiles and amphibia (incl. indications of the convex hull of the body cavity).

Table S1. Specimens used in this study, categories and measurements

Specimen as taken	Species name in tree	Food[a]	Chew[b]	Femur length cm	Torso volume cm^3	Free-hull ratio	Mirrored/ split torso	Origin[c]	Source[d]	ID at Origin
Early synapsids										
Chiniquodon theotonicus (Belesodon magnificus)	*Chiniquodon theotonicus*	carn		16.45	25257.3	0.235	mirr	GPIT	1	RE-07112
Dimetrodon incisivus	*Dimetrodon incisivus*	carn		17.99	52310.0	0.084	-	GPIT	1	RE-07100
Edaphosaurus boanerges	*Edaphosaurus boanerges*	herb		18.54	38933.1	0.129	-	AMNH	1	7003
Keratocephalus moloch	*Keratocephalus moloch*	herb		32.31	591338.0	0.299	mirr	GPIT	1	RE-07102
Lycaenops ornatus	*Lycaenops ornatus*	carn		18.18	10442.8	0.199	-	AMNH	1	2240
Moschops capensis	*Moschops capensis*	herb		38.28	445972.0	0.167	-	AMNH	1	5552
Ophiacodon retroversus	*Ophiacodon retroversus*	carn		17.90	32421.0	0.127	mirr	AMNH	1	4155
Sauroctonus parringtoni	*Sauroctonus parringtoni*	carn		18.65	18277.5	0.207	-	GPIT	1	RE-07113
Stahleckeria potens	*Stahleckeria potens*	herb		45.02	867003.0	0.172	-	GPIT	1	RE-07106
Tetragonias (Dicynodon) njalilus	*Tetragonias njalilus*	herb		20.46	67309.0	0.258	-	GPIT	1	RE-08649
Mammals										
Acinonyx jubatus	*Acinonyx jubatus*	carn		23.23	5913.2	0.252	-	ZFMK	1	MAM 1931.0070
Coelogenys paca	*Agouti paca*	herb		10.22	2212.2	0.307	-	ZMUZ	1	10698
Ailurus fulgens	*Ailurus fulgens*	herb		10.93	1457.1	0.203	mirr	BNHM	1	8223
Amphicyon ingens	*Amphicyon ingens*	carn		53.85	167553.0	0.220	-	AMNH	1	FAM 68117/54262
Archaeotherium mortoni	*Archaeotherium mortoni*	herb		28.58	58047.3	0.254	-	AMNH	1	11323
Arctictis binturong	*Arctictis binturong*	herb		15.59	4726.7	0.337	-	BNHM	1	7553
Bison bison	*Bison bison*	herb		42.42	275565.0	0.093	-		2	
Blastoceros pampaeus	*Blastocerus dichotomus*	herb		22.96	16767.9	0.237	-	AMNH	1	11202
Bos gaurus	*Bos frontalis*	herb		56.48	545800.0	0.243	-	AMNH	1	18465
Bos taurus	*Bos taurus*	herb		37.37	145353.0	0.214	-		2	
Brontops robustus	*Brontops robustus*	herb		80.50	1569812.0	0.138	-	AMNH	1	518
Camelus dromedarius	*Camelus dromedarius*	herb		54.66	284066.0	0.163	-	DMUG	1	no ID
Canis canis	*Canis lupus*	carn		26.45	22138.5	0.193	split	DMUG	1	no ID
Caracal caracal	*Caracal caracal*	carn		17.13	2708.5	0.323	split	BNHM	1	10766
Castor canadensis	*Castor canadensis*	herb		11.40	5654.2	0.250	-	BNHM	1	1997

(ctd.)

Specimen as taken	Species name in tree	Food[a]	Chew[b]	Femur length cm	Torso volume cm^3	Free-hull ratio	Mirrored/ split torso	Origin[c]	Source[d]	ID at Origin
Cavia porcellus	*Cavia porcellus*	herb		4.66	354.5	0.360	-	CZAEPW	1	no ID
Cephalophus niger	*Cephalophus niger*	herb		18.00	9507.9	0.244	-	BNHM	1	2493
Cervus elaphus	*Cervus elaphus*	herb		29.12	53778.3	0.196	-		2	
Choloepus didactylus	*Choloepus didactylus*	herb		16.87	5262.1	0.267	split	ZFMK	1	no ID
Dama dama	*Dama dama*	herb		21.17	21706.5	0.250	-	DMUG	1	no ID
Dicerorhinus sumatrensis	*Dicerorhinus sumatrensis*	herb		40.91	251521.0	0.073	-		2	
Diceros bicornis	*Diceros bicornis*	herb		43.14	364154.0	0.054	-	ZFMK	1	MAM 1934.0047
Dinohippus leidyanus	*Dinohippus leidyanus*	herb		33.51	73237.2	0.224	-	AMNH	1	17224
Elephantulus rozeti	*Elephantulus rozeti*	carn		2.41	14.7	0.285	-	BNHM	1	9159
Elephas maximus	*Elephas maximus*	herb		93.09	1323760.0	0.193	-	DMUG	1	no ID
Equus caballus	*Equus caballus*	herb		51.65	233771.0	0.114	-		2	
Equus scotti	*Equus scotti*	herb		41.07	209734.0	0.196	-	AMNH	1	10606
Felis catus	*Felis silvestris*	carn		12.64	1713.9	0.271	-	ZFMK	1	MAM 1986.0005
Nanger dama	*Gazella dama*	herb		24.89	24901.2	0.174	-	BNHM	1	1467
Giraffa camelopardalis	*Giraffa camelopardalis*	herb		49.87	295159.4	0.061	-	DMUG	1	no ID
Glossotherium robustus	*Glossotherium robustus*	herb		47.08	483877.0	0.139	-	AMNH	1	11277
Gomphotherium productum	*Gomphotherium productum*	herb		66.58	2739370.0	0.238	-	AMNH	1	10582
Gorilla gorilla	*Gorilla gorilla*	herb		38.25	43739.2	0.106	-	ZMUZ	1	11880
Herpestes brachyurus	*Herpestes brachyurus*	carn		7.28	676.7	0.269	-	ZMUZ	1	10328
Hexaprotodon liberiensis	*Hexaprotodon liberiensis*	herb		24.77	53075.2	0.180	-	DMUG	1	no ID
Hippopotamus amphibius	*Hippopotamus amphibius*	herb		48.91	475857.0	0.192	-	BNHM	1	2767
Hoplophoneus primaevus	*Hoplophoneus primaevus*	carn		21.35	9944.9	0.337	-	AMNH	1	1406
Hyaenodon horridus	*Hyaenodon horridus*	carn		21.92	12888.4	0.279	-	AMNH	1	1375
Hydrochaeris hydrochaeris	*Hydrochaeris hydrochaeris*	herb		19.87	23589.2	0.329	split	DMUG	1	no ID
Hystrix spp.	*Hystrix cristata*	herb		12.02	6234.3	0.273	-	DMUG	1	no ID
Paracerathrium tianshanensis	*Indricotherium transouralicum*	herb		124.63	4969740.0	0.259	-	BCNHM	3	no ID
Lama guanicoe	*Lama guanicoe*	herb		32.48	71884.6	0.230	-	ZMUZ	1	10814
Lemmus lemmus	*Lemmus lemmus*	herb		2.22	25.9	0.393	-	CZAEPW	1	no ID
Loxodonta africana	*Loxodonta africana*	herb		114.99	1546200.0	0.155	-		2	

(ctd.)

Specimen as taken	Species name in tree	Food[a]	Chew[b]	Femur length cm	Torso volume cm^3	Free-hull ratio	Mirrored/ split torso	Origin[c]	Source[d]	ID at Origin
Lutra lutra	*Lutra lutra*	carn		8.18	1841.2	0.198	split	BNHM	1	115
Mammut americanum	*Mammut americanum*	herb		110.36	3563910.0	0.285	-	AMNH	1	9951
Mammuthus jeffersoni	*Mammuthus columbi*	herb		127.38	2541860.0	0.213	-	AMNH	1	FAM 99927
Megaladapis edwardsi	*Megaladapis edwardsi*	herb		23.33	42604.3	0.258	-	AMNH	1	15868
Megaloceros giganteus	*Megaloceros giganteus*	herb		48.07	156848.0	0.229	-		2	
Merychippus quintus	*Merychippus quintus*	herb		28.14	38294.0	0.232	-	AMNH	1	14185
Metaxytherium floridanum	*Metaxytherium floridanum*	herb		17.20	279265.0	0.273	-	AMNH	1	26838
Myrmecophaga tridactyla	*Myrmecophaga tridactyla*	carn		22.46	10049.6	0.160	-	ZZ	1	no ID
Nasalis larvatus	*Nasalis larvatus*	herb		22.27	3223.0	0.305	-	ZFMK	1	MAM 1939.0042
Neohipparion affine	*Neohipparion affine*	herb		30.79	66395.5	0.268	-	AMNH	1	9815
Okapia johnstoni	*Okapia johnstoni*	herb		34.36	111079.0	0.099	-	BNHM	1	3940
Palaeoparadoxia tabatai	*Palaeoparadoxia tabatai*	herb		41.96	271982.0	0.240	-	AMNH	1	129177
Panthera leo	*Panthera leo*	carn		30.97	31630.9	0.249	-	DMUG	1	no ID
Panthera pardus	*Panthera pardus*	carn		25.07	14958.9	0.212	-	BNHM	1	273
Panthera tigris	*Panthera tigris*	carn		36.84	46061.8	0.208	-	DMUG	1	no ID
Pecari tajacu	*Pecari tajacu*	herb		17.68	12891.4	0.202	-	BNHM	1	1071
Phascolarctos cinereus	*Phascolarctos cinereus*	herb		12.96	2781.3	0.327	-	BNHM	1	6260
Phascolonus gigas	*Phascolonus gigas*	herb		33.80	168794.0	0.317	-	AMNH	1	129499
Platygonus leptorhinus	*Platygonus compressus*	herb		21.15	25493.9	0.207	-	AMNH	1	10388
Procavia capensis	*Procavia capensis*	herb		7.65	1488.4	0.356	-	ZMUZ	1	10850
Rangifer tarandus	*Rangifer tarandus*	herb		30.90	50442.0	0.100	-		2	
Smilodon floridanus	*Smilodon fatalis*	carn		39.34	59137.8	0.219	-	AMNH	1	FM 14398
Sus scrofa	*Sus scrofa*	herb		24.58	45418.0	0.180	-		2	
Tamandua mexicana	*Tamandua mexicana*	carn		7.70	865.3	0.245	-	BNHM	1	1257
Tapirus indicus	*Tapirus indicus*	herb		35.26	103340.0	0.149	-		2	
Tapirus terrestris	*Tapirus terrestris*	herb		29.90	50212.0	0.134	-	ZFMK	1	MAM 1934.0105
Toxodon burmeisteri	*Toxodon platensis*	herb		60.97	762687.0	0.143	-	AMNH	1	14943
Tragulus javanicus	*Tragulus javanicus*	herb		6.98	412.4	0.336	-	ZMUZ	1	11021
Ursus maritimus	*Ursus maritimus*	carn		41.98	72996.4	0.188	-		2	

(ctd.)

Specimen as taken	Species name in tree	Food[a]	Chew[b]	Femur length cm	Torso volume cm^3	Free-hull ratio	Mirrored/ split torso	Origin[c]	Source[d]	ID at Origin
Ursus spelaeus	*Ursus spelaeus*	herb		45.71	161547.0	0.128	-	AMNH	1	39416
Vombatus ursinus	*Vombatus ursinus*	herb		13.74	6447.2	0.215	-	ZMUZ	1	11068
Vulpes vulpes	*Vulpes vulpes*	carn		14.16	2358.6	0.220	-	ZFMK	1	MAM 1933.0126a
Wallabia spp.	*Wallabia bicolor*	herb		17.00	5361.8	0.337	split	DMUG	1	no ID
Otarid spp.	*Zalophus californianus*	carn		7.26	9898.8	0.148	-	DMUG	1	no ID
Birds										
Anser anser	*Anser anser*	herb		8.12	2626.3	0.127	-	DMUG	1	no ID
Apteryx owenii	*Apteryx owenii*	herb		8.61	396.9	0.230	-	BNHM	1	2344
Grus spp.	*Grus grus*	herb		16.23	4196.7	0.250	-	DMUG	1	no ID
Phoenicopterus roseus	*Phoenicopterus roseus*	carn		27.13	1194.0	0.229	-	DMUG	1	no ID
Rhea americana	*Rhea americana*	herb		20.53	12239.3	0.229	-	DMUG	1	no ID
Sagittarius serpentarius	*Sagittarius serpentarius*	carn		11.86	1334.9	0.206	-	DMUG	1	no ID
Struthio camelus	*Struthio camelus*	herb		32.22	73816.9	0.242	-	DMUG	1	no ID
Non-avian dinosaurs										
Allosaurus fragilis	*Allosaurus fragilis*	carn		84.28	774160.0	0.169	-	SMA	3	Big Al II
Atlasaurus imelakei	*Atlasaurus imelakei*	herb	nonchew	190.62	6535910.0	0.126	split	MMEM	3	no ID
Bactrosaurus johnsoni	*Bactrosaurus johnsoni*	herb	chew	81.00	505908.0	0.232	-	BCNHM	3	no ID
Datousaurus bashanensis	*Datousaurus bashanensis*	herb	nonchew	119.86	2829100.0	0.143	-	ZMNH	3	no ID
Diplodocus carnegii	*Diplodocus carnegii*	herb	nonchew	158.01	6693450.0	0.083	-	MNHB	3	no ID
Diplodocus longus	*Diplodocus longus*	herb	nonchew	144.33	3933920.0	0.127	-	NMSF	1	no ID
Anatotitan copei	*Edmontosaurus annectens*	herb	chew	118.17	1499110.0	0.201	-	AMNH	1	5886
Euoplocephalus tutus	*Euoplocephalus tutus*	herb	nonchew	66.54	1873940.0	0.261	-	NMSF	1	no ID
Gastonia burgei	*Gastonia burgei*	herb	nonchew	35.91	301690.0	0.280	-	USUEPM	1	no ID
Gigantspinosaurus sichuanensis	*Gigantspinosaurus sichuanensis*	herb	nonchew	67.36	775033.0	0.281	-	ZMNH	3	no ID
Brachiosaurus brancai	*Giraffatitan brancai*	herb	nonchew	197.46	17029000.0	0.101	-	MNHB	5	no ID
Iguanodon bernissartensis	*Iguanodon bernissartensis*	herb	chew	102.17	2242310.0	0.185	-	NMSF	1	no ID
Lufengosaurus huenei	*Lufengosaurus huenei*	herb	nonchew	56.38	339974.0	0.157	-	BCNHM	3	no ID
Mamenchisaurus constructus	*Mamenchisaurus constructus*	herb	nonchew	146.74	5709280.0	0.194	-	ZMNH	3	no ID
Mamenchisaurus jingyanensis	*Mamenchisaurus jingyanensis*	herb	nonchew	142.95	6206260.0	0.163	-	BCNHM	3	no ID

(ctd.)

Specimen as taken	Species name in tree	Food[a]	Chew[b]	Femur length cm	Torso volume cm^3	Free-hull ratio	Mirrored/ split torso	Origin[c]	Source[d]	ID at Origin
Omeisaurus yianfuensis	*Omeisaurus yianfuensis*	herb	nonchew	129.40	5695660.0	0.065	-	ZMNH	3	no ID
Plateosaurus engelhardti	*Plateosaurus engelhardti*	herb	nonchew	58.03	322912.0	0.102	-	GPIT	4	RE-07288
Protoceratops andrewsi	*Protoceratops andrewsi*	herb	chew	24.61	28244.8	0.456	-	BCNHM	3	no ID
Shunosaurus lii	*Shunosaurus lii*	herb	nonchew	90.41	1730150.0	0.106	-	ZMNH	3	no ID
Stegosaurus	*Stegosaurus armatus*	herb	nonchew	78.47	802276.0	0.236	mirr	SMA	3	Moritz
Stegosaurus stenops	*Stegosaurus stenops*	herb	nonchew	107.66	1425560.0	0.213	-	NMSF	1	no ID
Szechuanosaurus campi	*Szechuanosaurus campi*	carn		60.20	269308.0	0.143	-	ZMNH	3	no ID
Tenontosaurus tilletti	*Tenontosaurus tilletti*	herb	chew	71.65	411004.0	0.282	-	AMNH	1	FARB 3034
Triceratops elatus	*Triceratops horridus*	herb	chew	104.74	3113700.0	0.239	-	NMSF	1	no ID
Tyrannosaurus rex	*Tyrannosaurus rex*	carn		126.47	3762000.0	0.134	-	NMSF	1	no ID
Yandusaurus multidens	*Yandusaurus hongheensis*	herb	nonchew	15.80	4213.4	0.325	-	ZMNH	3	no ID
Yangchuanosaurus hepingensis	*Yangchuanosaurus shangyouensis*	carn		98.57	974264.0	0.167	-	ZMNH	3	no ID
Reptiles										
Iguana rhinolopha	*Iguana iguana*	herb		9.01	1012.1	0.271	-	BNHM	1	1260
Sphenodon punctatus	*Sphenodon punctatus*	carn		4.42	163.8	0.183	split	ZMUZ	1	no ID
Stenaulorhynchus stockley	*Stenaulorhynchus stockley*	herb		17.71	33364.7	0.197	-	GPIT	1	RE-07192
Trilophosaurus buettneri	*Trilophosaurus buettneri*	herb		23.88	11695.5	0.151	-	AMNH	1	7502
Varanus salvator	*Varanus salvator*	carn		13.18	13188.5	0.105	-	ZMUZ	1	no ID
Amphibia										
Diadectes phaseolinus	*Diadectes phaseolinus*	herb		18.75	72289.2	0.231	-	AMNH	1	4684
Eryops megacephalus	*Eryops megacephalus*	carn		19.46	32237.5	0.324	-	AMNH	1	4657

[a]based on Walls (1981), Losos and Greene (1988), Rand et al. (1990), Weishampel et al. (1990), Reisz and Sues (2000), Reisz (2006), Wilman et al. (2014) and the Paleobiology Database (www.paleobiodb.org)

[b]based on Weishampel et al. (1990) and Wings and Sander (2007)

[c]for skeletons from sources 1, 3-5: AMNH American Museum of Natural History New York USA, BCNHM = Bejing Natural History Museum China, BNHM = Natural History Museum Basle Switzerland, CZAEPW = Clinic of Zoo Animals Exotic Pets and Wildlife Univeristy of Zurich Switzerland, DMUG = Anatomy Museum Department of Morphology Faculty of Veterinary Medicine Ghent University Belgium, MMEM = Moroccan Ministry of Energy and Mining Morocco, MNHB = Natural History Museum Berlin Germany, NMSF = Senckenberg Naturmuseum Frankfurt Germany, GPIT = Paleontological Collection University of Tübingen Germany, SMA = Sauriermuseum Aathal Switzerland, USUEPM = Utah State University Eastern Prehistoric Museum Price USA, ZFMK = Alexander Koenig Research Museum Bonn Germany, ZMNH = Zigong Museum of Natural History China, ZMUZ = Zoological Museum University of Zurich Switzerland, ZZ = Zurich Zoo Switzerland

[d]Sources: 1 = this study, 2 = Sellers et al. (2012), 3 = described in Stoinski et al. (2011), 4 = described in Gunga et al. (2007), 5 = described in Gunga et al. (2008)

Phylogenetic tree

The phylogenetic tree (Fig. S6) used in the PGLS analysis was constructed based on various sources. The topology was based on a combination of tree sources that included some of the most recent phylogenetic hypotheses. Due to the taxa selection of the present study, which was mainly driven by mounted skeleton availability and the logistics of obtaining their respective scans or photographs, it was not possible to build a supertree based on a character matrix because the taxa considered were too distantly related. Due to the sample, inevitably certain taxonomic groups (i.e., mammals) are more represented than others. The phylogeny includes both fossil and living tetrapods. The basic topology of tetrapod groups is based on tree of life project (Maddison and Schulz, 2007) supplemented with specific references.

Eryops megacephalus is here basal to all the other taxa as member of Temnospondyli (extinct group of primitive tetrapods) (Ruta et al., 2007). It is followed by *Diadectes phaseolinus*, the sister taxon of all the Amniota (Berman and Henrici, 2003). Within the Amniota an early split is recognised between the Diapsida and the Synapsida (represented by basal Eupleycosauria, therapsids, and mammals) (Benton, 2014).

Within Diapsida, the sample is characterized by a mix of extant and fossil Sauria. The presence of extant *Sphenodon*, *Iguana* and *Varanus* characterizes the split of Lepidosauriamorpha from Archosauriamorpha that include crocodiles (not present in our study), birds and their fossil relatives (i.e., dinosaurs). The position of *Sphenodon* relative to the other Squamata follows Pyron et al. (Pyron et al., 2013).

Within Archosauromorpha we positioned *Trilophosaurus* and *Stenaulorhynchus* basal to dinosaurs and birds after Ezcurra et al. (Ezcurra et al., 2014) who presented a recent updated phylogeny of Sauria. In their topology *Stenaulorhynchus* is not present however *Trilophosaurus* is positioned basal to Rhynchosauria (the group to which *Stenaulorhynchus* belongs).

Dinosauria is the other large clade of Archosauromorpha. Its topology is based on the supertree of Lloyd et al. (Lloyd et al., 2008) with the manual addition of extant Aves as from the topology in Xu et al. (Xu et al., 2014). The position of certain specific dinosaur taxa was updated such as that of *Datousaurus bashanensis* that is basal to Eusaropoda (Sekiya, 2011) and for *Szechuanosaurus campi* that is closely related to *Yangchuanosaurus* within theropods (Carrano et al., 2012). Modern bird topology was generated after Jetz et al. (Jetz et al., 2012), and Prum et al. (Prum et al., 2015) with respect to the position of the kiwi (*Apteryx owenii*) and the rhea (*Rhea americana*).

Within Synapsida, the position of primitive Eupelycosauria and the general topology of therapsids follows Sidor (Sidor, 2003). The historical *Beselodon magnificus* was updated as *Chiniquodon theotonicus* (member of Eucynodontia) (Abdala and Giannini, 2002), and *Scymnognathus parringtoni* was named *Sauroctonus parringtoni (Gebauer, 2014)*.

For mammals the topology of extant taxa was generated following Bininda-Emonds et al. (Bininda-Emonds et al., 2007, Bininda-Emonds et al., 2008) with the addition of specific fossil branches after Raia et al. (Raia et al., 2013). A substantial addition was the inclusion of the fossil Notoungulate *Toxodon* and the Demostylia *Palaeoparadoxia*, whose taxonomic position was recently updated as basal members of Perissodactyla (Cooper et al., 2014, Welker et al., 2015). Following Cooper et al. (Cooper et al., 2014) for *Palaeoparadoxia* also allowed to place the ancient sirenid *Metaxytherium* as sister taxon of Proboscidea. For fossil Xenathra we followed the topology presented by Gaudin (Gaudin, 2004). The position of Ferae (Carnivora and Creodonta) and basal ungulates follows Raia et al. (Raia et al., 2013) and Spaulding et al. (Spaulding et al., 2009) while the relationship of primates and extant rodents follows Bininda-Emonds et al. (Bininda-Emonds et al., 2007, Bininda-Emonds et al., 2008).

In order to date the tree we opted to combine multiple empirical and analytical approaches. Firstly we recorded first and last occurrence for each taxon with the assumption that last occurrence for all extant species is zero. To avoid bias in relation to the scattered information, we employed the palaeodb website (http://fossilworks.org/?page=paleodb) to record species' time ranges. When a particular species was not present in the database, we used the genus range or conservatively stratigraphic clues based on the literature. We then employed the script 'timePaleoPhy' from the R package 'paleotree' (Bapst, 2013) to constrain time of divergence of taxa based on their stratigraphic occurrences. This script follows the same method proposed by Brusatte et al. (Brusatte et al., 2008) to date the supertree of fossil dinosaurs. In addition, we constrained the tree internal nodes based on Kepska et al. (Ksepka et al., 2015). The list of nodes and their respective dates (Table S2) was compiled after searching the fossil calibration database that includes some but not all of the internal nodes for our topology.

Table S2. Time of divergence provided for different nodes in the tree. Dates are conservatively based on the maximum nodal age reported on the website http://fossilcalibrations.org/ developed by Ksepka et al. (Ksepka et al., 2015). All the other internal nodes ages were set to 'NA' and automatically generated using the script timepaleophy (Bapst, 2013).

Node #	Node label	Time
1	Tetrapoda	351
3	Amniota	332.9
11	Theria	169.6
14	Boreoeutheria	164.6
15	Euarchontoglires	164.6
16	Rodentia	66
19	Primates	66
25	Whippomorpha	66
29	Bovidae	28.1
56	Carnivora	66
73	Xenarthra	164.6
76	Afrotheria	164.6
78	Sirenia	66
79	Proboscidea	23.03
83	Marsupialia	131.3
89	Diapsida	295.9
90	Archosauromorpha	255.9
92	Dinosauria	235
93	Ornitischia	230
105	Sauropodomorpha	232
120	Palaeognathae	86.8
122	Neognathae	86.8
123	Neoaves	60.2
125	Lepidosauria	252.7
126	Squamata	209.5

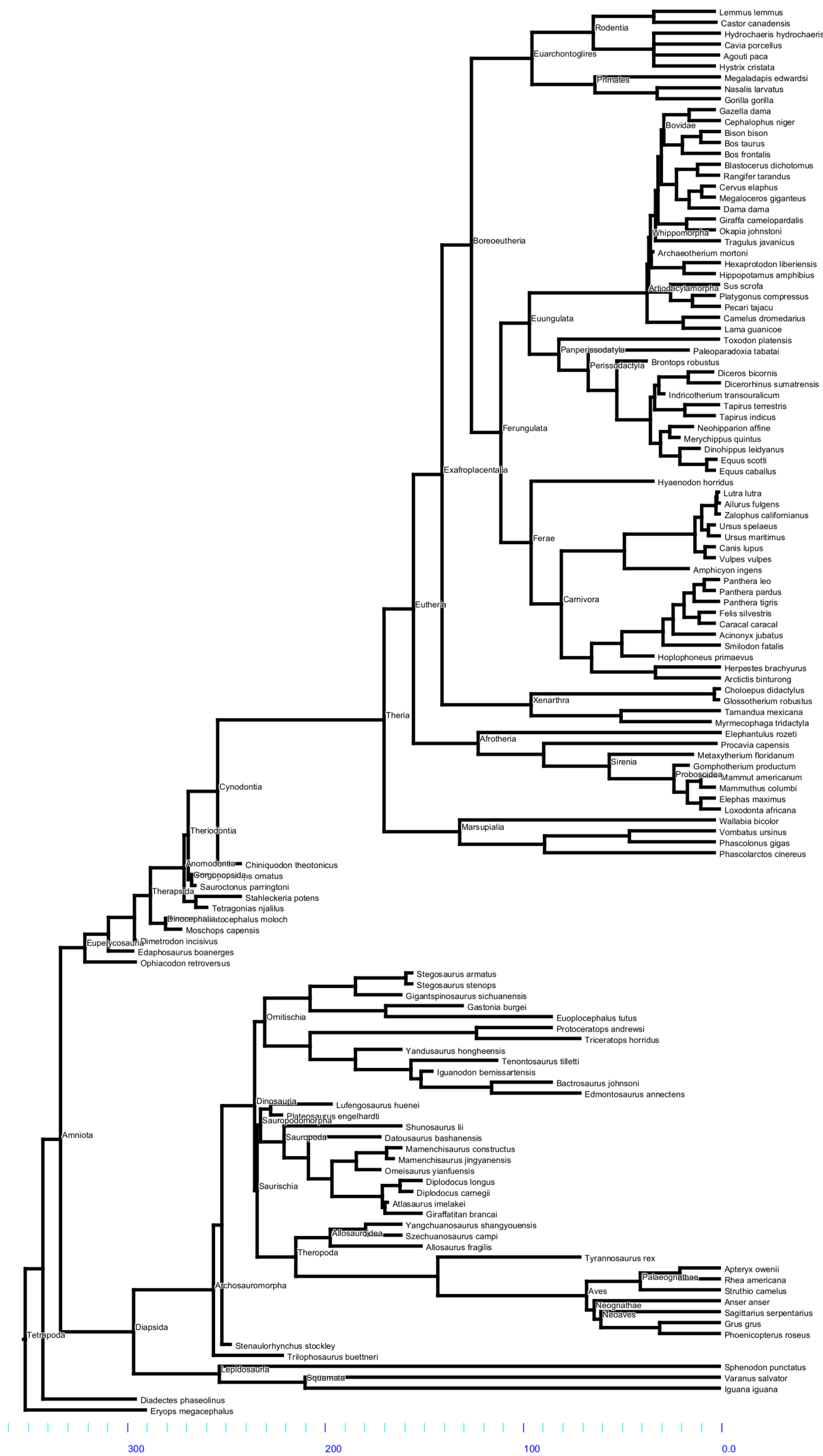


Figure S6. Phylogenetic tree (also available as supplementary nexus file)

<u>Outliers</u>

Three outliers were eliminated from the dataset used in the main study after visual inspection: the flamingo (*Phoenicopterus*), the sirenian (*Metaxytherium*) and the sea lion (*Zalopus*) (Fig. S7). In the case of the flamingos, we can only speculate that its typical diet - shrimp and algae caught in the filter system of the beak (Zweers et al., 1995) - is so small and requires so little processing that a particularly small gastrointestinal tract and coelomic cavity is feasible, and/or that flamingos have particularly long legs for their body volume. In the case of the marine mammals, it is plausible that the different mechanical constraints of their lifestyle leads to systematically different proportions of limbs and torso (Jones and Pierce, 2016).

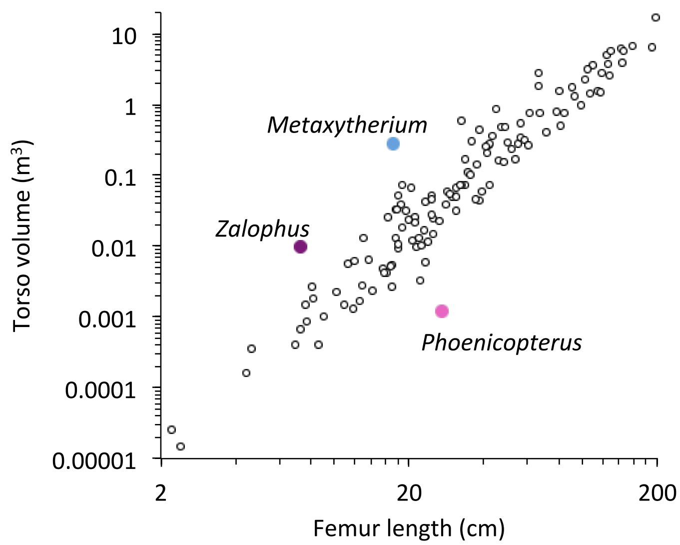


Figure S7. Visual outlier inspection: exclusion of the flamingo (combination of very long femur and very small torso) and two marine mammals (combination of very short femurs and very voluminous torsos)

Considerations about body mass in relation to torso volume

While the necessity to control for body size is self-evident, the answer to the question about which proxy is most suitable is not. Body mass is the most common basis against which other morphological and physiological measures are compared (Peters, 1983, Calder, 1996, Sibly et al., 2012). However, the volume of the torso represents a major proportion of overall body mass. Therefore, differences in torso volume most certainly are reflected in body mass differences already. On the other hand, we could hence predict that we could use body mass itself as a proxy for 'torso volume', and the relationship of body mass to femur length should resemble that of torso volume to femur length.

For the testing of these hypotheses, a valid dataset is required where all measurements are taken from the same, healthy individuals. In particular, when using body mass in this way, the feeding status of the animals used for the measurement is critical. To our knowledge, the largest dataset on femur length and body mass is presented by Campione and Evans (2012); however, the methods do not indicate a protocol about the feeding status, i.e. the degree of gut fill, in the animals. In particular in herbivores, gut fill represents a constant, relevant proportion of body mass (Clauss et al., 2013) that is considered the reason for their larger torso volumes. Using the elephant as an example, Clauss et al. (2005) demonstrated how the feeding status of animals whose body mass and gut fill are measured can influence the position of a species in comparative datasets. To date, most likely, no completely reliable large data collection on body mass and femur length exists. However, it is noteworthy that in the data evaluated by Campione and Evans (2012), there is a difference in the femur length-body mass relationship between Carnivora (i.e., mainly carnivores) and Ungulata (i.e., mainly herbivores) that could indicate that, at comparable femur length, Ungulata have higher body masses than Carnivora - a finding that would corroborate the prediction made above. Campione and Evans (2012) demonstrate that femur circumference is better related to body mass than femur length; for the question of our study this means that femur circumference would probably be a less suitable proxy as it equalizes differences in body mass at similar stature.

To perform an explorative test of these considerations, we compiled body mass data for the extant mammals, birds and reptiles of our dataset from a single source - the Animal Diversity Web (www.animaldiversity.org, accessed 25.05.2016). We consistently collected the mean (or calculated it from the minimum and maximum provided), even if in some cases the data given did not appear intuitively correct, added it to our own dataset (Table S1), and performed analyses using the same methods as outlined in the main text.

There was a linear relationship (scaling including the exponent of 1.0 in the 95%CI) between torso volume and body mass, with no influence of diet (Table S3). In contrast, there was an expected cubic scaling for the relationship of body mass and femur length, and diet was a significant factor, suggesting that for similar femur lengths, herbivores have higher body masses than carnivores (Table S4).

Table S3. Results of statistical analyses according to Torso volume = *a* (factor) Body mass^b (and the corresponding factor*Body mass interaction) in Ordinary Least Squares (OLS) and Phylogenetic Generalized Least Squares (PGLS) for extant mammals, birds and reptiles (n=63)

Stats	**λ**	**a (95%CI)**	**p**	**b (95%CI)**	**p**	**factor[#] (95%CI)**	**p**	**interaction† p**
						Diet		
OLS	(0)	384 (286, 515)	<0.001	0.94 (0.88, 1.00)	<0.001	1.07 (0.77, 1.48)	0.680	n.s.
PGLS	0	384 (286, 515)	<0.001	0.94 (0.88, 1.00)	<0.001	1.07 (0.77, 1.48)	0.681	n.s.

this is only an explorative analysis with Body mass estimates that have no connection to the Torso volume data generated in this study
Torso volume in cm^3, Body mass in kg
[#]factor coding: Diet (carnivore = 0, herbivore = 1)
†models were calculated with interaction term first; if this was not significant, the model was again calculated without the interaction term; estimates for the factor in this table always represent the models where either the interaction was significant or excluded

Table S4. Results of statistical analyses according to Body mass = *a* (factor) Femur length^b (and the corresponding factor*Femur length interaction) in Ordinary Least Squares (OLS) and Phylogenetic Generalized Least Squares (PGLS) for extant mammals, birds and reptiles (n=63)

Stats	**λ**	**a (95%CI)**	**p**	**b (95%CI)**	**p**	**factor[#] (95%CI)**	**p**	**interaction† p**
						Diet		
OLS	(0)	0.004 (0.002, 0.007)	<0.001	2.98 (2.78, 3.19)	<0.001	1.75 (1.20, 2.55)	0.005	n.s.
PGLS	0	0.004 (0.002, 0.007)	<0.001	2.98 (2.78, 3.19)	<0.001	1.75 (1.20, 2.55)	0.005	n.s.

this is only an explorative analysis with Body mass estimates that have no connection to the Femur length data generated in this study
Body mass in kg, Femur length in cm
[#]factor coding: Diet (carnivore = 0, herbivore = 1)
†models were calculated with interaction term first; if this was not significant, the model was again calculated without the interaction term; estimates for the factor in this table always represent the models where either the interaction was significant or excluded

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