

Additional File 3 for:

Differing effects of size and lifestyle on bone structure in mammals

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Additional File 3A. Specimen list.

List of all sampled specimens, with their corresponding lifestyle and abbreviated name of their specialised clade, terrestrial sister-group of a specialised clade, or more distantly related terrestrial clade (the latter are referred to as “Else”). See corresponding timetree as Supplementary Figure 2.

Species	Collection number	Lifestyle	Clade abbreviation
<i>Anomalurus beecrofti</i>	ZMB_Mam_36475	Ae	Ae_Ano
<i>Anomalurus derbianus</i>	ZMB_Mam_36344	Ae	Ae_Ano
<i>Anomalurus pelii</i>	ZMB_Mam_18404	Ae	Ae_Ano
<i>Idiurus macrotis</i>	ZMB_Mam_10088	Ae	Ae_Ano
<i>Idiurus zenkeri</i>	ZMB_Mam_22747	Ae	Ae_Ano
<i>Dobsonia peronii</i>	ZMB_Mam_66825	Ae	Ae_Chi
<i>Megaderma spasma</i>	ZMB_Mam_85644	Ae	Ae_Chi
<i>Noctilio leporinus</i>	ZMB_Mam_85657	Ae	Ae_Chi
<i>Pipistrellus pipistrellus</i>	ZMB_Mam_55128	Ae	Ae_Chi
<i>Pteropus giganteus</i>	MNHN_A_1251	Ae	Ae_Chi
<i>Pteropus vampyrus</i>	ZMB_Mam_88424	Ae	Ae_Chi
<i>Galeopterus variegatus</i>	ZMB_Mam_69096	Ae	Ae_Der
<i>Cynocephalus volans</i>	ZMB_Mam_69105	Ae	Ae_Der
<i>Acrobates pygmaeus</i>	ZMB_Mam_6241	Ae	Ae_Mars
<i>Petauroides volans</i>	ZMB_Mam_106893	Ae	Ae_Mars
<i>Petaurus australis</i>	MNHN-ZM-MO1883-1533	Ae	Ae_Mars
<i>Petaurus breviceps</i>	ZMB_Mam_104697	Ae	Ae_Mars
<i>Petaurus norfolcensis</i>	MNHN-ZM-MO1961-951	Ae	Ae_Mars
<i>Aeromys tephromelas</i>	NHMUK 1977.2886	Ae	Ae_Sciu
<i>Eoglaucmys fimbriatus</i>	NHMUK GERM 1721.a	Ae	Ae_Sciu
<i>Glaucmys volans</i>	MNHN_ZM_MO_1951_1023	Ae	Ae_Sciu
<i>Hylopetes phayrei</i>	NHMUK ZD 1994.199	Ae	Ae_Sciu
<i>Iomys horsfieldi</i>	NHMUK 1977.2885	Ae	Ae_Sciu
<i>Petaurillus hosei</i>	NHMUK ZD 1900.7.29.26	Ae	Ae_Sciu
<i>Petaurista petaurista</i>	ZMB_Mam_78560	Ae	Ae_Sciu
<i>Petinomys fuscicapillus</i>	NHMUK 1977.465	Ae	Ae_Sciu
<i>Petaurista philippensis</i>	ZMB_Mam_91292	Ae	Ae_Sciu
<i>Pteromys volans</i>	ZMB_Mam_78602	Ae	Ae_Sciu
<i>Delphinus sp</i>	ZMB_Mam_697.59	Aq	Aq_Cet
<i>Globicephala melas</i>	MNHN_LR_M_961	Aq	Aq_Cet
<i>Inia geoffrensis</i>	ZMB_Mam_41500	Aq	Aq_Cet
<i>Kogia breviceps</i>	MNHN_LR_M_1644	Aq	Aq_Cet

<i>Lagenodelphis hosei</i>	MNHN_LR_M1687	Aq	Aq_Cet
<i>Orcinus orca</i>	MNHN_1880_260	Aq	Aq_Cet
<i>Peponocephala electra</i>	MNHN_LR_M_103.08.076	Aq	Aq_Cet
<i>Phocoena phocoena</i>	MNHN_LR_M_958	Aq	Aq_Cet
<i>Sotalia sp</i>	ZMB_Mam_35828	Aq	Aq_Cet
<i>Stenella coeruleoalba</i>	MNHN_LR_M1848	Aq	Aq_Cet
<i>Tursiops truncatus</i>	MNHN_LR_M_1127	Aq	Aq_Cet
<i>Ziphius cavirostris</i>	MNHN_LR_M_942	Aq	Aq_Cet
<i>Dugong dugon</i>	ZMB_Mam_69340	Aq	Aq_Sir
<i>Hydrodamalis gigas</i>	MNHN_AC_1919-48	Aq	Aq_Sir
<i>Trichechus manatus</i>	ZMB_Mam_17377	Aq	Aq_Sir
<i>Trichechus senegalensis</i>	ZMB_Mam_69334	Aq	Aq_Sir
<i>Trichechus inunguis</i>	ZMB_Mam_35805	Aq	Aq_Sir
<i>Amblysomus hottentotus</i>	NMW26095	Su	Su_Chry
<i>Amblysomus hottentotus</i>	NMW7194	Su	Su_Chry
<i>Calcochloris obtusirostris</i>	ZMB_Mam_35173	Su	Su_Chry
<i>Chrysochloris stuhlmanni</i>	NHMUK 1934.4.1.8	Su	Su_Chry
<i>Chrysochloris asiatica</i>	ZMB_Mam_76897	Su	Su_Chry
<i>Chrysochloris asiatica</i>	NMW970	Su	Su_Chry
<i>Chrysospalax trevelyani</i>	NHMUK ZE 1951.11.14.4	Su	Su_Chry
<i>Ctenomys brasiliensis</i>	NHMUK ZD 1897.10.3.68	Su	Su_Cten
<i>Ctenomys opimus</i>	IRSNB 13028	Su	Su_Cten
<i>Ctenomys talarum</i>	NHMUK ZE 1968.8.20.1	Su	Su_Cten
<i>Ctenomys tucumanus</i>	ZMB_Mam_18180	Su	Su_Cten
<i>Ctenomys magellanicus</i>	ZMB_Mam_38821	Su	Su_Cten
<i>Ellobius fuscocapillus</i>	NMW12052	Su	Su_Ello
<i>Ellobius lutescens</i>	NMW20329	Su	Su_Ello
<i>Ellobius talpinus</i>	ZMB_Mam_78541	Su	Su_Ello
<i>Orthogeomys heterodus</i>	ZMB_Mam_106984	Su	Su_Geo
<i>Orthogeomys hispidus</i>	NHMUK ZD 1993.120	Su	Su_Geo
<i>Pappogeomys bulleri</i>	NHMUK 93.2.5.45	Su	Su_Geo
<i>Thomomys bottae</i>	ZMB_Mam_078534	Su	Su_Geo
<i>Thomomys talpoides</i>	NMW63141	Su	Su_Geo
<i>Thomomys talpoides</i>	NMW63144	Su	Su_Geo
<i>Bathyergus suillus</i>	ZMB_Mam_107241	Su	Su_Hete
<i>Cryptomys hottentotus</i>	NMW18413	Su	Su_Hete
<i>Geomys bursarius</i>	NHMUK 1384.a	Su	Su_Hete
<i>Georchus capensis</i>	NHMUK ZD 2019.218	Su	Su_Hete
<i>Georchus capensis</i>	ZMB_Mam_106888	Su	Su_Hete
<i>Heterocephalus glaber</i>	ZMB_Mam_79109	Su	Su_Hete
<i>Heliophobius argenteocinereus</i>	ZMB_Mam_107240	Su	Su_Hete
<i>Chelemys macronyx</i>	NMW43360	Su	Su_Noti
<i>Notoryctes typhlops</i>	NHMUK ZD 1981.1181	Su	Su_Noto
<i>Notoryctes typhlops</i>	MNHN-ZM-MO 1893-473	Su	Su_Noto
<i>Notoryctes typhlops</i>	ZMB_Mam_35694	Su	Su_Noto
<i>Spalacopus cyanus</i>	ZMB_Mam_8317	Su	Su_Octo
<i>Oryzorictes hova</i>	NHMUK ZD 1991.248	Su	Su_Ory
<i>Oryzorictes hova</i>	MNHN-ZM-MO 1985-1624	Su	Su_Ory
<i>Oryzorictes tetradactylus</i>	ZFMK MAM 1979.0155	Su	Su_Ory
<i>Prometheomys schaposchnikowi</i>	MNHN_ZM_2012_24	Su	Su_Prom

<i>Nannospalax ehrenbergi</i>	NMW65068	Su	Su_Spal
<i>Rhizomys sumatrensis</i>	ZMB_Mam_21249	Su	Su_Spal
<i>Spalax graecus</i>	NMW2158	Su	Su_Spal
<i>Spalax microphthalmus</i>	ZMB_Mam_78545	Su	Su_Spal
<i>Tachyoryctes splendens</i>	ZMB_Mam_72566	Su	Su_Spal
<i>Euroscaptor mizura</i>	ZMB_Mam_103981	Su	Su_Tal
<i>Mogera wogura</i>	ZMB_Mam_62455	Su	Su_Tal
<i>Parascalops breweri</i>	NMW62569	Su	Su_Tal
<i>Parascaptor leucura</i>	NHMUK ZE 1951.11.12.9	Su	Su_Tal
<i>Scalopus aquaticus</i>	NHMUK ZE 1958.3.11.7	Su	Su_Tal
<i>Talpa europaea</i>	ZMB_Mam_60682	Su	Su_Tal
<i>Chlamyphorus truncatus</i>	ZMB_Mam_6007	Su	Su_Xen
<i>Abrocoma budini</i>	NHMUK 1920.3.17.63	Te	Else
<i>Abrocoma bennettii</i>	NMW23394	Te	Else
<i>Caluromys philander</i>	ZMB_Mam_26760	Te	Else
<i>Chinchilla lanigera</i>	ZMB_Mam_81126	Te	Else
<i>Ctenodactylus gundi</i>	ZMB_Mam_71181	Te	Else
<i>Dasyprocta punctata</i>	ZMB_Mam_72483	Te	Else
<i>Dolichotis patagonum</i>	MNHN_AC_2000-827	Te	Else
<i>Echinops telfairi</i>	ZMB_Mam_71612	Te	Else
<i>Geogale aurita</i>	MNHN-ZM-MO1982-1001	Te	Else
<i>Hystrix africaeaustralis</i>	ZMB_Mam_70881	Te	Else
<i>Laonastes aenigmamus</i>	NHMUK ZD 1998.409	Te	Else
<i>Lepus europaeus</i>	ZMB_Mam_70801	Te	Else
<i>Microgale cowani</i>	ZMB_Mam_71614	Te	Else
<i>Myrmecobius fasciatus</i>	ZMB_Mam_3121	Te	Else
<i>Elephas maximus</i>	Confluences MHNL	Te	Else
<i>Ochotona princeps</i>	ZMB_Mam_93877	Te	Else
<i>Ochotona rufescens</i>	MNHN_CG2000-409	Te	Else
<i>Antechinus swainsonii</i>	IRSNB_21d	Te	Else
<i>Setifer setosus</i>	ZMB_Mam_44588	Te	Else
<i>Sicista betulina</i>	NMW29531	Te	Else
<i>Solenodon cubanus</i>	ZMB_Mam_2761	Te	Else
<i>Sus scrofa</i>	ZMB_Mam_7975	Te	Else
<i>Tayassu pecari</i>	ZMB_Mam_A.18.11	Te	Else
<i>Tenrec ecaudatus</i>	NMW2432	Te	Else
<i>Tupaia javanica</i>	ZMB_Mam_87169	Te	Else
<i>Acinonyx jubatus</i>	MNHN_AC_1998.1981	Te	Out_Ae_Chi
<i>Ailuropoda melanoleuca</i>	ZMB_Mam_17246	Te	Out_Ae_Chi
<i>Canis lupus</i>	MNHN_CG_1996.2499	Te	Out_Ae_Chi
<i>Crocota crocuta</i>	ZMB_Mam_13295	Te	Out_Ae_Chi
<i>Equus burchellii</i>	ZMB_Mam_15963	Te	Out_Ae_Chi
<i>Helogale parvula</i>	ZMB_Mam_22986	Te	Out_Ae_Chi
<i>Leptailurus serval</i>	ZMB_Mam_58145	Te	Out_Ae_Chi
<i>Mustela eversmannii</i>	ZMB_Mam_12407	Te	Out_Ae_Chi
<i>Mustela nivalis</i>	ZMB_Mam_56731	Te	Out_Ae_Chi
<i>Diceros bicornis</i>	ZMB_Mam_32194	Te	Out_Ae_Chi
<i>Tapirus indicus</i>	ZMB_Mam_4950	Te	Out_Ae_Chi
<i>Civettictis civetta</i>	ZMB_Mam_68945	Te	Out_Ae_Chi
<i>Vulpes vulpes</i>	ZMB_Mam_49955	Te	Out_Ae_Chi

<i>Dicerorhinus sumatrensis</i>	ZMB_Mam_105847	Te	Out_Ae_Chi
<i>Aotus azarae</i>	ZMB_Mam_35793	Te	Out_Ae_Der
<i>Otolemur garnettii</i>	ZMB_Mam_5294	Te	Out_Ae_Der
<i>Pan troglodytes</i>	MNHN_AC_1950.194	Te	Out_Ae_Der
<i>Papio anubis</i>	ZMB_Mam_74869	Te	Out_Ae_Der
<i>Aepyprymnus rufescens</i>	ZMB_Mam_35059	Te	Out_Ae_Mars
<i>Bettongia gaimardi</i>	ZMB_Mam_60597	Te	Out_Ae_Mars
<i>Bettongia lesueur</i>	NHMUK ZD 1858.10.16.3	Te	Out_Ae_Mars
<i>Bettongia penicillata</i>	NHMUK ZD 1858.5.26.23	Te	Out_Ae_Mars
<i>Hypsiprymnodon moschatus</i>	ZMB_Mam_78469	Te	Out_Ae_Mars
<i>Potorous tridactylus</i>	MNHN-ZM-MO 1881-1148	Te	Out_Ae_Mars
<i>Cephalophus silvicultor</i>	MNHN_AC_1981.1023	Te	Out_Aq_Cet
<i>Dama dama</i>	ZMB_Mam_94752	Te	Out_Aq_Cet
<i>Kobus ellipsiprymnus</i>	MNHN_AC_1887.1237	Te	Out_Aq_Cet
<i>Lama glama</i>	NHMUK GERM 1860.e	Te	Out_Aq_Cet
<i>Moschus moschiferus</i>	ZMB_Mam_71049	Te	Out_Aq_Cet
<i>Okapia johnstoni</i>	MNHN_AC_1978.27	Te	Out_Aq_Cet
<i>Tragelaphus imberbis</i>	ZMB_Mam_48713	Te	Out_Aq_Cet
<i>Tragulius napu</i>	ZMB_Mam_A 14 08	Te	Out_Aq_Cet
<i>Vicugna vicugna</i>	ZMB_Mam_56204	Te	Out_Aq_Cet
<i>Dendrohyrax arboreus</i>	ZMB_Mam_21098	Te	Out_Aq_Sir_Su_Xen
<i>Dendrohyrax arboreus</i>	NHMUK 6.6.5.23	Te	Out_Aq_Sir_Su_Xen
<i>Heterohyrax brucei</i>	ZMB_Mam_21479	Te	Out_Aq_Sir_Su_Xen
<i>Procavia capensis</i>	ZMB_Mam_89416	Te	Out_Aq_Sir_Su_Xen
<i>Calomyscus bailwardi</i>	NMW18256	Te	Out_SciuAnoSpalProm
<i>Cricetomys gambianus</i>	ZMB_Mam_5371	Te	Out_SciuAnoSpalProm
<i>Dicrostonyx groenlandicus</i>	ZMB_Mam_78542	Te	Out_SciuAnoSpalProm
<i>Hyomys goliath</i>	ZMB_Mam_034358	Te	Out_SciuAnoSpalProm
<i>Meriones meridianus</i>	ZMB_Mam_43005	Te	Out_SciuAnoSpalProm
<i>Rhabdomys pumilio</i>	ZMB_Mam_86677	Te	Out_SciuAnoSpalProm
<i>Tatera indica</i>	ZMB_Mam_72793	Te	Out_SciuAnoSpalProm
<i>Uromys anak</i>	ZMB_Mam_34364	Te	Out_SciuAnoSpalProm
<i>Petrodromus tetradactylus</i>	ZMB_Mam_84912	Te	Out_Su_Chry_Ory
<i>Capromys pilorides</i>	ZMB_Mam_3202	Te	Out_Su_Cten
<i>Thrichomys apereoides</i>	ZMB_Mam_8283	Te	Out_Su_Cten
<i>Echimys chrysurus</i>	ZMB_Mam_8345	Te	Out_Su_Cten
<i>Kannabateomys amblyonyx</i>	ZMB_Mam_7259	Te	Out_Su_Cten
<i>Proechimys mincae</i>	ZMB_Mam_13543	Te	Out_Su_Cten
<i>Lagurus lagurus</i>	NHMUK ZE 1962.3.21.2	Te	Out_Su_Ello
<i>Chaetodipus formosus</i>	MNHN-ZM-MO 1914-35B	Te	Out_Su_Geo
<i>Heteromys desmarestianus</i>	ZFMK MAM 1981.1464	Te	Out_Su_Geo
<i>Perognathus longimembris</i>	NMW61838	Te	Out_Su_Geo
<i>Perognathus fasciatus</i>	ZMB_Mam_5071	Te	Out_Su_Geo
<i>Petromus typicus</i>	ZMB_Mam_105768	Te	Out_Su_Hete
<i>Thryonomys swinderianus</i>	ZMB_Mam_72392	Te	Out_Su_Hete
<i>Thryonomys gregorianus</i>	NHMUK 76.193	Te	Out_Su_Hete
<i>Abrothrix olivaceus</i>	MNHN-ZM-MO_1884-1293	Te	Out_Su_Noti
<i>Abrothrix longipilis</i>	NHMUK ZD 1858.9.6.5	Te	Out_Su_Noti
<i>Echymipera clara</i>	ZMB_Mam_15764	Te	Out_Su_Noto
<i>Perameles nasuta</i>	IRSNB_39	Te	Out_Su_Noto

<i>Octodon degus</i>	ZMB_Mam_8321	Te	Out_Su_Octo
<i>Atelerix albiventris</i>	ZMB_Mam_5810	Te	Out_Su_Tal
<i>Echinosorex gymnura</i>	ZMB_Mam_72232	Te	Out_Su_Tal
<i>Hemiechinus auritus</i>	NMW41180	Te	Out_Su_Tal
<i>Hylomys megalotis</i>	NHMUK ZD 1999.47	Te	Out_Su_Tal
<i>Hylomys suillus</i>	NHMUK ZE 1960.8.4.7	Te	Out_Su_Tal
<i>Paraechinus hypomelas</i>	NMW15184	Te	Out_Su_Tal
<i>Uropsilus soricipes</i>	NMW64409	Te	Out_Su_Tal

Footnotes. Lifestyles: Ae, aerial; Aq, fully aquatic; Su, subterranean, Te, Terrestrial. Clades: each specialised clade is referred to with the abbreviation of the corresponding lifestyle followed by a unique abbreviation; the terrestrial most closely related species of each specialised clade is referred to as “Out_ *the abbreviation of the specialised clade* (note that some of these correspond to several specialised clades); Else, other, more distantly related terrestrial families. Museum collections: IRSNB, Institut royal des Sciences naturelles de Bruxelles; MHNL, Musée des Confluences, Lyon, France; MNHN, Muséum national d’Histoire naturelle, Paris, France; NHMUK, Natural History Museum, London, UK; NMW, Naturhistorisches Museum Wien, Austria; ZFMK MAM, Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany; ZMB_Mam, Mammals collection of the Museum für Naturkunde, Berlin.

Additional File 3B. Descriptive statistics

Descriptive statistics. Tb.Th, Tb.Sp, DA, and Conn.D were acquired on a subset of the specimens for which the Connectivity exceeded 40 (as they are not meaningful for volumes of interest comprising few or no trabeculae).

	Mean	Min	Max
Vertebral mean Cg (%)			
Terrestrial	35.220	17.789	62.674
Aerial	33.164	14.921	45.912
Aquatic	62.425	58.249	71.983
Subterranean	30.556	17.289	51.209
Connectivity (no units)			
Terrestrial	4958.585	0.000	298141.750
Aerial	19.134	0.000	98.125
Aquatic	100620.699	3500.000	711702.375
Subterranean	82.298	2.500	1191.625
BV.TV (no units)			
Terrestrial	0.228	0.000	0.533
Aerial	0.212	0.000	0.425
Aquatic	0.423	0.309	0.703
Subterranean	0.203	0.029	0.489
Humeral mean Cg (%)			
Terrestrial	60.664	37.513	82.480
Aerial	53.130	30.213	62.519
Aquatic	78.030	49.205	99.619
Subterranean	61.914	42.445	80.032
CSS (no units)			
Terrestrial	2.070	1.121	5.252
Aerial	1.268	1.031	1.660
Aquatic	1.953	1.281	2.873
Subterranean	3.157	1.242	10.837
DE (no units)			
Terrestrial	4.819	3.065	7.026
Aerial	7.200	5.336	9.924
Aquatic	2.386	0.847	3.681
Subterranean	3.364	1.162	5.715
Tb.Th (mm)			
Terrestrial	0.261	0.064	1.777
Aerial	0.153	0.108	0.189
Aquatic	0.346	0.127	1.557

	Subterranean	0.118	0.059	0.209
Tb.Sp (mm)				
	Terrestrial	0.752	0.272	2.999
	Aerial	0.528	0.361	0.762
	Aquatic	0.477	0.313	0.814
	Subterranean	0.418	0.255	0.692
DA (no units)				
	Terrestrial	0.723	0.382	0.908
	Aerial	0.631	0.549	0.703
	Aquatic	0.745	0.503	0.866
	Subterranean	0.830	0.635	0.932
Conn.D (mm ⁻³)				
	Terrestrial	14.546	0.402	208.006
	Aerial	10.203	6.989	11.948
	Aquatic	5.988	0.385	24.455
	Subterranean	41.919	5.088	115.576

Additional File 3C. AN(C)OVAs with body mass

AN(C)OVAs detailed outputs.

Lifestyle abbreviations: Ae, Aerial; Aq, Aquatic; Te, Terrestrial; Su, Subterranean.

1. Vertebral parameters

1.1. Whole dataset

Vertebral mean Cg ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.4920789

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	16.526634	3.499226	4.722940	0.0000
log10(BM)	7.242742	0.631763	11.464330	0.0000

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	z-value	Pr(> z)
Aq - Ae	8.3201	3.9621	2.100	0.1374
Su - Ae	-0.8203	2.2286	-0.368	0.9810
Te - Ae	-1.7844	2.0045	-0.890	0.7930
Su - Aq	-9.1403	3.7020	-2.469	0.0570
Te - Aq	-10.1045	3.4217	-2.953	0.0145
Te - Su	-0.9641	1.4334	-0.673	0.8980

Nagelkerke pseudo R²: 0.6762754

Vertebral mean Cg ~ log10(Body Mass)

	Value	Std.Error	t-value	p-value
(Intercept)	14.397094	3.385307	4.252818	0.0000
log10(BM)	7.760812	0.590105	13.151577	0.0000

Nagelkerke pseudo R²: 0.6329046

log10(Connectivity) ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.3782865

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	-0.4336638	0.26574029 -	1.631908	0.1045
log10(BM)	0.6428774	0.0486077	13.225837	0.0000

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	1.4042	0.2840	4.943	< 0.001
Su - Ae	0.6612	0.1793	3.688	0.00113
Te - Ae	0.2756	0.1607	1.716	0.29370
Su - Aq	-0.7430	0.2652	-2.801	0.02347
Te - Aq	-1.1285	0.2346	-4.811	< 0.001
Te - Su	-0.3855	0.1214	-3.175	0.00720

Nagelkerke pseudo R²: 0.769842

log10(Connectivity) ~ log10(Body Mass

	Value	Std.Error	t-value	p-value
(Intercept)	-0.5254737	0.9220687	-0.569886	0.5695
log10(BM)	0.6997265	0.0532410	13.142635	0.0000

Nagelkerke pseudo R²: 0.6332184

BV.TV ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.1268139

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.07216842	0.02955185	2.442095	0.0156
log10(BM)	0.05885153	0.00694925	8.468757	0.0000

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	0.015705	0.036799	0.427	0.971
Su - Ae	-0.000248	0.023458	-0.011	1.000
Te - Ae	-0.029485	0.021057	-1.400	0.477
Su - Aq	-0.015953	0.035654	-0.447	0.967
Te - Aq	-0.045190	0.030415	-1.486	0.424
Te - Su	-0.029237	0.017833	-1.640	0.336

Nagelkerke pseudo R²: 0.4737552

BV.TV ~ log10(Body Mass)

	Value	Std.Error	t-value	p-value
(Intercept)	0.05929340	0.02915428	2.033781	0.0435
log10(BM)	0.05840329	0.00604638	9.659215	0.0000

Nagelkerke pseudo R²: 0.4389989

1.2. Terrestrial pruned to match Aquatic size

Vertebral Mean Cg ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.1980319

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	14.439071	21.166159	0.682177	0.5071
log10(BM)	9.144339	3.987814	2.293071	0.0392
Te-Aq	-10.591180	3.049641 -	3.472927	0.0041

log10(Connectivity) ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.3864759

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	-0.1833932	0.3345509 -	0.548177	0.5848
log10(BM)	0.5512236	0.1017805	5.415810	0.0000
Te-Aq	1.07108	0.24897	-4.302	< 0.001

1.3. Terrestrial pruned to match Aerial and Subterranean Size

log10(Connectivity) ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.3019896

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	-0.0826887	0.2673884	-0.309246	0.7576
log10(BM)	0.4880283	0.0719708	6.780925	0.0000
Te-Ae	0.2647	0.1476	1.793	0.25427
Te-Su	-0.3803	0.1141	-3.334	0.00397

2. Humeral parameters

2.1. Whole dataset

Humeral mean Cg ~ log10(Body Mass) + Lifestyle

Pagel's lambda

0.6574772

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	48.20127	5.661718	8.513543	0.0000
log10(BM)	2.91733	0.898195	3.247990	0.0014

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	13.128	6.276	2.092	0.138
Su - Ae	6.036	3.415	1.768	0.263
Te - Ae	4.343	3.088	1.406	0.465
Su - Aq	-7.092	5.763	-1.231	0.578
Te - Aq	-8.785	5.428	-1.619	0.339
Te - Su	-1.694	2.009	-0.843	0.817

Humeral mean Cg ~ log10(Body Mass)

	Value	Std.Error	t-value	p-value
(Intercept)	50.89430	5.710878	8.911817	0.000
log10(BM)	3.56231	0.851195	4.185066	0.000

Nagelkerke pseudo R²: 0.1398405

log10(CSS) ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.637239

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.09745506	0.10245958	0.951156	0.3431
log10(BM)	0.01028903	0.01654009	0.622066	0.5349

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	0.19283	0.11489	1.678	0.30715
Su - Ae	0.31182	0.06233	5.003	< 0.001
Te - Ae	0.20654	0.05634	3.666	0.00119
Su - Aq	0.11899	0.10569	1.126	0.64685
Te - Aq	0.01371	0.09946	0.138	0.99894
Te - Su	-0.10529	0.03700	-2.845	0.01954

log10(CSS) ~ log10(Body Mass)

	Value	Std.Error	t-value	p-value
(Intercept)	0.29166734	0.13393460	2.1776849	0.0310
log10(BM)	0.01243528	0.01739865	0.7147265	<u>0.4759</u>

Nagelkerke pseudo R²: 0.005091859

log10(DE) ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.9782044

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.8705816	0.08513065	10.226418	0.0000
log10(BM)	-0.0100423	0.00899478 -	1.116464	0.266

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	-0.54516	0.07914	-6.888	< 0.001
Su - Ae	-0.31264	0.04427 -	7.063	< 0.001
Te - Ae	-0.19787	0.04121	-4.801	< 0.001
Su - Aq	0.23252	0.07019	3.313	0.00443
Te - Aq	0.34729	0.06781	5.122	< 0.001
Te - Su	0.11477	0.01987	5.776	< 0.001

log10(DE) ~ log10(Body Mass)

	Value	Std.Error	t-value	p-value
(Intercept)	0.7004276	0.10652242	6.575401	0.0000
log10(BM)	-0.0235471	0.01017686 -	2.313793	0.022

Nagelkerke pseudo R²: 0.02494447

2.2. Terrestrial pruned to match Aerial and Subterranean Size

log10(CSS) ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.6403116

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.0445801	0.11493737	0.387864	0.6988
log10(BM)	0.0316706	0.02457316	1.288830	0.1999
Te-Ae	0.22123	0.05966	3.708	<0.001
Te-Su	-0.10536	0.03875	-2.719	0.0278

log10(DE) ~ log10(Body Mass) + Lifestyle

Pagel's lambda
0.9773708

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.8393310	0.08583106	9.778873	0.000
log10(BM)	0.0039557	0.01135413	0.348396	0.7281
Te-Ae	-0.20131	0.04143	-4.859	<0.001
Te-Su	0.11737	0.01973	5.949	< 0.001

2.3. DE allometry in the terrestrial taxa

log10(DE) ~ log10(Body Mass)

	Value	Std.Error	t-value	p-value
(Intercept)	0.7657001	0.05213702	14.686303	0.0000
log10(BM)	-0.0348112	0.00840933	-4.139593	< 0.001

Nagelkerke pseudo R²: 0.2410223

Additional File 3D. AN(C)OVAs with specimen-specific body size proxies

AN(C)OVAs detailed outputs.

Lifestyle abbreviations: Ae, Aerial; Aq, Aquatic; Te, Terrestrial; Su, Subterranean.

1. Vertebral parameters

1.1. Whole dataset

Vertebral mean Cg ~ log(Vertebral_centrum_length) + Lifestyle

Pagel's lambda
0.5515288

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	15.967524	3.752081	4.255645	0.0000
log(VertL)	9.362762	0.825957	11.335656	0.0000

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	z-value	Pr(> z)
Aq - Ae	10.6641	4.0266	2.648	0.03541
Su - Ae	0.4067	2.3187	-0.175	0.99786
Te - Ae	-1.8826	2.0900	-0.901	0.78737
Su - Aq	-11.0708	3.7476	-2.954	0.01438
Te - Aq	-12.5466	3.4651	-3.621	0.00141
Te - Su	-1.4758	1.4645	-1.008	0.72439

Vertebral mean Cg ~ log(Vertebral_centrum_length)

	Value	Std.Error	t-value	p-value
(Intercept)	14.10409	4.159763	3.390599	9e-04
log(VertL)	10.02336	0.823731	12.168250	0.0000

Nagelkerke pseudo R²: 0.5869862

log(Connectivity) ~ log(Vertebral_centrum_length) + Lifestyle

Pagel's lambda
0.55818

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	-0.760339	0.7991580	-0.951425	0.3427
log(VertL)	1.771254	0.1602438	11.053496	0.0000

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	3.6395	0.7825	4.651	< 0.001
Su - Ae	1.5695	0.4958	3.165	0.00736
Te - Ae	0.6036	0.4470	1.350	0.50519
Su - Aq	-2.0701	0.7179	-2.883	0.01831
Te - Aq	-3.0360	0.6452	-4.706	< 0.001
Te - Su	-0.9659	0.3133	-3.083	0.00969

log(Connectivity) ~ log(Vertebral centrum length)

	Value	Std.Error	t-value	p-value
(Intercept)	-0.1872968	1.0885475 -	0.172061	0.8636
log(VertL)	1.8862857	0.1711185	11.023273	0.0000

Nagelkerke pseudo R²: 0.4824922

BV.TV ~ log(Vertrebral_centrum_length) + Lifestyle

Pagel's lambda
0.3461863

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.08123194	0.03981464	2.040253	0.0428
log(VertL)	0.07407308	0.00958539	7.727704	0.0000

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	0.0233287	0.0422055	0.553	0.941
Su - Ae	-0.0009192	0.0272091	-0.034	1.000
Te - Ae	-0.0337508	0.0244241	-1.382	0.487
Su - Aq	-0.0242480	0.0396518	-0.612	0.922
Te - Aq	-0.0570795	0.0347457	-1.643	0.333
Te - Su	-0.0328316	0.0188409	-1.743	0.281

BV.TV ~ log(Vertebral centrum length)

	Value	Std.Error	t-value	p-value
(Intercept)	0.06783887	0.04113441	1.649200	0.1009
log(VertL)	0.07307459	0.00891487	8.196933	0.0000

Nagelkerke pseudo R²: 0.3778663

1.2. Terrestrial pruned to match Aquatic size

Vertebral Mean Cg ~ log(Vertebral_centrum_length) + Lifestyle

Pagel's lambda

0.6178141

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	10.456846	5.730015	1.824925	0.0716
log(VertL)	10.607906	1.268990	8.359330	0.0000
Te-Aq	-13.363764	3.322355	-4.022377	0.0001

log(Connectivity) ~ log(Vertebral_centrum_length) + Lifestyle

Pagel's lambda
0.5547799

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	1.7962133	1.2443517	1.443493	0.1518
log(VertL)	1.4809046	0.2659399	5.568568	0.0000
Te-Aq	-2.8420086	0.6676666	-4.256629	0.0000

1.3. Terrestrial pruned to match Aerial and Subterranean Size

log(Connectivity) ~ log(Vertebral_centrum_length) + Lifestyle

Pagel's lambda
0.4313344

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.731928	0.6578026	1.112687	0.2679
log(VertL)	1.252803	0.2184246	5.735632	0.0000
Te-Ae	0.525197	0.4018929	1.306808	0.1936
Te-Su	-0.995753	0.2857582	-3.484600	0.0007

2. Humeral parameters

2.1. Whole dataset

Humeral mean Cg ~ log(mean_total_cross-sectional_area) + Lifestyle

Pagel's lambda
0.64127

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	52.27987	5.378621	9.719939	0.0000
log(MeanArea)	1.32066	0.553781	2.384808	0.0184

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	15.7933	6.2245	2.537	0.047
Su - Ae	5.9057	3.4534	1.710	0.291
Te - Ae	5.0618	3.0864	1.640	0.328
Su - Aq	-9.8876	5.6649	-1.745	0.274
Te - Aq	-10.7315	5.4111	-1.983	0.174
Te - Su	-0.8439	2.0089	-0.420	0.972

Humeral mean Cg ~ log(mean total cross-sectional area)

	Value	Std.Error	t-value	p-value
(Intercept)	56.06108	5.422449	10.338702	0.000
log(MeanArea)	1.79860	0.537809	3.344315	0.001

Nagelkerke pseudo R²: 0.09309527

log(CSS) ~ log(mean_total_cross-sectional_area) + Lifestyle

Pagel's lambda
0.6544086

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.2291447	0.22828617	1.003761	0.3171
log(MeanArea)	0.0302043	0.02320436	1.301667	<u>0.1951</u>

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	0.39033	0.26194	1.490	0.41350
Su - Ae	0.69558	0.14557	4.778	< 0.001
Te - Ae	0.46138	0.13016	3.545	0.00174
Su - Aq	0.30525	0.23818	1.282	0.54551
Te - Aq	0.07106	0.22756	0.312	0.98811
Te - Su	-0.23419	0.08422	-2.781	0.02354

log(CSS) ~ log(mean_total_cross-sectional_area)

	Value	Std.Error	t-value	p-value
(Intercept)	0.6431275	0.29040728	2.214571	0.0283
log(MeanArea)	0.0421687	0.02446698	1.723495	<u>0.0869</u>

Nagelkerke pseudo R²: 0.02652733

log(DE) ~ log(mean_total_cross-sectional_area) + Lifestyle

Pagel's lambda
0.9732087

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	2.0175333	0.18358951	10.989371	0.0000
log(MeanArea)	-0.0419341	0.01234671 -	3.396376	9e-04

Multiple Comparisons of Means: Tukey Contrasts

	Value	Std.Error	t-value	p-value
Aq - Ae	-1.15655	0.17342	-6.669	< 0.001
Su - Ae	-0.68674	0.09803	-7.006	< 0.001
Te - Ae	-0.42660	0.09062	-4.708	< 0.001
Su - Aq	0.46981	0.15338	3.063	0.00976
Te - Aq	0.72995	0.14886	4.904	< 0.001
Te - Su	0.26014	0.04426	5.878	< 0.001

log(DE) ~ log(mean total cross-sectional area)

	Value	Std.Error	t-value	p-value
(Intercept)	1.6223822	0.2285688	7.098002	0.0000
log(MeanArea)	-0.0627009	0.0144669	-4.334094	0.0000

Nagelkerke pseudo R²: 0.085116

2.2. Terrestrial pruned to match Aerial and Subterranean Size

log(CSS) ~ log(mean_total_cross-sectional_area) + Lifestyle

Pagel's lambda
0.5932886

Coefficients

	Value	Std.Error	t-value	p-value
(Intercept)	0.6612625	0.20331205	3.252451	0.0015
log(MeanArea)	0.0640891	0.03335165	1.921618	0.0569
Te-Ae	-0.5146113	0.12943284 -	-3.975894	0.0001
Te-Su	0.2052093	0.08697299	-2.359460	0.0198

log(DE) ~ log(mean_total_cross-sectional_area) + Lifestyle

Pagel's lambda
0.9837882

Coefficients

	Value	Std.Error	t-value	p-value
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(Intercept)	1.5611948	0.17930662	8.706844	0.000
log(MeanArea)	-0.0277517	0.01609240 -	1.724522	0.087
Te-Ae	-0.4323139	0.09628532	-4.489925	0.000
Te-Su	0.2558572	0.04572239	5.595885	0.000

Additional File 3E. Phylogenetic signal.

Phylogenetic signal among terrestrial species.

Sample size range from 82 to 92 (depending on the trait), for all species analysed individually and is 37 when terrestrial sister-groups (TSG) are aggregated. Mapping (function contmap, phytools package (Revell 2012) for the Connectivity and diaphysis elongation (DE), the only traits for which a significant signal was found when the TSG are aggregated, is also displayed.

Vertebral mean Cg (size-corrected)

All species individually

Phylogenetic signal lambda: 0.266709

logL(lambda) : -275.644

LR(lambda=0) : 2.3316

P-value (based on LR test) : 0.126772

TSG aggregated

Phylogenetic signal lambda : 7.07461e-05

logL(lambda) : -121.226

LR(lambda=0) : -0.0010767

P-value (based on LR test) : 1

BV.TV (size-corrected)

All species individually

Phylogenetic signal lambda : 0.124471

logL(lambda) : 90.5531

LR(lambda=0) : 1.64627

P-value (based on LR test) : 0.199467

TSG aggregated

Phylogenetic signal lambda : 7.07461e-05

logL(lambda) : 35.8722

LR(lambda=0) : -0.00101486

P-value (based on LR test) : 1

Connectivity (size-corrected)

All species individually

Phylogenetic signal lambda : 0.54035

logL(lambda) : -84.3502

LR(lambda=0) : 7.27064

P-value (based on LR test) : **0.00700909**

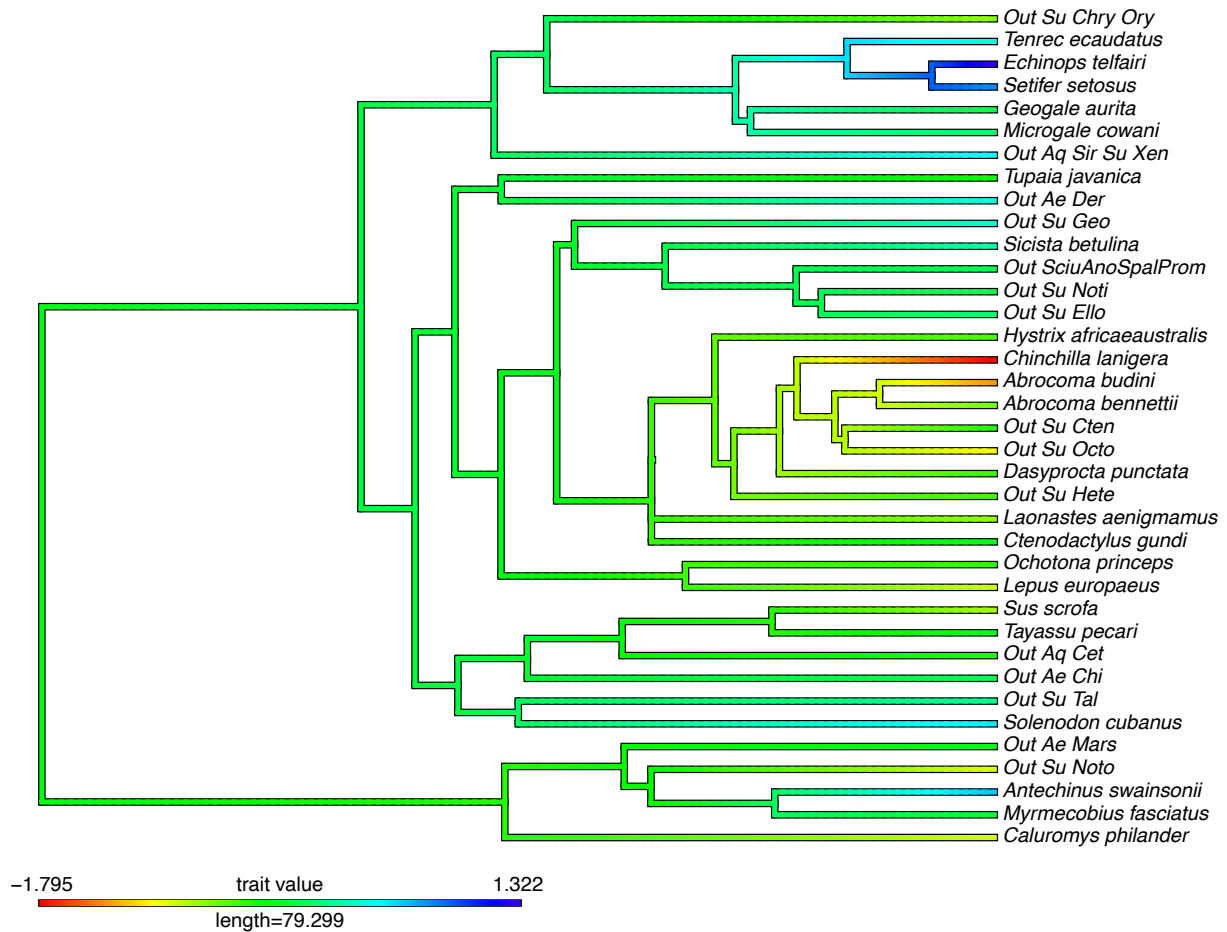
TSG aggregated

Phylogenetic signal lambda : 0.742712

logL(lambda) : -30.5181

LR(lambda=0) : 6.76367

P-value (based on LR test) : **0.0093032**



Humeral mean Cg (size-corrected)

All species individually

Phylogenetic signal lambda : 0.649341

logL(lambda) : -295.02

LR(lambda=0) : 10.8479

P-value (based on LR test) : **0.000989104**

TSG aggregated

Phylogenetic signal lambda : 7.07461e-05

logL(lambda) : -126.236

LR(lambda=0) : -0.000901852

P-value (based on LR test) : 1

log10(CSS)

All species individually

Phylogenetic signal lambda: 0.465252

logL(lambda): 49.6645

LR(lambda=0): 11.6607

P-value (based on LR test): **0.000638344**

TSG aggregated

Phylogenetic signal lambda: 0.115859

logL(lambda): 19.9334

LR(lambda=0): 0.12607

P-value (based on LR test): 0.722542

DE (size-corrected)

All species individually

Phylogenetic signal lambda : 0.854163

logL(lambda) : 108.255

LR(lambda=0) : 19.0383

P-value (based on LR test) : **1.2812e-05**

Phylogenetic signal lambda : 0.792325

logL(lambda) : 51.7664

LR(lambda=0) : 4.13848

P-value (based on LR test) : **0.0419188**

TSG aggregated

