

Supplementary Materials:
Independent origins of vertebral complexity in tetrapods

Authors: L. E. Roberts^{1,2*}, J. J. Head¹

Affiliations:

¹Department of Zoology, University of Cambridge; Cambridge, CB2 3EJ, UK

²Natural History Museum, London, SW7 5HD, UK

*Corresponding author. Email: lucy.roberts@nhm.ac.uk

This supplement includes:

Supplementary Table 1

Supplementary Data Table 1 | Information on each specimen used in regionalization analyses.

	Institution Code	Specimen Number	Region Score	Delta-AIC	Heterogeneity	Log-body mass	Body Mass (kg)	Region score 5% models	Delta-AIC 5% models	Heterogeneity 5% models
<i>Stereosternum tumidum</i>	UMZC	T.1342	3	70.6	0.92	NA	NA	3	29.00	1.21
<i>Champsosaurus laramiensis</i>	FMNH	PR.665	2	11.21	0.76	NA	NA	2	25.05	0.90
<i>Dolichorhynchops osborni</i>	USNM	PAL.419645	3.99	9.19	1.13	NA	NA	3	22.73	2.23
<i>Alligator mississippiensis</i>	TMM	M.4135	4	76.17	1.75	2.15	141.25	4	119.58	1.92
<i>Alligator sinensis</i>	TCWC	86174	4	102.69	1.57	1.13	13.49	4	89.18	1.71
<i>Osteolaemus tetraspis</i>	TMM/CrocBase	M.6774/FDC 1	4	59.36	1.70	1.23	16.98	3	37.15	1.74
<i>Crocodylus acutus</i>	UMZC/TMM	6051-83/6040	4	76.3	1.61	2.12	131.83	4	59.94	1.76
<i>Crocodylus niloticus</i>	UMZC	R.611	4	70.06	1.71	1.94	87.10	4	20.91	1.87
<i>Mecistops cataphractus</i>	TMM	M.3529	4	67	1.66	1.83	67.61	4	10.29	1.79
<i>Crocodylus moreletii</i>	TMM	M.4980	4	116.8	1.73	2.04	109.65	4	157.31	1.89
<i>Crocodylus porosus</i>	TMM	M.7365	4	113.9	1.72	2.43	269.15	4	143.45	1.88
<i>Caiman crocodilus</i>	CrocBase	NNC4	4	72.86	1.62	1.31	20.42	4	48.46	1.77
<i>Gavialis gangeticus</i>	UMZC	R.5783	4	102.67	1.74	2.05	112.20	4	106.81	1.89
<i>Tomistoma schlegelii</i>	UMZC	R.5842	4	71.56	1.79	2.15	141.25	4	77.83	1.82
<i>Protosuchus richardsoni</i>	AMNH	3024	2	13.38	1.36	-1.4	0.04	2	21.59	1.50
<i>Postosuchus kirkpatricki</i>	UCMP	139146	3	15.9	1.17	1.74	55.41	3	15.58	1.29
<i>Prestosuchus chiniquensis</i>	UCMP	32779	3	20.8	1.10	NA	NA	3	7.11	1.26
<i>Mahajangasuchus insignis</i>	FMNH	PR.2721	3	45.48	1.90	NA	NA	3	25.87	2.12
<i>Desmatosuchus spurensis</i>	UMMP	VP.7476	3	27.84	1.28	-0.55	0.28	2.97	7.22	1.60
<i>Rutiodon tenuis</i>	UCMP	1222, 34253, 122240, 122239	2	28.9	1.31	-0.85	0.14	2	37.38	1.58
<i>Triophosaurus buettneri</i>	FMNH	PR.259	2.16	3.33	1.56	1.56	36.66	2	16.23	1.74
<i>Euparkeria capensis</i>	SAM	PK-5867	3	14.9	0.79	-0.23	0.59	3	14.90	1.18
<i>Anhanguera robustus</i>	TMM	43417	2	23.9	2.26	1.08	12.02	2	23.90	2.04
<i>Stegosaurus stenops</i>	NHMMUK	R36730	4	14.56	1.69	3.23	1698.24	3	3.08	1.78
<i>Sauropelta edwardsorum</i>	YPM	5071, -51, -21, -37, -45, -48, -49, -54, -55, -62, -66, -67, -68, -75, -83, -96, -98, 5301, 5315, 5324, 5495	2	31.67	2.05	3.48	3019.95	2	31.67	1.85
<i>Thescelosaurus</i>	UCMP	137225	2	30.71	1.17	-0.47	0.34	2	30.71	1.07
<i>Tenontosaurus tilletti</i>	MCZ	4205.R	3	15.17	1.79	2.91	812.83	2.82	2.97	2.34
<i>Dryosaurus altus</i>	YPM	57717	3	13.54	1.90	2.2	158.49	3	6.51	2.12
<i>Plateosaurus</i>	MFN	MB R.1937	3	33.24	1.46	2.96	912.01	3	62.72	1.70
<i>Herrerasaurus ischigualastensis</i>	TMM	UT.43451	3	18.02	1.22	2.43	269.15	3	18.02	1.11
<i>Tyrannosaurus rex</i>	USNM /FMNH	MOR.555/P R.2081	3	63.42	1.88	3.89	7762.47	3	63.42	1.72
<i>Majungasaurus crenatissimus</i>	UA	8678	3	21.7	2.11	3.2	1584.89	3	21.70	1.92
<i>Anzu wyliei</i>	CM	78000, 78001	2.18	2.98	2.48	1.1	12.54	2.18	2.98	2.26
<i>Hesperornis regalis</i>	YPM	1207	2	35.85	2.10	1.36	22.91	2	35.85	1.91
<i>Falcarius utahensis</i>	UMNH	VP.12440-3, 14534-6, 14657, 15021, 15026, 15197, 1599, 589, C6.825, C6.1645	2	44.54	1.86	1.92	83.18	2	44.54	1.69
<i>Andalgalornis steulleti</i>	FMNH	P.14357	2	35.04	2.42	1.6	39.81	2	35.04	2.13
<i>Emeus crassus</i>	YPM/FMNH	9887-464/PA.34	3	33.14	1.33	1.75	56.23	3	19.61	1.53

<i>Dromaius novaehollandiae</i>	UMZC	369/370	4	52.66	1.17	1.57	37.15	4	29.79	1.47
<i>Cygnus cygnus</i>	UMZC	250	4	52.1	1.18	0.97	9.35	3.94	5.58	1.50
<i>Cygnus olor</i>	TMM	M.14467	4	24.77	1.25	1	10.00	4	41.01	1.73
<i>Cygnus atratus</i>	CM	S16508	4	50.71	1.27	0.75	5.60	3.82	3.00	1.50
<i>Pygoscelis papua</i>	UMZC	164.FA	4	28.07	1.95	0.78	6.03	4	28.07	1.76
<i>Gavia immer</i>	UCMP	131528	3	44.88	1.84	0.61	4.07	3	44.88	1.66
<i>Pelecanus erythrorhynchos</i>	TMM	M.14467	3	71.1	1.89	0.85	7.08	3	71.10	1.68
<i>Pelecanus crispus</i>	UMZC	258.B	3	46.53	1.92	0.95	8.91	3	46.53	1.72
<i>Grus leucogeranus</i>	UMZC	244.D	3	79	1.72	0.78	6.03	3	79.00	1.54
<i>Casuarus casuaris</i>	UMZC	372	4	64.08	1.25	1.64	43.65	4	75.80	1.52
<i>Pezophaps solitaria</i>	UMZC	632-638	2	37.75	1.85	1.23	16.98	2	37.75	1.64
<i>Raphus cucullatus</i>	UMZC	415	2	15.37	2.11	1.08	12.02	2	15.37	1.88
<i>Apteryx lawryi</i>	UMZC	5	3	27.2	1.69	0.36	2.30	3	27.20	1.52
<i>Aegypius monachus</i>	UMZC	517AA	2	14.15	2.40	0.95	8.91	2	14.15	2.12
<i>Circus macrourus</i>	UMZC	504MA	3	41.88	1.99	-0.35	0.45	3	41.88	1.79
<i>Aegithalos caudatus</i>	UMZC	27	3	44.34	1.91	-2.09	0.01	3	44.34	1.73
<i>Anthropoides virgo</i>	UMZC	344.cc	4	64.11	1.64	0.36	2.29	4	30.53	1.78
<i>Aix sponsa</i>	FMNH	M22045	4	48.37	1.89	-0.19	0.65	4	48.37	1.71
<i>Eudromia elegans</i>	UMZC	404E	4	38.05	1.42	-0.18	0.66	4	38.05	1.28
<i>Struthio camelus</i>	UMZC	374	4	37.19	1.53	2.05	112.20	4	37.72	1.41
<i>Rhea americana</i>	UMZC	378	3	20.07	1.78	1.36	23.00	3	20.07	1.61
<i>Utahceratops gettyi</i>	UMNH	VP.16682, 16685, 12198	2	31.7	2.29	3.4	2500.00	2	31.70	2.08
<i>Varanus niloticus</i>	UCMP	123072	3	12.47	0.69	1.37	23.44	2.83	3.13	0.83
<i>Varanus dumerilii</i>	UMZC	R.19180	4	44.37	0.47	0.6	3.98	4	69.95	0.67
<i>Hemidactylus frenatus</i>	UMZC	18325	3	10.4	0.84	-2.2	0.01	2.9	4.47	1.01
<i>Chamaeleo chamaeleon</i>	MVZ	236480	4	80.46	1.25	-1.02	0.10	4	80.46	1.13
<i>Chamaeleo dilepis</i>	UMZC	R.19830	4	9.26	1.15	-0.86	0.14	4	9.26	1.05
<i>Lacerta viridis</i>	UF	H-65017	4	53.55	0.58	-1.04	0.09	3	31.06	0.70
<i>Agama agama</i>	UMZC	R.18880	3.99	9.11	0.94	-0.92	0.12	3.98	8.07	0.99
<i>Cnemidophorus lemniscatus</i>	UMZC	R.19250	4	72.56	0.74	-1.36	0.04	4	19.34	0.87
<i>Lygosoma frontoparietale</i>	UMMZ	78792	4	62.18	0.55	-2.92	0.00	3	38.49	0.75
<i>Acanthocercus cyanogaster</i>	YPM	848	4	92.89	0.95	-0.79	0.16	4	116.82	1.01
<i>Draco dussumieri</i>	UF	19920	4	48.29	1.24	-2.06	0.01	4	39.02	1.44
<i>Nephurus asper</i>	MVZ	225769	3.3	1.67	0.78	-1.58	0.03	3	17.11	0.95
<i>Anolis carolinensis</i>	UMZC	R.19010	3	16.26	0.94	-2.06	0.01	3.2	2.77	1.00
<i>Calotes versicolor</i>	UMZC	R.18820	4	45.76	1.08	-0.93	0.12	4	21.89	1.14
<i>Heloderma suspectum</i>	UF	167975	4	54.05	0.42	-0.01	0.98	3	6.92	0.70
<i>Shinisaurus crocodilurus</i>	UF	60925	4	23.41	0.57	0.13	1.35	4	25.06	0.70
<i>Xenosaurus rectocollaris</i>	UF	51438	4	36.61	0.59	-1.53	0.03	4	31.22	0.94
<i>Aeluroscalabotes felinus</i>	FMNH	269091	4	68.66	0.82	-1.41	0.04	4	61.78	0.99
<i>Zonosaurus madagascariensis</i>	UMMZ	207231	4	75.89	0.54	-1.16	0.07	4	34.21	0.70
<i>Diploglossus monotropis</i>	UF	80152	4	86.01	0.41	-0.65	0.22	3	24.08	0.38
<i>Lepidophyma flavimaculatum</i>	YPM	16879	3	10.05	0.66	-1.14	0.07	3	30.83	0.80
<i>Abronia graminea</i>	CAS	138886	4	11.98	0.67	-1.72	0.02	4	66.06	0.89
<i>Lanthanotus borneensis</i>	FMNH	134698	4	26.85	0.43	0.13	1.35	3	30.77	0.60
<i>Sceloporus undulatus</i>	UMZC	R.19080	4	99.88	0.99	-1.61	0.03	4	27.04	1.09
<i>Sphenodon punctatus</i>	UMMZ	40651	3	9.76	0.73	0	1.00	3	39.74	0.79
<i>Necturus maculosus</i>	UF	M25695	3	24.35	0.79	-1	0.10	3	12.51	0.71
<i>Triturus cristatus</i>	UF	M19233	2	34.25	0.81	-2	0.01	2	43.44	0.71
<i>Proteus anguinus</i>	UMZC	R.16145	3	19.38	0.55	-1.76	0.02	3	32.23	1.49
<i>Mus musculus</i>	UMZC	E.2204	4	27.85	1.93	-1.7	0.02	3	31.33	2.34
<i>Tachyglossus aculeatus</i>	YPM	MAM.01487 2	4	55.92	1.40	0.45	2.80	3	8.82	1.68
<i>Procynosuchus delharpea</i>	UMZC	2020.17	3	16.81	1.01	0.47	2.92	2.95	5.96	1.39
<i>Didelphis albiventris</i>	UMMZ	166631	4	24.58	1.65	0.1	1.25	4	14.83	1.88

<i>Columba palumbus</i>	UMZC	409A	2	15.1	2.13	-0.31	0.49	2	15.10	1.88
<i>Ramphastos ambiguus</i>	NHMUK	S2202.21.8	3	18.82	2.06	-0.22	0.60	3	18.82	1.83
<i>Balaeniceps rex</i>	NHMUK	S1952.1.100	3	85.59	1.87	0.78	6.00	3	85.59	1.70
<i>Eusauropsphargis dalsassoi</i>	PIMUZ	A/111 4380	1.93	5.2	1.45	NA	NA	1.93	5.20	1.34
<i>Varanus komodoensis</i>	TMM	M.17921	4	20.33	0.86	2.01	102.33	3	49.38	1.12

Institutional abbreviations are as follows: UMZC = University Museum of Zoology, University of Cambridge; FMNH = Field Museum of Natural History, Chicago; USNM = Smithsonian National Museum of Natural History, Washington D.C.; TMM = Texas Memorial Museum, The University of Texas at Austin; CrocBase = <https://osf.io/6zamj/>; TCWC = The Biodiversity Research and Teaching Collections (Texas A&M University Biodiversity Research and Teaching Collections); YPM = The Peabody Museum of Natural History, Yale; UCMP = The University of California Museum of Paleontology, Berkeley; AMNH = American Museum of Natural History, New York; UMMP = The University of Michigan Museum of Paleontology; SAM = Iziko South African Museum; NHMUK = The Natural History Museum, London; MCZ = Harvard Museum of Comparative Zoology; DMNS = Denver Museum of Nature & Science; CM = Carnegie Museum of Natural History, Pittsburgh; NMHU = Natural History Museum of Utah, Salt Lake City; UF = Florida Museum of Natural History; MVZ = Museum of Vertebrate Zoology, University of California, Berkeley; UMMZ = University of Michigan Museum of Zoology; CAS = California Academy of Sciences, San Francisco; PIMUZ = Palaeontological Museum of the University of Zurich; UA, Université d'Antananarivo, Antananarivo, Madagascar.