

*Supplementary Material for*

**Quantifying the completeness of the bat fossil record**

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This PDF includes:

**TABLE S1.** Skeletal proportions used throughout completeness metrics

**FIG S1.** Individual taxon completeness scores per time bin

**FIG S2.** Changes in completeness and diversity through time, based on generic-level taxa

**FIG S3.** Distribution of bat completeness scores between different completeness metrics

**TABLE S2.** Statistical comparisons between generic and species level completeness metrics

**TABLE S3.** Statistical comparisons between generic and species level completeness metrics, excluding Lagerstätten taxa

**TABLE S4.** Results of model-fitting analyses of observed taxonomic richness

**FIG S4.** Tetrapod-bearing formations and collections for Cenozoic taxa per time bin

**FIG S5.** Distribution of skeletal completeness scores between different bat subgroups

**FIG S6.** Distribution of character completeness scores between different bat subgroups

**TABLE S5.** Statistical comparisons between skeletal completeness scores of different subgroups

**TABLE S6.** Statistical comparisons between character completeness scores of different subgroups

**FIG S7.** Distribution of bat skeletal completeness between continents

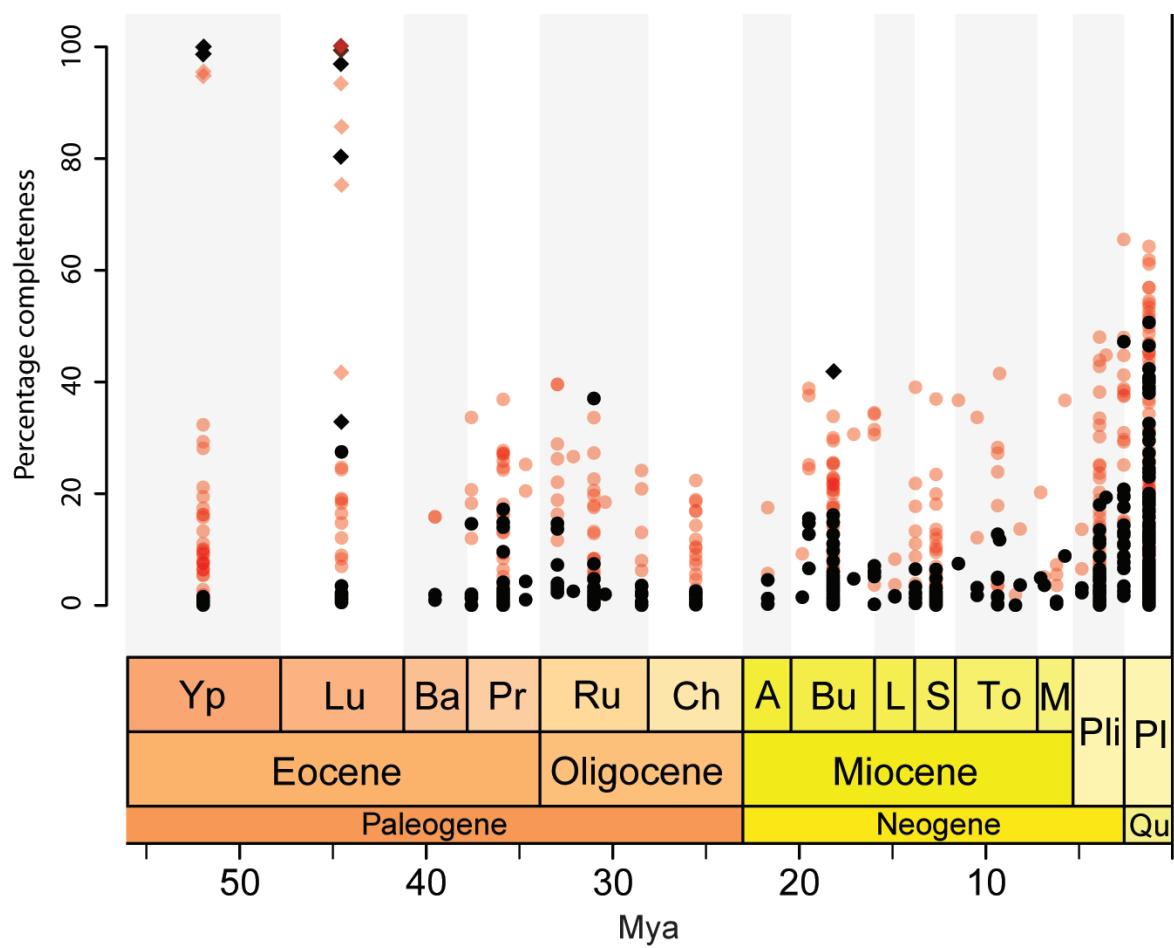
**FIG S8.** Distribution of bat character completeness between continents

**TABLE S7.** Statistical comparisons of skeletal completeness scores between continents

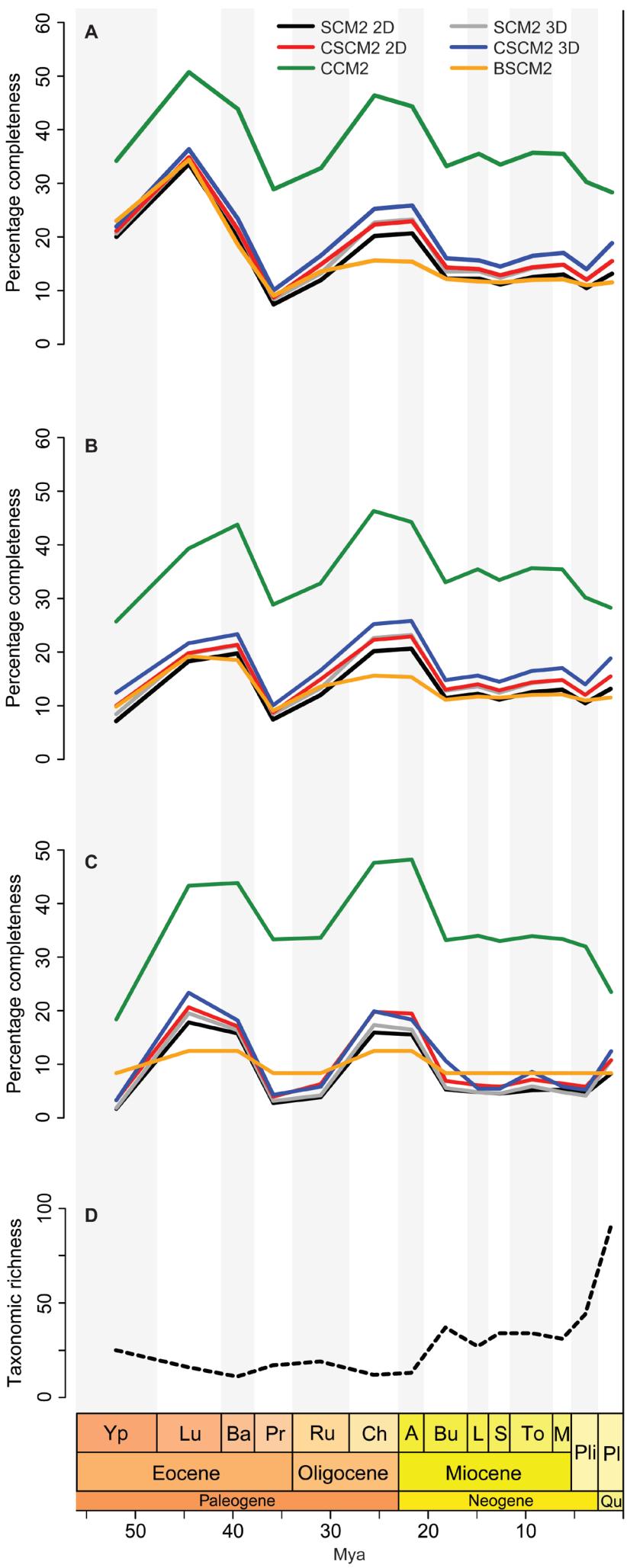
**TABLE S8.** Statistical comparisons of character completeness scores between continents

**TABLE S1.** Percentages attributed to different osteological elements based on skeletal and character proportioning methods.

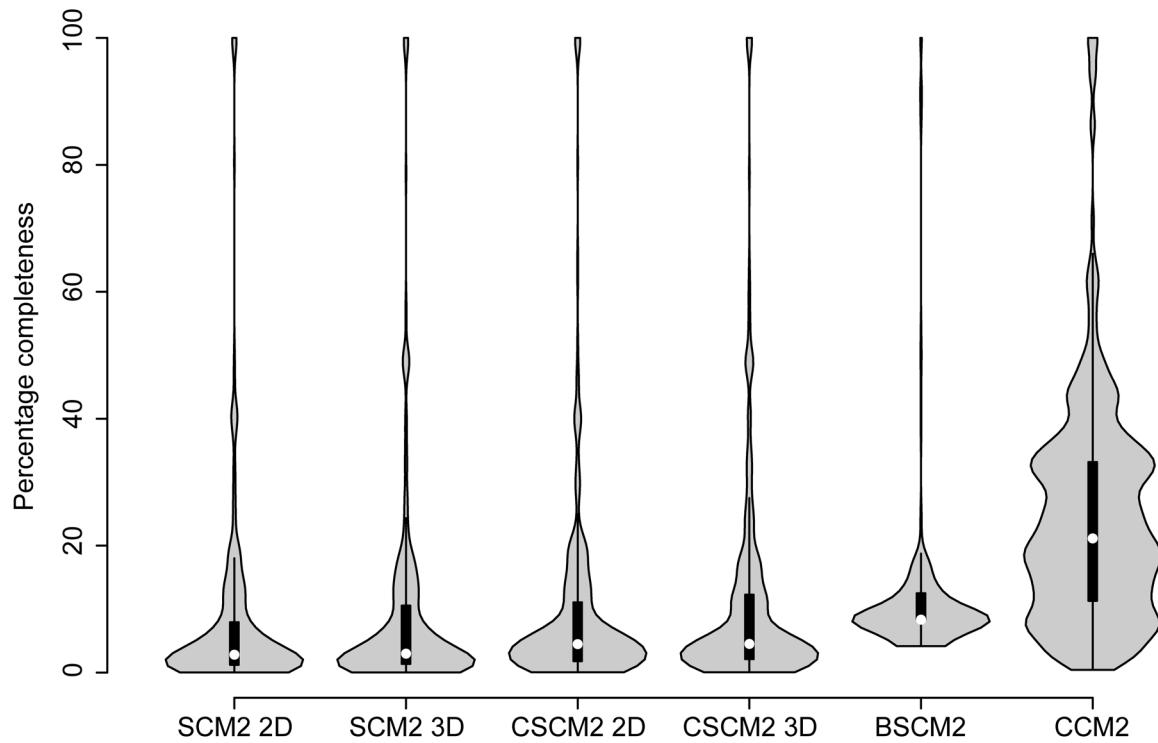
	SCM		3D		CCM	
	2D	Extinct	Extinct	Extant	Extinct	Extant
Skull	17.90	19.99	18.38	18.33	48.41	48.21
Cranium-rostrum	12.94	14.27	13.25	13.21	5.62	5.60
Upper Incisors	0.06	0.08	0.07	0.07	2.81	2.80
Upper Canines	0.11	0.20	0.12	0.12	2.95	2.94
Upper Premolars	0.14	0.15	0.10	0.10	4.83	4.81
Upper Molars	0.15	0.43	0.59	0.59	11.31	11.26
Mandibles	3.80	3.80	3.51	3.50	0.43	0.43
Lower Incisors	0.07	0.07	0.02	0.02	2.16	2.15
Lower Canines	0.10	0.13	0.04	0.04	1.44	1.43
Lower Premolars	0.20	0.21	0.13	0.13	6.27	6.24
Lower Molars	0.33	0.65	0.55	0.55	10.59	10.55
Vertebrae & Ribs	19.58	17.58	21.32	21.26	12.25	12.20
Cervicals						
Dorsals						
Lumbars	8.58	7.98	13.10	13.06	10.66	10.62
Sacrals						
Caudals						
Ribs	11.00	9.60	8.22	8.20	1.59	1.58
Pectoral Girdles	7.93	8.58	9.52	9.49	7.06	7.03
Clavicle	1.05	1.26	1.81	1.80	0.29	0.29
Scapula	5.80	6.34	6.05	6.03	4.32	4.30
Sternum	1.08	0.98	1.66	1.66	2.45	2.44
Forelimbs	39.60	41.05	38.50	38.40	17.22	17.14
Humeri	6.30	4.25	11.13	11.10	6.70	6.67
Ulnae	1.50	2.30	0.60	0.60	0.50	0.50
Radii	9.00	9.70	12.39	12.36	1.22	1.22
Carpals	0.80	0.80	14.38	14.34	4.32	4.30
Manus digits	22.00	24.00			4.47	4.45
Pelvic Girdle	4.50	3.00	2.71	2.70	2.59	2.58
Pelvis	4.50	3.00	2.71	2.70	2.59	2.58
Hindlimbs	10.49	9.80	9.57	9.82	12.46	12.84
Femora	3.10	1.90	3.83	3.82	2.52	2.51
Patella	0.03	0.17	0.10	0.10	0.14	0.14
Tibiae	2.40	1.45	2.71	2.70	1.87	1.87
Fibulae	1.10	1.15	0.42	0.42	0.86	0.86
Calcar	0.00	0.95	0.00	0.28	0.00	0.43
Tarsals	0.57	0.78	2.51	2.50	5.33	5.31
Pes digits	3.29	3.40			1.73	1.72
TOTAL (%)	100	100	100	100	100.00	100.00



**FIG S1.** Individual taxon completeness scores per time bin. Key: red, CCM2; black, SCM2; circle, non-Lagerstätten taxa; diamond, Lagerstätten taxa.



**FIG S2.** Changes in completeness (A-C) and raw diversity (D) through time, based on generic-level taxa. (A) mean scores, including Lagerstätten taxa; (B) mean scores, excluding Lagerstätten taxa; (C) median scores, including Lagerstätten taxa; and (D) generic diversity changes.



**FIG S3.** Distribution of bat completeness scores between different metrics.

**TABLE S2.** Results of pairwise comparisons between species- and generic-level time series of completeness values using GLS. Statistically significant results indicated in bold.

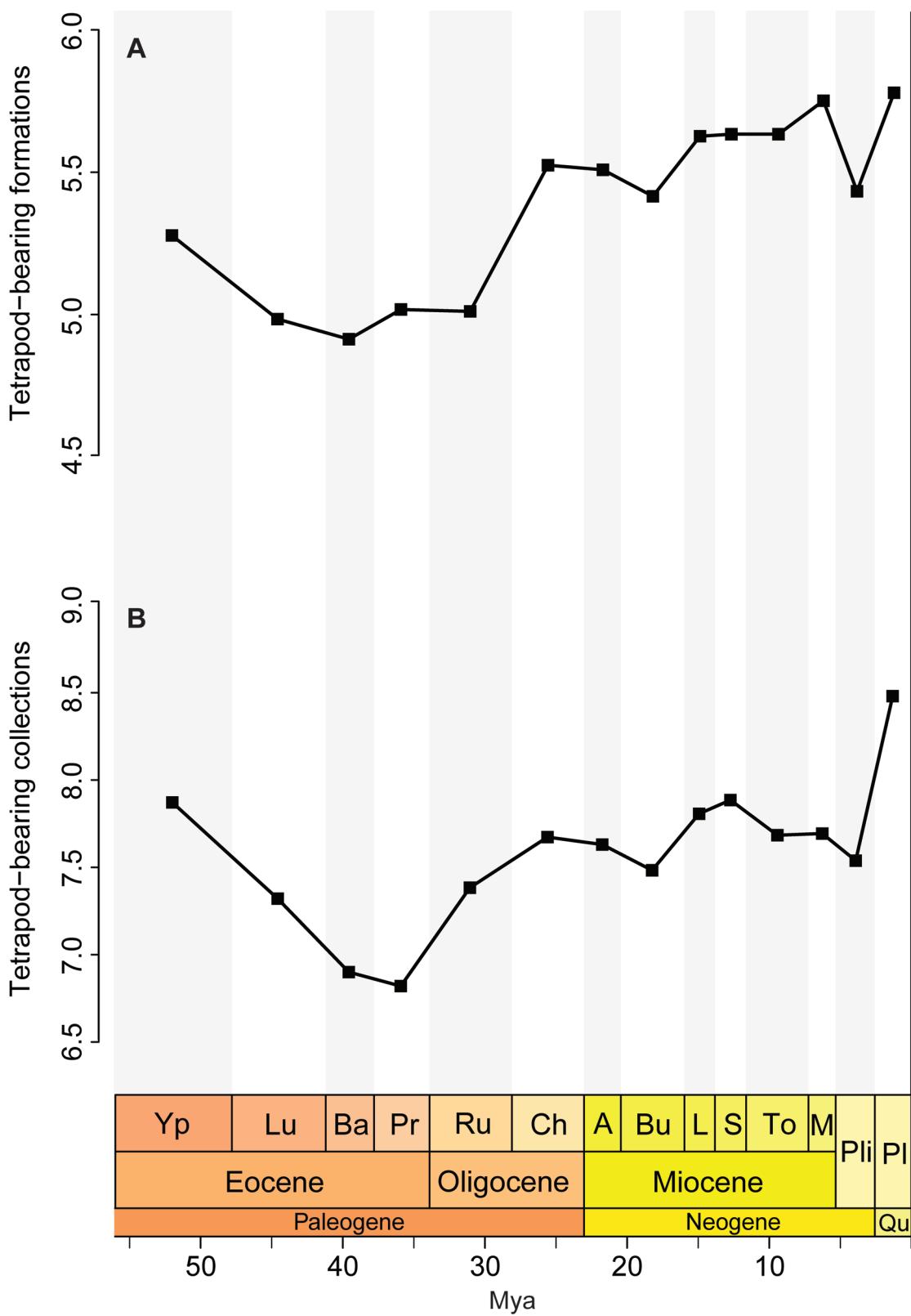
Comparison	Slope	t-value	p-value	R <sup>2</sup>
SCM2 2D ~ Gen. SCM2 2D	0.875	1.82	0.0944	0.202
SCM2 3D ~ Gen. SCM2 3D	0.867	1.71	0.1133	0.187
CSCM2 2D ~ Gen. CSCM2 2D	0.808	1.79	0.099	0.203
CSCM2 3D ~ Gen. CSCM2 3D	0.817	1.71	0.1121	0.194
CCM2 ~ Gen. CCM2	0.556	1.92	0.0789	0.235
BSCM2 ~ Gen. BSCM2	0.949	7.69	<0.0001	0.76

**TABLE S3.** Results of pairwise comparisons between species- and generic-level time series of completeness values following removal of Lagerstätten taxa using GLS. Statistically significant results indicated in bold.

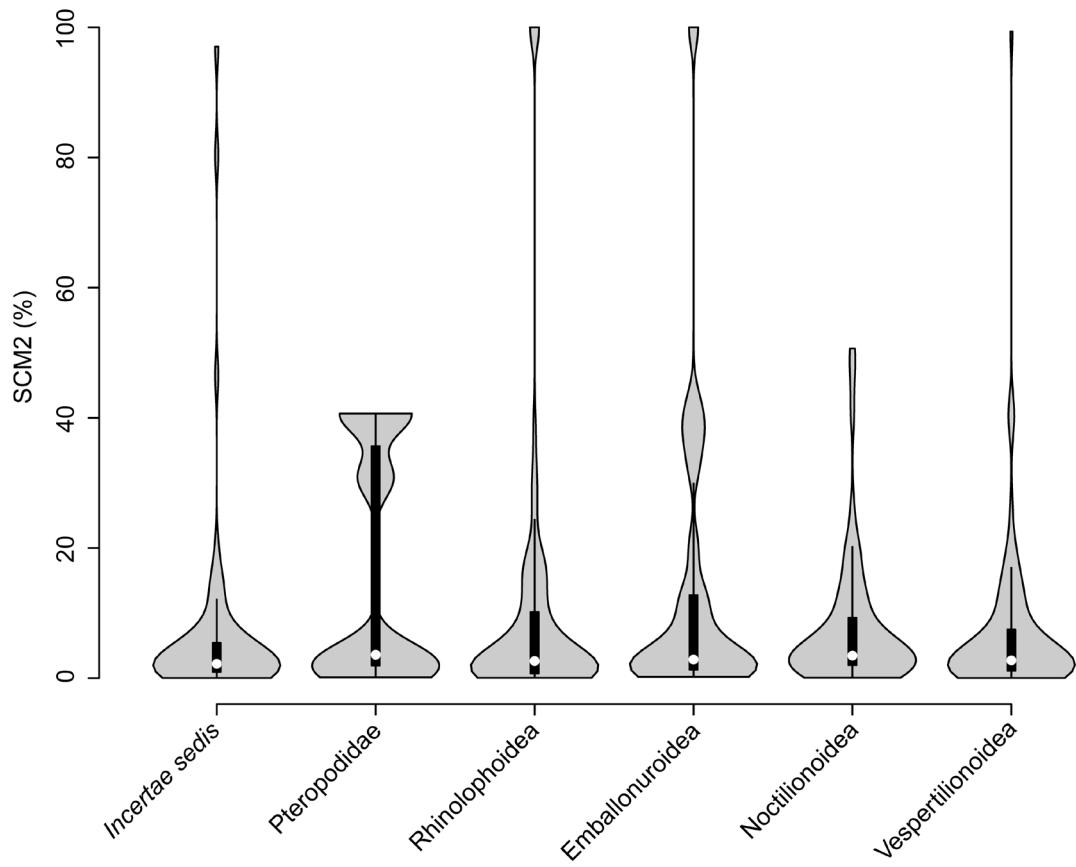
Comparison	Slope	t-value	p-value	R <sup>2</sup>
SCM2 2D ~ Gen. SCM2 2D	-0.331	-0.86	0.4084	0.06
SCM2 3D ~ Gen. SCM2 3D	-0.281	-0.69	0.5001	0.043
CSCM2 2D ~ Gen. CSCM2 2D	-0.35	-0.98	0.3455	0.072
CSCM2 3D ~ Gen. CSCM2 3D	-0.208	-0.51	0.6188	0.023
CCM2 ~ Gen. CCM2	0.002	0.01	0.9893	0.039
BSCM2 ~ Gen. BSCM2	0.154	1.4	0.1854	0.165

**TABLE S4.** Results of model-fitting analyses testing the best explanations of observed taxonomic richness. The three models receiving the highest AIC weights are highlighted in bold, but coefficients in all three are non-significant. Abbreviations: BinL, length of time bin; CCM2, character completeness metric; SCM2 2D, skeletal completeness metric, 2D version; TaxDiv, taxonomic diversity (species richness); TBCs, tetrapod-bearing collections; TBFs, tetrapod-bearing formations.

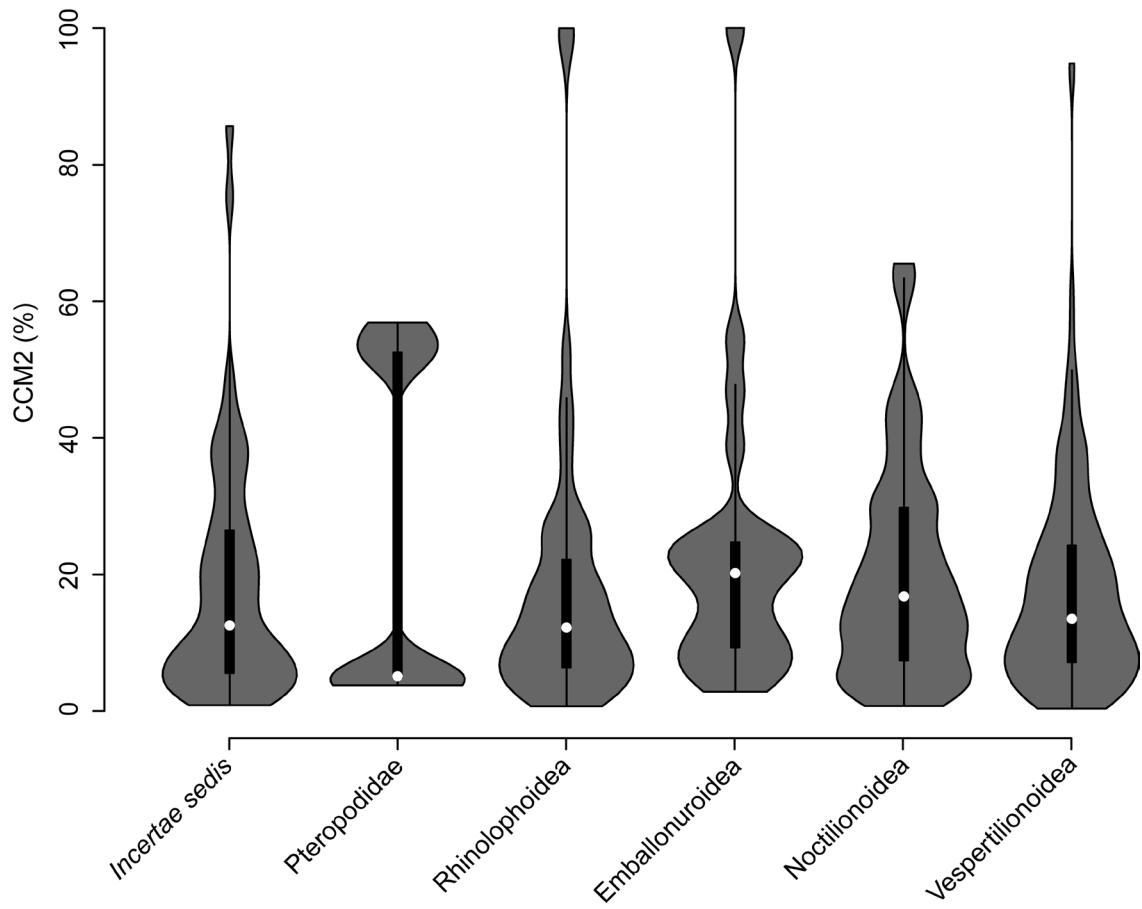
Comparison	R <sup>2</sup>	AIC weight
TaxDiv ~ BinL	0.004	<b>0.21</b>
TaxDiv ~ SCM2 2D	0.029	<b>0.25</b>
TaxDiv ~ SCM2 2D + BinL	0.029	0.02
TaxDiv ~ SCM2 2D + TBFs	0.077	0.03
TaxDiv ~ SCM2 2D + TBCs	0.206	0.07
TaxDiv ~ SCM2 2D + TBFs + BinL	0.099	0.001
TaxDiv ~ SCM2 2D + TBCs + BinL	0.216	0.002
TaxDiv ~ SCM2 2D + TBCs + TBFs	0.287	0.005
TaxDiv ~ SCM2 2D + TBCs + TBFs + BinL	0.384	0.0002
TaxDiv ~ CCM2	0.043	<b>0.27</b>
TaxDiv ~ CCM2 + BinL	0.053	0.02
TaxDiv ~ CCM2 + TBFs	0.052	0.02
TaxDiv ~ CCM2 + TBCs	0.202	0.07
TaxDiv ~ CCM2 + TBFs + BinL	0.078	0.001
TaxDiv ~ CCM2 + TBCs + BinL	0.267	0.004
TaxDiv ~ CCM2 + TBCs + TBFs	0.393	0.014
TaxDiv ~ CCM2 + TBCs + TBFs + BinL	0.414	0.0002



**FIG S8.** Numbers of (A) geological formations yielding tetrapod fossils (tetrapod-bearing formations, TBFs) and numbers of (B) ‘collections’ (= localities) yielding tetrapod fossils (tetrapod-bearing collections, TBCs) per time bin.



**FIG S5.** Distribution of skeletal completeness between different groups of bat.



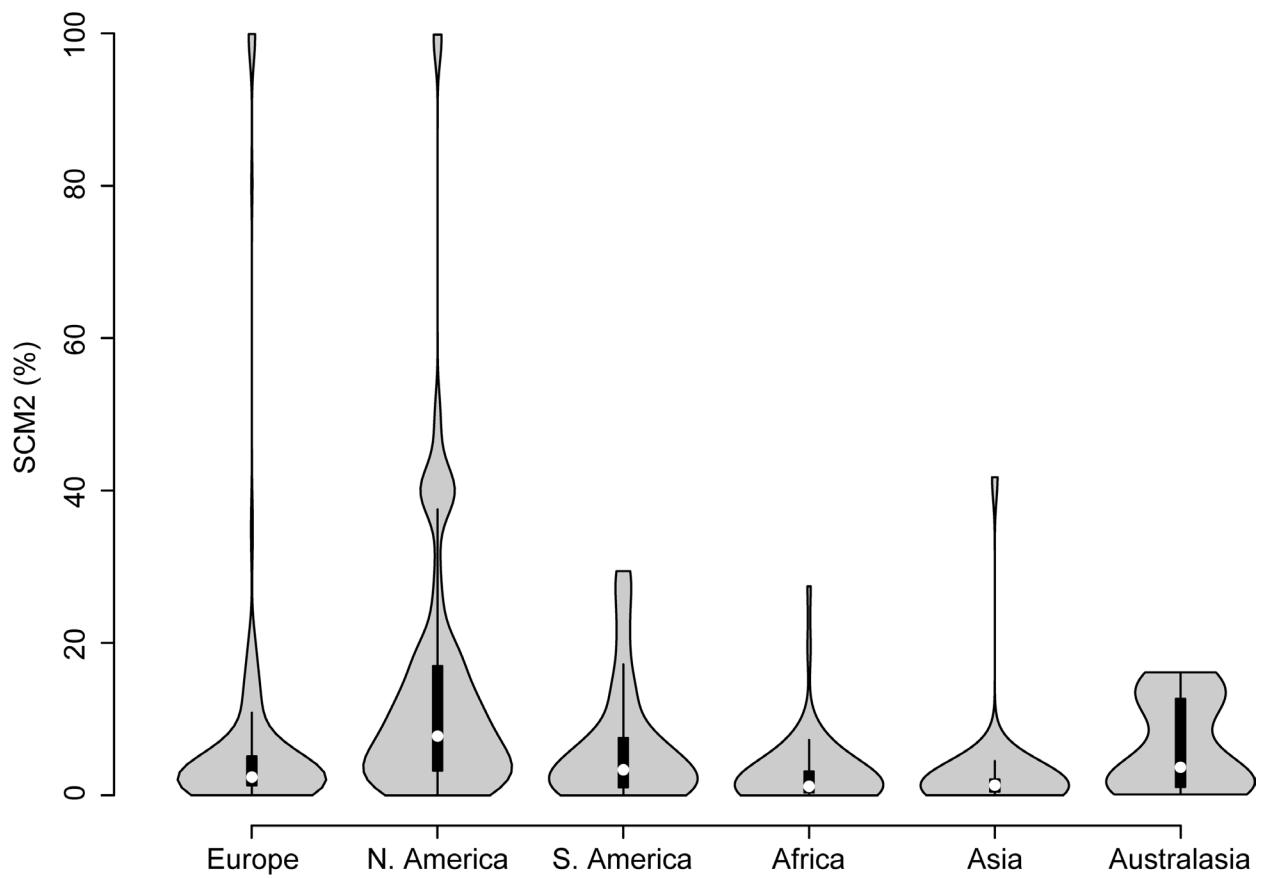
**FIG S6.** Distribution of character completeness between different groups of bat.

**TABLE S5.** Results of comparisons of the population median and distribution of SCM2 values between major chiropteran subgroup using Mann-Whitney-Wilcoxon tests. Statistically significant results indicated in bold.

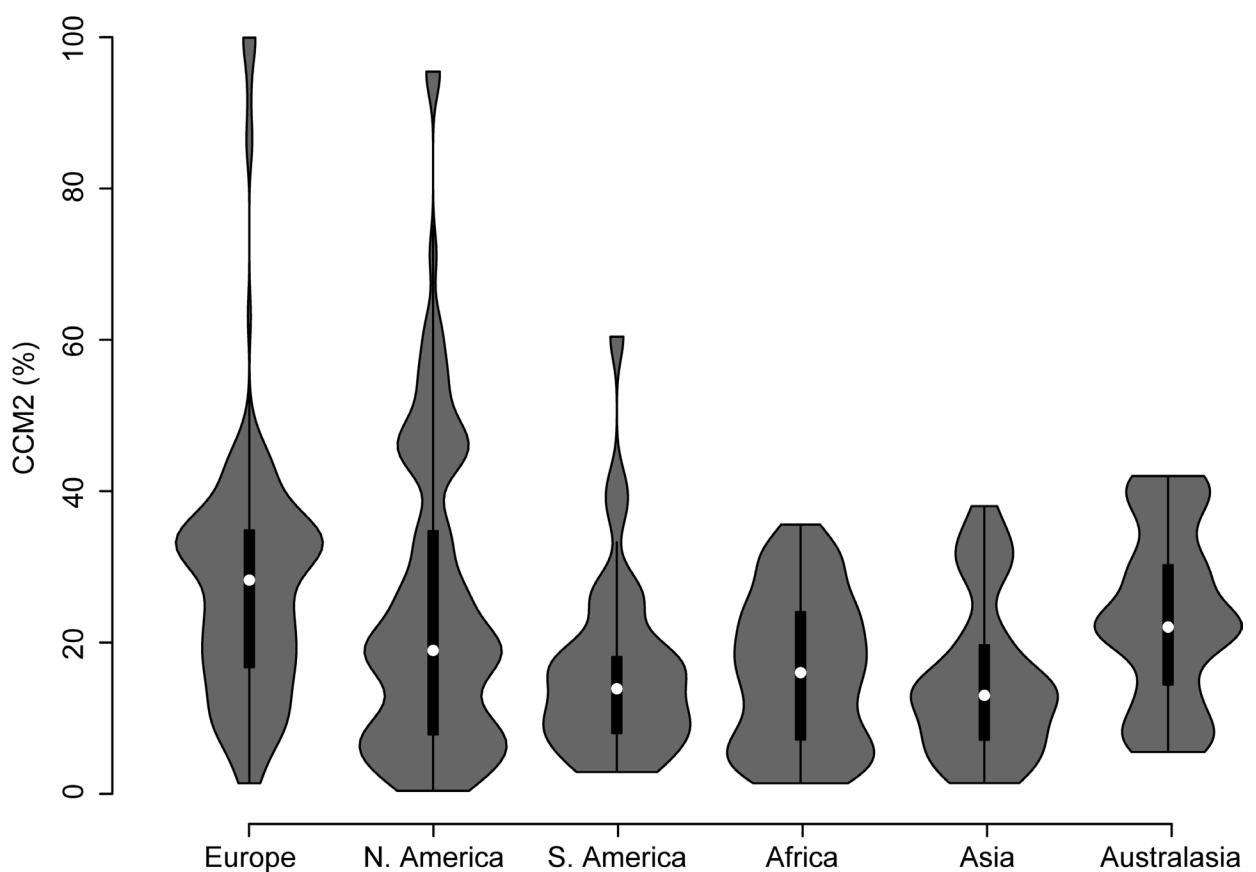
Dataset 1	Dataset 2	Test statistic (W)	p-value	p-value following FDR corrections
<i>Incertae sedis</i>	Pteropodoidea	153	0.294861	0.505144
<i>Incertae sedis</i>	Rhinolophoidea	2526	0.449242	0.612602
<i>Incertae sedis</i>	Emballonuroidea	560	0.102511	0.505144
<i>Incertae sedis</i>	Noctilionoidea	1427.5	<b>0.028219</b>	0.423283
<i>Incertae sedis</i>	Vespertilioidea	5119	0.324695	0.505144
Pteropodoidea	Rhinolophoidea	405.5	0.309514	0.505144
Pteropodoidea	Emballonuroidea	93	0.823732	0.95046
Pteropodoidea	Noctilionoidea	255.5	0.549876	0.687345
Pteropodoidea	Vespertilioidea	820.5	0.336763	0.505144
Rhinolophoidea	Emballonuroidea	982	0.209208	0.505144
Rhinolophoidea	Noctilionoidea	2645.5	0.199776	0.505144
Rhinolophoidea	Vespertilioidea	9044	0.967965	0.967965
Emballonuroidea	Noctilionoidea	810	0.930891	0.967965
Emballonuroidea	Vespertilioidea	2797.5	0.195066	0.505144
Noctilionoidea	Vespertilioidea	7012.5	0.104748	0.505144

**TABLE S6.** Results of comparisons of the population median and distribution of CCM2 values between major chiropteran subgroups using Mann-Whitney-Wilcoxon tests. Statistically significant results indicated in bold.

Dataset 1	Dataset 2	Test statistic (W)	p-value	p-value following FDR corrections
<i>Incertae sedis</i>	Pteropodoidea	188	0.758959	0.969228
<i>Incertae sedis</i>	Rhinolophoidea	2781	0.836235	0.969228
<i>Incertae sedis</i>	Emballonuroidea	593.5	0.193501	0.72563
<i>Incertae sedis</i>	Noctilionoidea	1654.5	0.302791	0.756978
<i>Incertae sedis</i>	Vespertilioidea	5476.5	0.804519	0.969228
Pteropodoidea	Rhinolophoidea	337.5	0.914811	0.969228
Pteropodoidea	Emballonuroidea	76	0.623593	0.969228
Pteropodoidea	Noctilionoidea	221.5	0.969228	0.969228
Pteropodoidea	Vespertilioidea	691.5	0.917933	0.969228
Rhinolophoidea	Emballonuroidea	934	0.116679	0.72563
Rhinolophoidea	Noctilionoidea	2599.5	0.148425	0.72563
Rhinolophoidea	Vespertilioidea	8615	0.490002	0.969228
Emballonuroidea	Noctilionoidea	855	0.618823	0.969228
Emballonuroidea	Vespertilioidea	2802	0.189891	0.72563
Noctilionoidea	Vespertilioidea	6726	0.286286	0.756978



**FIG S7.** Distribution of bat skeletal completeness between different continents.



**FIG S8.** Distribution of bat character completeness between different continents.

**TABLE S7.** Results of comparisons of the population median and distribution of SCM2 values between continents using Mann-Whitney-Wilcoxon tests. Statistically significant results indicated in bold.

Dataset 1	Dataset 2	Test statistic (W)	p-value	p-value following FDR corrections
Europe	North America	5213.5	<b>1.92E-08</b>	<b>9.76E-08</b>
Europe	South America	3010.5	0.658154	0.705165
Europe	Africa	7292.5	<b>0.000141</b>	<b>0.000531</b>
Europe	Asia	3972	<b>0.0002</b>	<b>0.000599</b>
Europe	Australasia	1733.5	0.399977	0.499971
North America	South America	2169	<b>0.003087</b>	<b>0.007716</b>
North America	Africa	4566	<b>5.66E-11</b>	<b>8.49E-10</b>
North America	Asia	2397	<b>1.95E-08</b>	<b>9.76E-08</b>
North America	Australasia	1261	0.059325	0.080898
South America	Africa	1321	<b>0.011311</b>	<b>0.018851</b>
South America	Asia	693.5	<b>0.013815</b>	<b>0.020722</b>
South America	Australasia	327	0.612231	0.705165
Africa	Asia	924.5	0.734964	0.734964
Africa	Australasia	370	<b>0.00647</b>	<b>0.013864</b>
Asia	Australasia	179	<b>0.009503</b>	<b>0.017819</b>

**TABLE S8.** Results of comparisons of the population median and distribution of CCM2 values between continents using Mann-Whitney-Wilcoxon tests. Statistically significant results indicated in bold.

Dataset 1	Dataset 2	Test statistic (W)	p-value	p-value following FDR corrections
Europe	North America	10523.5	<b>0.008805</b>	<b>0.026416</b>
Europe	South America	4710.5	<b>5.73E-06</b>	<b>2.87E-05</b>
Europe	Africa	8070	<b>5.19E-08</b>	<b>7.78E-07</b>
Europe	Asia	4232.5	<b>5.64E-06</b>	<b>2.87E-05</b>
Europe	Australasia	2230	0.287942	0.392648
North America	South America	1965	0.061703	0.092555
North America	Africa	3313	0.058029	0.092555
North America	Asia	1778.5	<b>0.041286</b>	0.077411
North America	Australasia	894	0.460188	0.575235
South America	Africa	940	0.61804	0.662186
South America	Asia	538.5	0.706364	0.706364
South America	Australasia	211	<b>0.011711</b>	<b>0.029278</b>
Africa	Asia	960	0.517829	0.597495
Africa	Australasia	398.5	<b>0.015894</b>	<b>0.03406</b>
Asia	Australasia	177	<b>0.008495</b>	<b>0.026416</b>