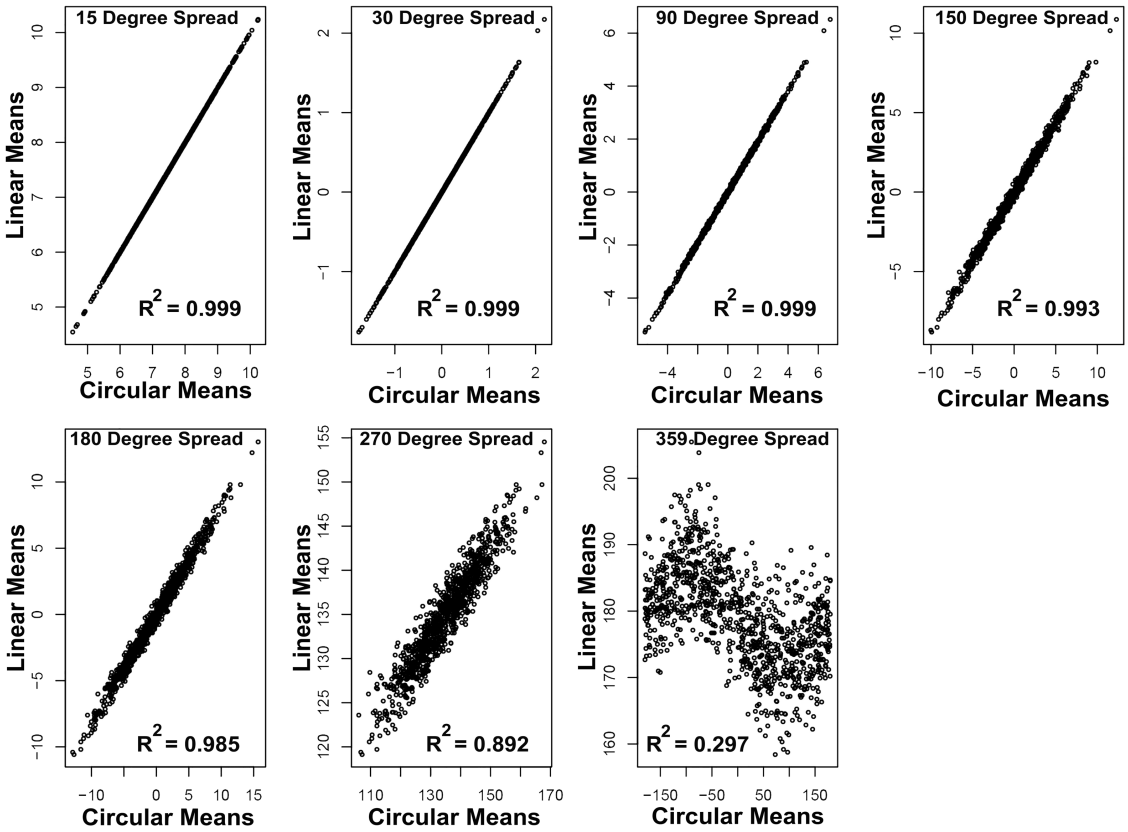

Figure S1: Circular means versus linear means from randomly generated angular data. Means calculated from 200 simulated angular data points across a desired angular spread were assessed in R (version 3.1.1) using linear and circular analyses. As spread of angular measurements increases, the ability to use linear analyses on circular data decreases (R^2 decreases). However, with a 150-degree spread (approximating our collected included angle data), circular data behaves linearly (R^2=0.9931), making linear analyses acceptable. Plots and analyses produced with the help of Steven Worthington at the Institute for Quantitative Social Science, Harvard University.

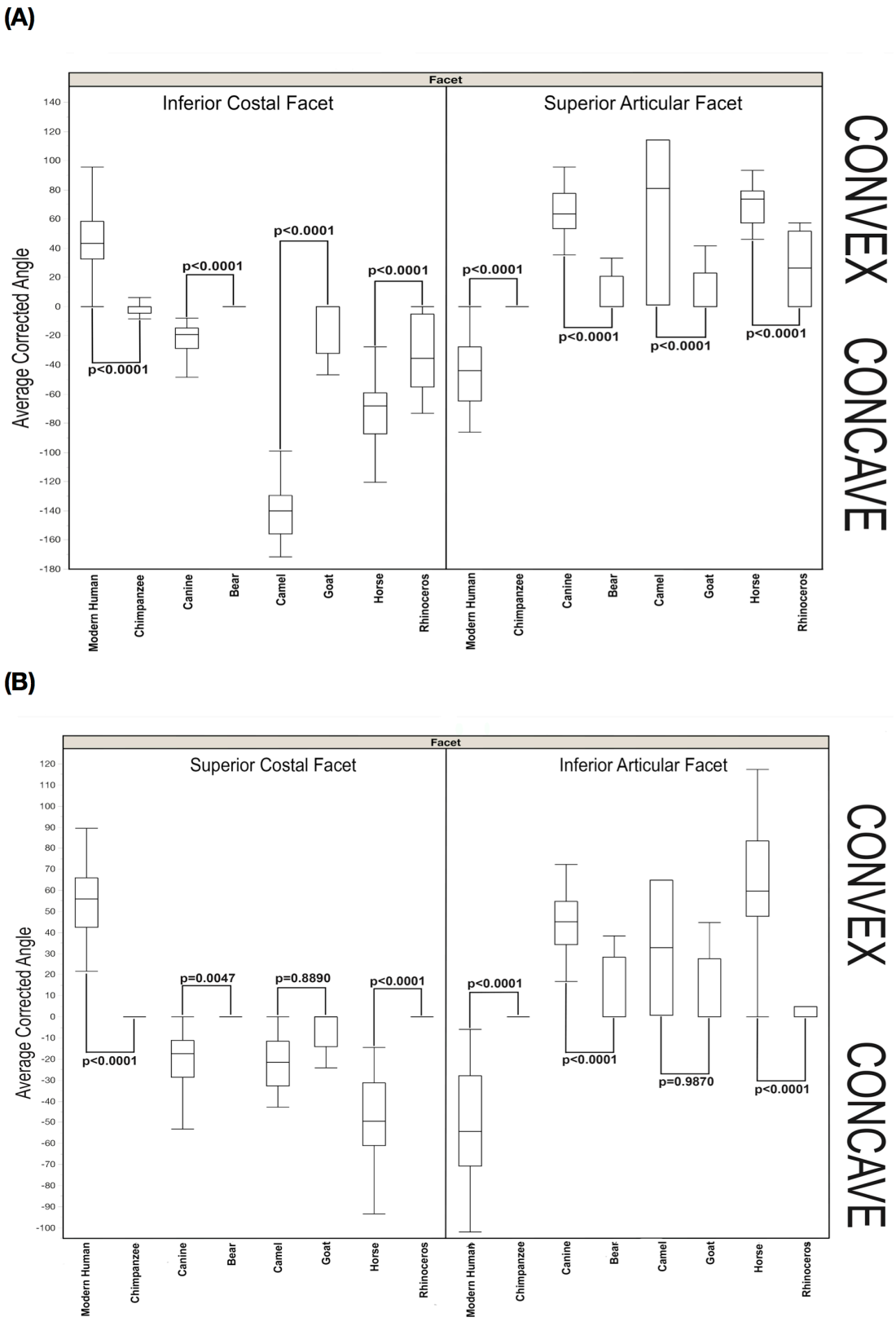

Figure S2: Differences in costovertebral joint morphology between closely related

endurance-adapted cursors and non-endurance extant species in the superior (A) and inferior (B) sites of articulation in costovertebral joint. Negative included angel values indicate convex joint facets, while positive values indicate concavity. Larger values are associated with greater joint curvature. Endurance-adapted cursorial species generally exhibited increased curvature relative to closely related non-cursorial species within the same Order.

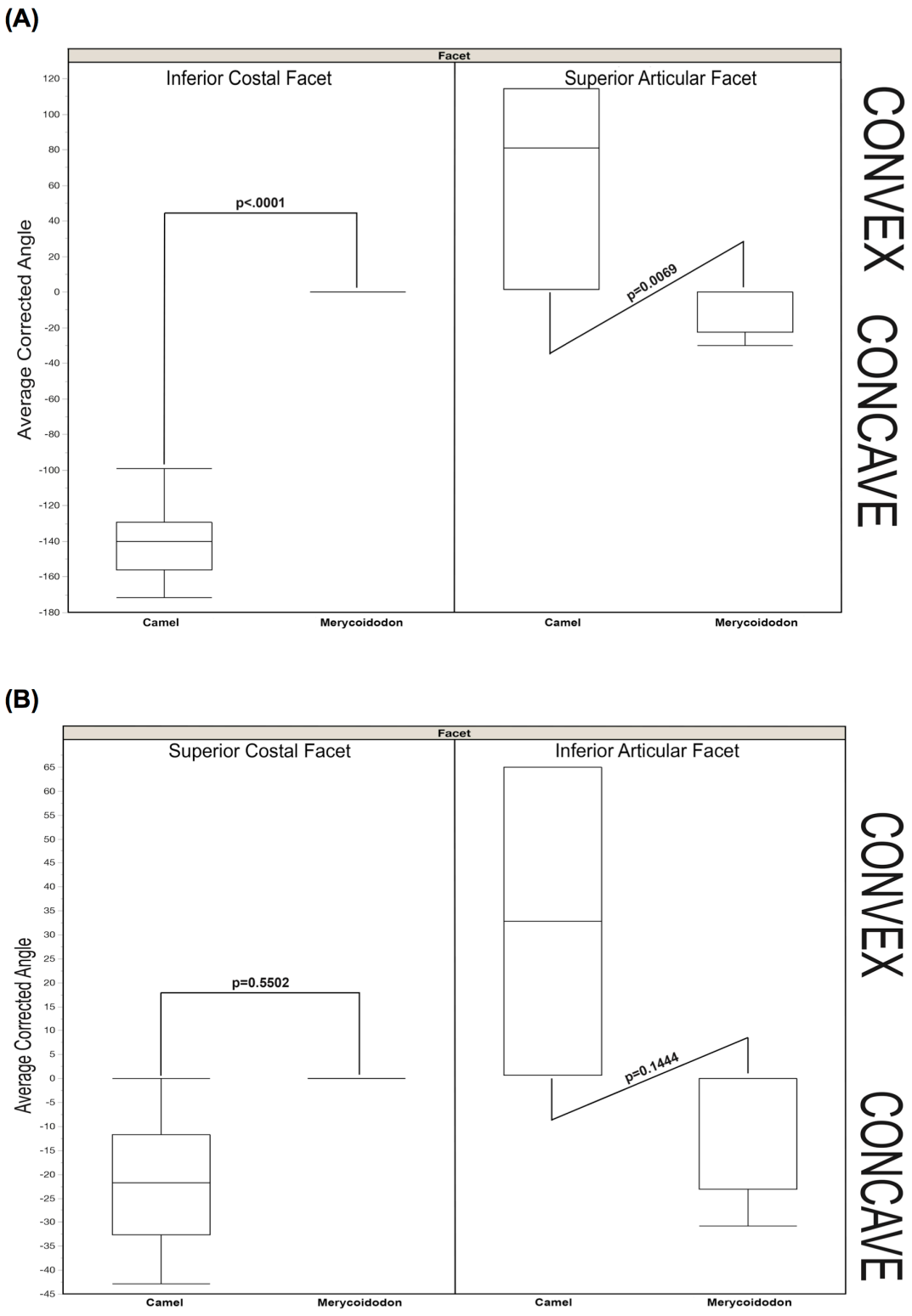

Figure S3: Differences in costovertebral joint morphology between extant camels and *Merycoidodon culbertsoni* in the superior (A) and inferior (B) sites of articulation in costovertebral joint. Negative included angel values indicate convex joint facets, while

positive values indicate concavity. Larger values are associated with greater joint curvature. Camels exhibited increased curvature in the upper site of articulation. As with camels and goats, camels differ from *Merycoidodon* at the superior site of articulation of the costovertebral joint. The superior site of articulation in camels exhibits an almost ball-and-socket joint-architecture and appears to be the primary articulation point between the vertebrae and heads of the ribs. The inferior site of articulation of the costovertebral joint appears reduced, with the superior site of articulation being primarily responsible for rib movement.

Table S1: Measurements of heart rate (HR), tidal volume (V_T) and respiration rate (f_R) in humans, dogs and goats. Estimated HR_{MAX} values are calculated based on $\dot{V}O_2$ and associated HR measurements (taken when the animals where trotting at the fastest speeds they would sustain) and previously measured $\dot{V}O_{2MAX}$ values for dogs (Lucas et al., 1980) and for goats (Taylor et al., 1980) ($HR_{MAX} = \frac{HR_{measured} \times VO_{2MAX}}{VO_{2measured}}$).

Participant/ Subject ID	Species	Body Mass (kg)	HR_{MAX} * indicates estimated value calculated from $\dot{V}O_2$. [R] indicates values reported elsewhere.	HR (beat/min)	V_T (L)	f_R (breaths/min)
R1	*Homo sapiens*	65.6	182	49	1.362	23
				76	1.223	22
				111	2.087	29
				140	2.811	33
				179	3.691	37
				182	3.447	37
R2	*Homo sapiens*	69.6	191	60	0.872	13
				97	0.914	31
				135	2.09	32
				153	2.36	35
				183	2.689	44
				191	2.397	50
R3	*Homo sapiens*	72.7	188	66	1.152	21
				87	1.291	24
				120	2.472	34
				154	2.473	45
				178	2.449	56
				178	2.055	51
R4	*Homo sapiens*	65.3	196	73	0.851	9
				86	1.13	21
				125	1.71	30
				153	2.155	33
				191	2.435	45
				193	2.514	49
S1	*Homo sapiens*	66.7	194	72	1.969	16
				96	1.906	19
				141	2.156	30
				154	2.21	37
				190	2.013	62
				196	1.619	42

S2	*Homo sapiens*	77.1	188	64	0.909	12
				92	1.276	25
				113	1.624	47
				155	2.46	48
				185	2.754	53
S3	*Homo sapiens*	56.3	200	69	0.426	30
				86	0.717	24
				119	1.323	29
				195	2.32	39
				196	1.807	47
S4	*Homo sapiens*	70.9	186	69	1.236	12
				75	1.366	19
				115	1.814	24
				152	3.165	31
				180	2.582	61
				178	2.109	49
S5	*Homo sapiens*	84.8	196	58	0.976	14
				94	2.166	17
				120	2.215	44
				152	2.58	36
				188	2.971	57
				186	2.243	62
S6	*Homo sapiens*	78.6	184	61	0.583	23
				80	0.975	32
				113	2.398	30
				151	3.077	35
				178	3.58	46
				177	3.16	47
G1	*Capra hiricus*	40	258*	139	0.824	89
			209 ± 8^{R} (Hohimer et al., 1984)	191	0.614	122
				205	0.591	147
				218	0.295	186
				230	0.287	189
G2	*Capra hiricus*	27.69	236	131	0.724	69
			209 ± 8^{R} (Hohimer et al., 1984)	180	0.343	77
				218	0.318	89
				236	0.616	97
G3	*Capra hiricus*	41.9	239*	111	0.502	63
			209 ± 8^{R} (Hohimer et al., 1984)	169	0.498	72

				183	0.56	81
				222	0.435	108
D1	*Canis familiaris*	35.7	313*	93	1.776	23
			294±5^{R} (Lucas et al., 1980)	145	0.816	32
				155	0.663	36
				151	0.57	32
				147	0.434	77
D2	*Canis familiaris*	31.06	314*	62	1.472	23
			294±5^{R} (Lucas et al., 1980)	116	0.556	38
				109	0.452	29
				109	0.437	29
				105	0.386	44
D3	*Canis familiaris*	25.96	312*	56	0.58	24
			294±5^{R} (Lucas et al., 1980)	84	0.668	22
				96	0.699	22
				93	0.727	23
				93	0.547	24

Table S2: Repeatability of included angle measurements for the inferior costal facet (ICF), superior articular facet (SAF), superior costal facet (SCF) and inferior articular facet (IAF).

Species	**Facet**	**% of Total Variation due to Repeated Measurement**	**Repeatability** (Barrentine, 1991)
Homo sapiens	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Pan troglodytes	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Equus caballus	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Rhinoceros unicornis **and** ***Dicerorhinus sumatrensis***	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Canus familiaris **and** ***Canus lupus***	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Ursus americanus	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Camelus dromedarius	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Capra hiricus	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
H. neanderthalensis	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
H. erectus	SAF		
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent
Au. sediba	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent

Au. afarensis	SAF		
	IAF		
	SCF	<1	Excellent
	ICF	<1	Excellent
Merycoidodon culbertsoni	SAF	<1	Excellent
	IAF	<1	Excellent
	SCF	<1	Excellent
	ICF	<1	Excellent

Table S3: Measured inferior costal facet (ICF), superior articular facet (SAF), superior costal facet (SCF) and inferior articular facet (IAF) included angles across sampled species. Negative included angle values indicate concave joint facets, while positive values indicate convexity. Larger values are associated with greater joint concavo-convexity. Angle values of 0 indicate a flat facet.

Species	Facet	Number of samples	Mean Angle (degrees)	Std. Error
Homo sapiens	SAF	47	-46.29	2.75
	IAF	52	-50.56	2.62
	SCF	56	54.67	1.58
	ICF	70	46.24	1.87
Pan troglodytes	SAF	54	0.41	2.55
	IAF	54	3.69	13.35
	SCF	56	-1.04	4.82
	ICF	70	-3.35	1.87
Equus caballus	SAF	24	71.36	3.83
	IAF	24	61.40	3.94
	SCF	24	-47.52	2.41
	ICF	30	-73.03	2.86
Rhinoceros unicornis and ***Dicerorhinus sumatrensis***	SAF	15	29.44	4.85
	IAF	14	4.51	5.04
	SCF	16	0.00	2.95
	ICF	20	-27.37	3.92
Canus familiaris and ***Canus lupus***	SAF	28	64.79	3.55
	IAF	28	45.20	3.57
	SCF	32	-19.73	2.09
	ICF	40	-23.35	2.48
Ursus americanus	SAF	23	9.19	3.91
	IAF	23	11.70	3.94
	SCF	24	0.00	2.41

	ICF	30	-2.15	2.86
Camelus dromedarius	SAF	3	65.56	10.84
	IAF	2	32.84	13.35
	SCF	16	-15.95	3.41
	ICF	20	-140.29	3.50
Capra hiricus	SAF	14	10.61	5.02
	IAF	14	11.24	5.04
	SCF	24	-6.53	2.41
	ICF	30	-10.80	2.86
H. neanderthalensis	SAF	3	-17.11	10.84
	IAF	5	-28.02	8.44
	SCF	7	41.34	4.47
	ICF	8	32.94	5.54
H. erectus	SAF			
	IAF	2	-47.06	13.35
	SCF	6	47.78	4.82
	ICF	7	48.26	5.92
Au. sediba	SAF	3	-3.82	10.84
	IAF	3	3.95	10.90
	SCF	9	0.00	3.94
	ICF	14	0.67	4.19
Au. afarensis	SAF			
	IAF			
	SCF	2	0.00	8.35
	ICF	2	0.00	11.08
Merycoidodon culbertsoni	SAF	4	-7.47	9.38
	IAF	4	-7.67	9.44

	SCF	13	2.06	3.28
	ICF	14	0.00	4.19

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