Supporting Information [SI]

Trabecular structure of the elbow reveals divergence in knuckle-walking biomechanical strategies of African apes

SI Table S1. Descriptive statistics (number (N), mean (M) and standard deviation (SD)) for bone volume fraction (BV/TV) and degree of anisotropy (DA) values per region (whole epiphysis, capitulum [Cap] and trochlea [Troch]) by genus.

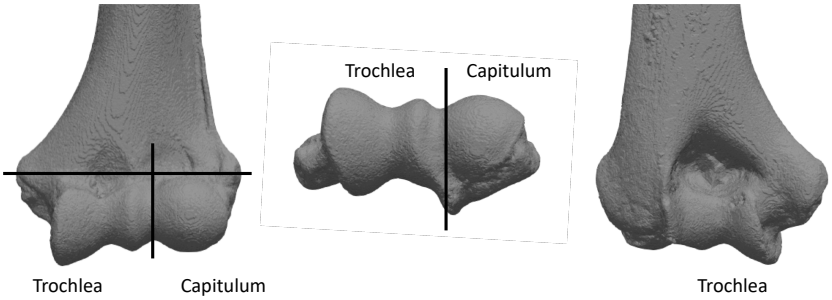
Genus	N	BV/TV		DA		BV/TV Cap		DA Cap		BV/TV Troch		DA Troch	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Pan	7	0.26	0.02	0.42	0.02	0.32	0.04	0.36	0.04	0.40	0.04	0.35	0.03
Gorilla	7	0.29	0.04	0.35	0.04	0.32	0.04	0.34	0.04	0.34	0.04	0.29	0.04
Pongo	5	0.28	0.05	0.37	0.07	0.29	0.02	0.34	0.06	0.37	0.08	0.32	0.07
Symphalangus	3	0.23	0.02	0.33	0.03	0.26	0.02	0.32	0.02	0.34	0.04	0.28	0.05
Macaca	3	0.22	0.02	0.35	0.02	0.27	0.03	0.31	0.05	0.31	0.02	0.32	<0.00
Papio	2	0.28	0.01	0.39	0.04	0.33	0.01	0.33	<0.00	0.36	0.05	0.36	0.04
Ateles	4	0.20	0.03	0.32	0.03	0.24	0.02	0.28	0.02	0.27	0.03	0.30	0.03
Alouatta	2	0.21	<0.00	0.30	0.01	0.28	<0.00	0.29	0.01	0.24	0.01	0.28	0.02

SI Table S2. Results of the linear regressions carried out between average humeral head diameters (BM) and BV/TV and DA values for the whole epiphysis. The humeral head diameters were obtained following Jungers (1991). All data were log-transformed using natural logarithms (ln).

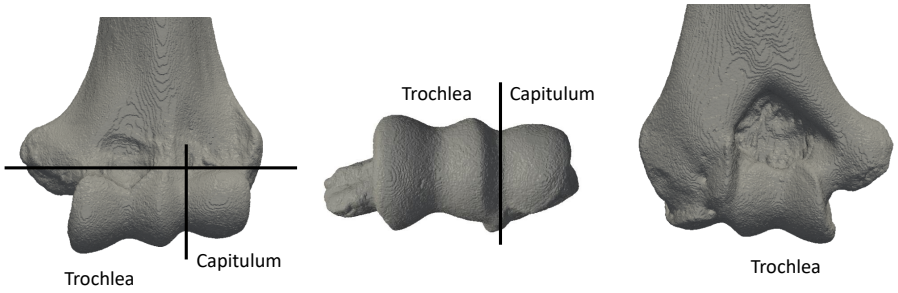
Linear Model	R2	Adjusted R2	F-statistic	p value
BM ~ BV/TV	0.61	0.60	49.34	<0.000
BM ~ DA	0.11	0.08	3.89	0.058

Anterior Distal Posterior

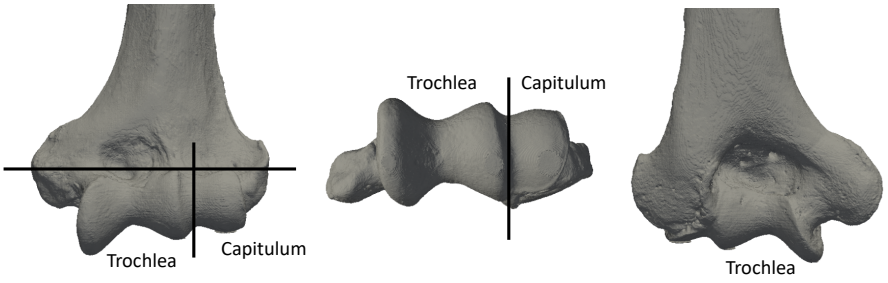
Pan troglodytes verus



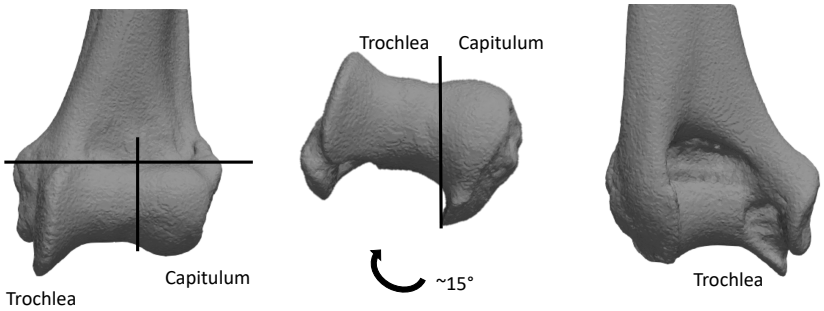
Gorilla gorilla gorilla



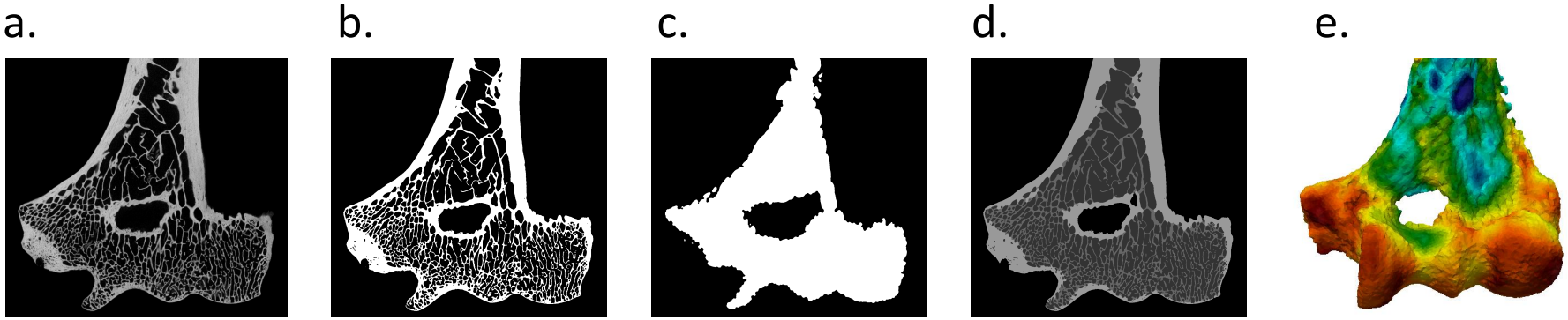
Gorilla beringei beringei



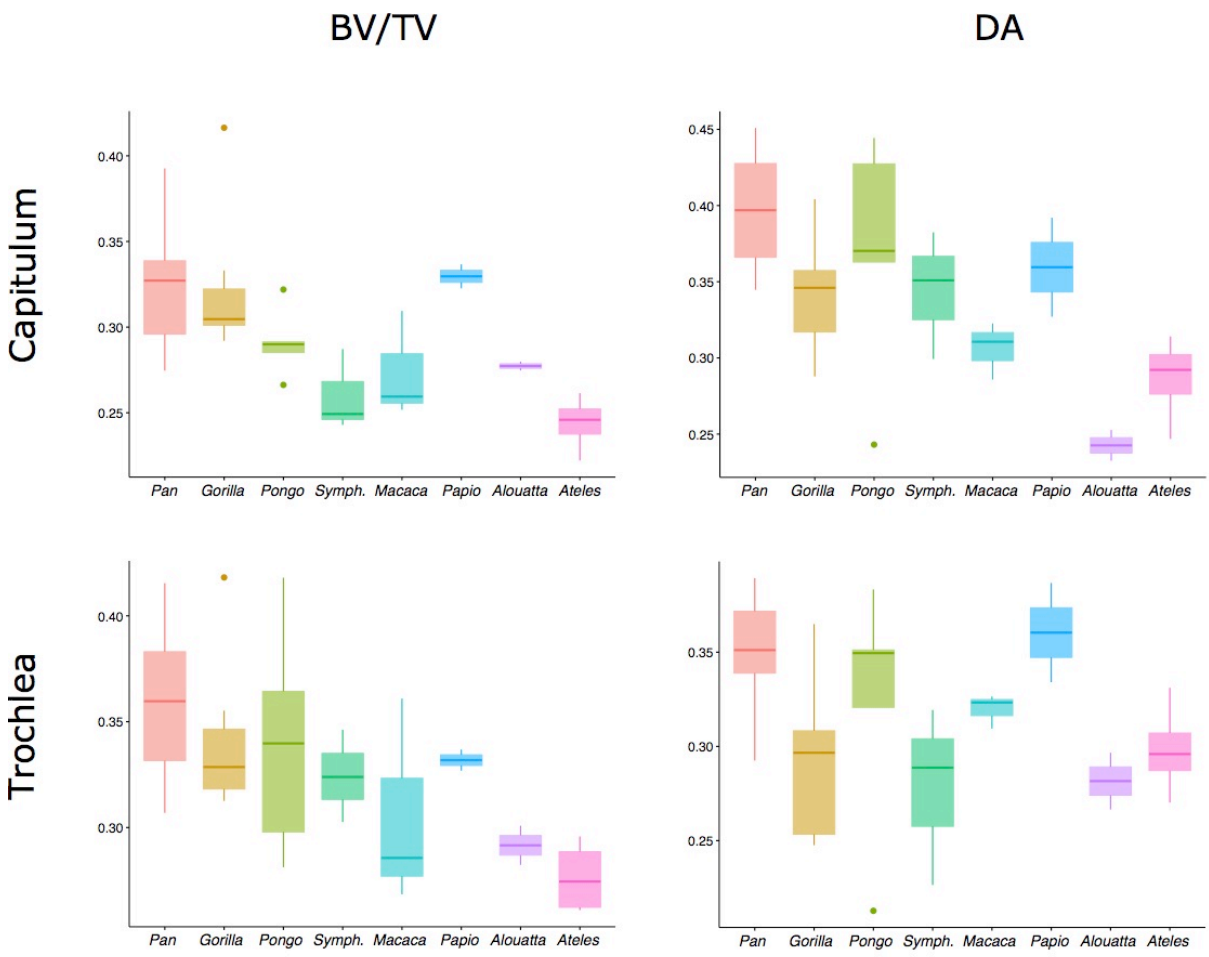
Papio hamadryas



SI Fig S1. Left distal humeri of a mountain gorilla (*Gorilla beringei beringei*), a western lowland gorilla (*Gorilla gorilla gorilla*) and a common chimpanzee (*Pan troglodytes verus*), which exemplify the shared ape-like distal humerus shape, characterized by a globular capitulum and spool-shaped trochlea with a well-developed lateral keel; below them is Hamadryas baboon (*Papio hamadryas*), which exemplifies the monkey-like distal humerus shape, with a more cylindrical trochlea with a prominent medial keel and a less rounded capitulum. Since the distal humerus articulates independently both with the radius and the ulna, we analysed the trabecular structure of both the complete epiphysis and then the capitulum and trochlea separately. Cutting planes within the distal humerus were identified in Avizo 6.3® (Visualization Sciences Group, SAS) using anatomical landmarks that accounted for variation in morphology across the sample. The mediolateral cutting plane separated the articular surface from the rest of the epiphysis, aligning with the most superior aspect of the trochlea in all specimens. The proximodistal cutting plane separated the capitulum from the trochlea. In hominoids, the deepest point in zona conoidea (also the most lateral aspect of the trochlear ridge) was identified as the natural limit between articular surfaces. In monkeys, the medial epicondyle is posteriorly displaced and the articular surface of the capitulum is reduced as it grades posteriorly. Therefore, each non-hominoid specimen (as exemplified by the Hamadryas baboon specimen depicted) was rotated laterally on the proximodistal axis to identify the cutting planes. In the image, black lines mark the position of the cutting planes used to separate the articular surfaces from the humeral metaphysis on the axial plane (proximo-distal) and the limit between the capitulum and the trochlea on the sagittal (medio-lateral) plane.



SI Fig. S2. Medtool 4.2 (www.dr-pahr.at/) processing steps on a chimpanzee individual, in a slice of roughly the middle of the distal humerus in the coronal (anteroposterior) plane: (a) original microCT scan slice; (b) segmented slice; (c) inner trabecular area (trabecular mask); (d) final mask processing showing inner air, outer air, trabecular bone and cortical bone. (e) is the resulting bone volume fraction (BV/TV) colour map for the whole epiphysis in 3D; the cortical bone has been removed and the bone volume fraction has been computed for the entire epiphysis.

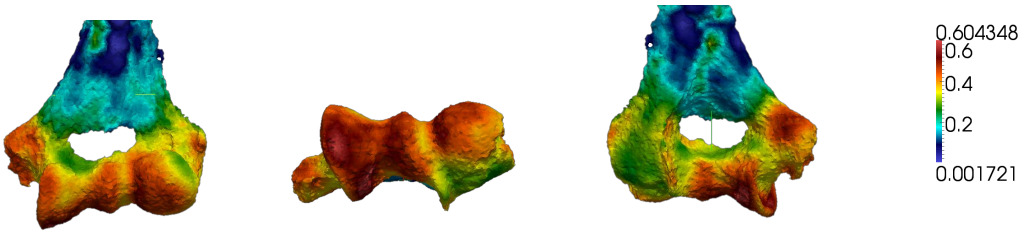


SI Fig. S3. Box-and-whisker plots of bone volume fraction (BV/TV) and degree of anisotropy (DA) of the capitulum (top row) and the trochlea (bottom row) separately, grouped by genus.

Pan troglodytes verus

Anterior Distal Posterior

MPI-TC 11778



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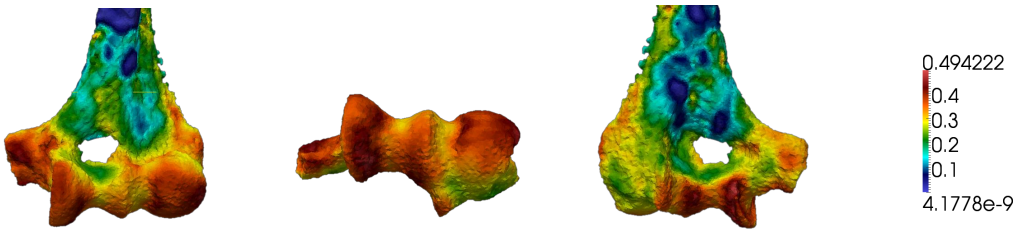

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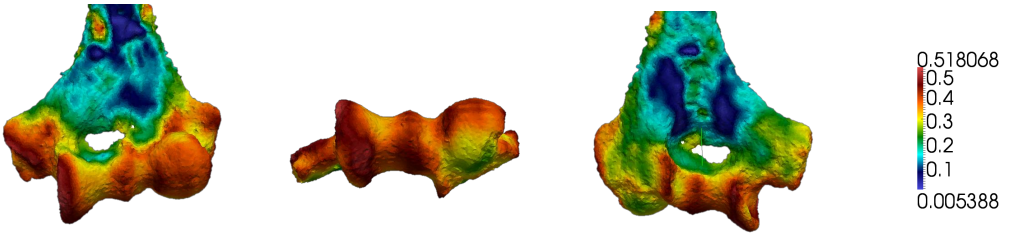

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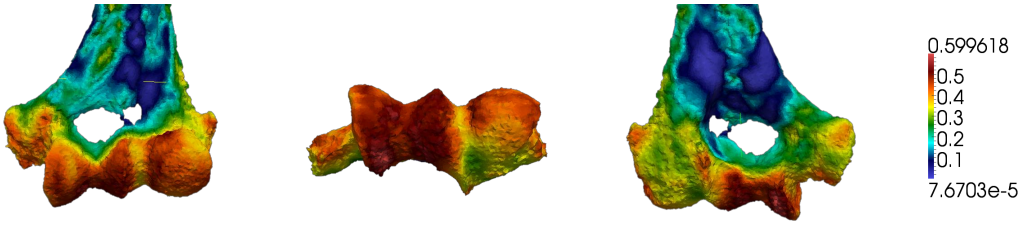
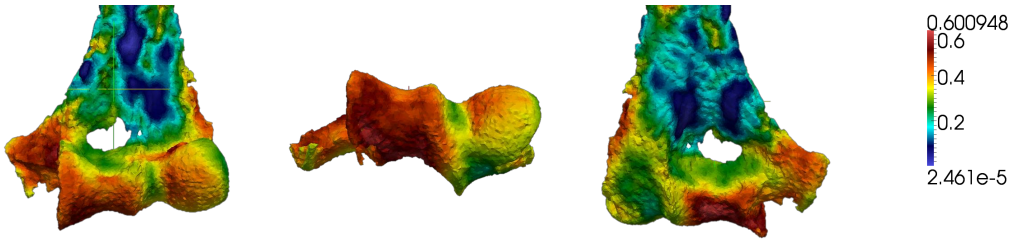


Pan troglodytes verus (cont.)

Anterior Distal Posterior

MPI-TC 15019



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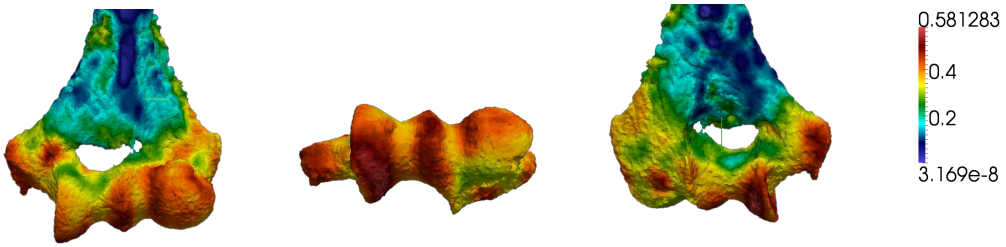

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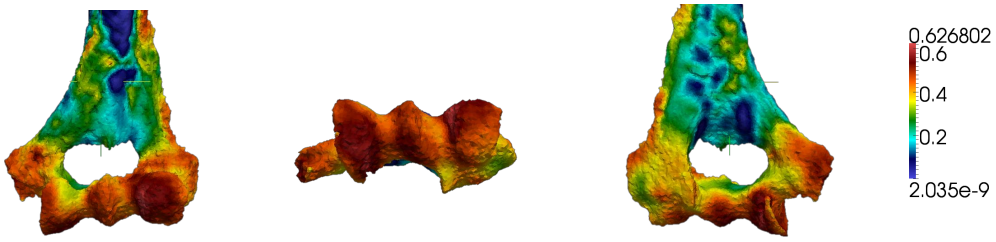
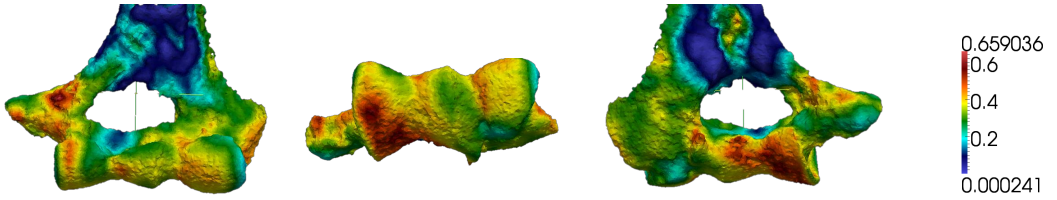


Gorilla gorilla

Anterior Distal Posterior

MERI 95



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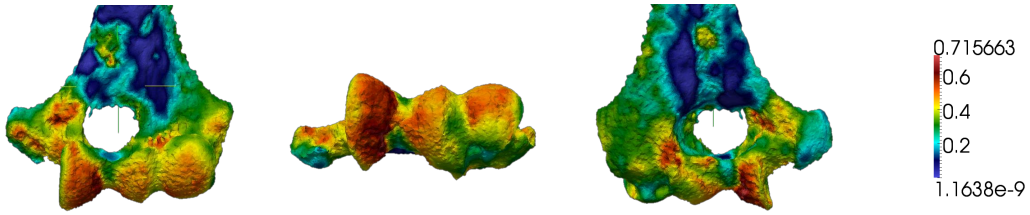

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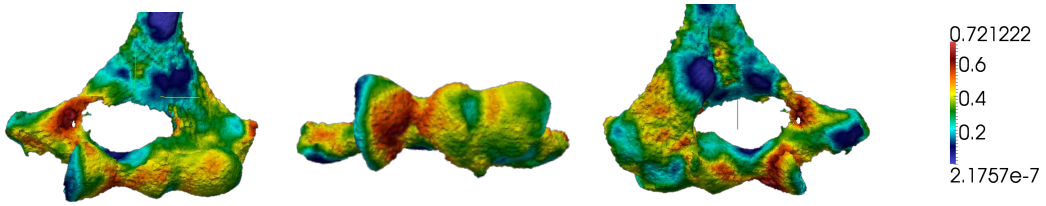

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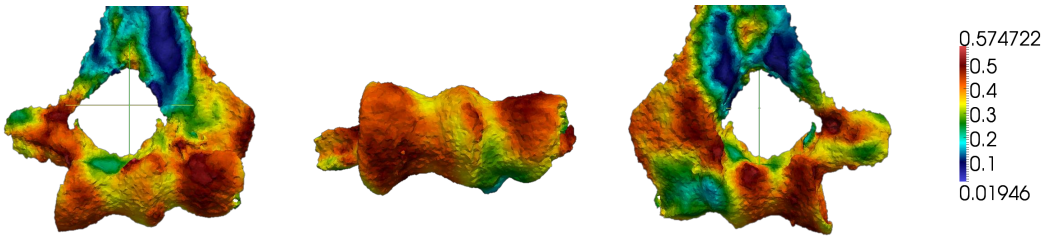
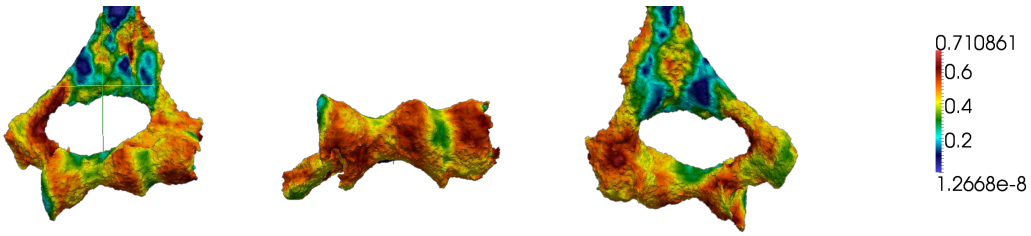


Gorilla beringei

Anterior Distal Posterior

GP.026



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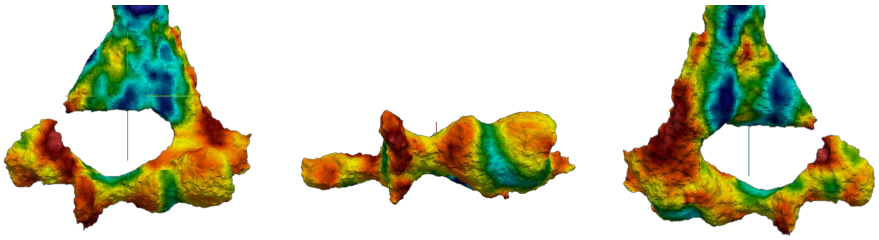

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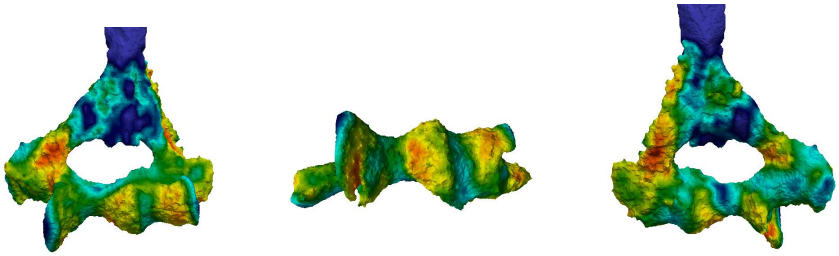
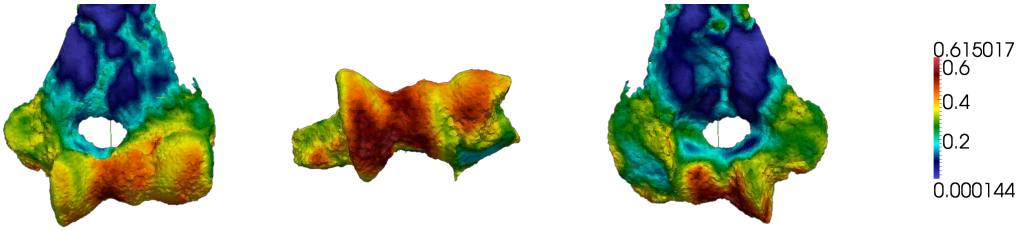


Pongo pygmaeus

Anterior Distal Posterior

ZMB 6948



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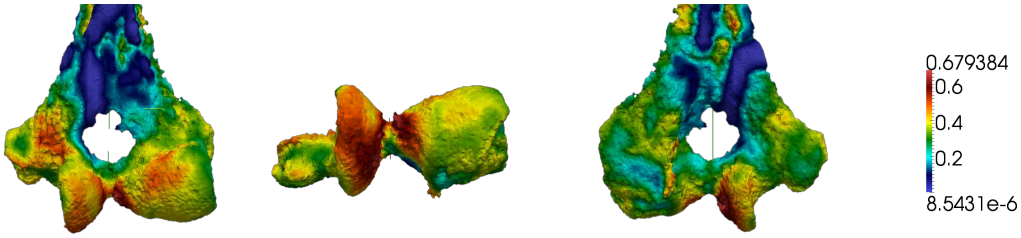

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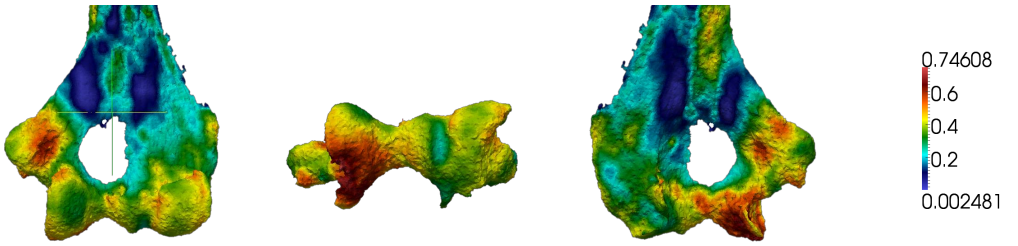

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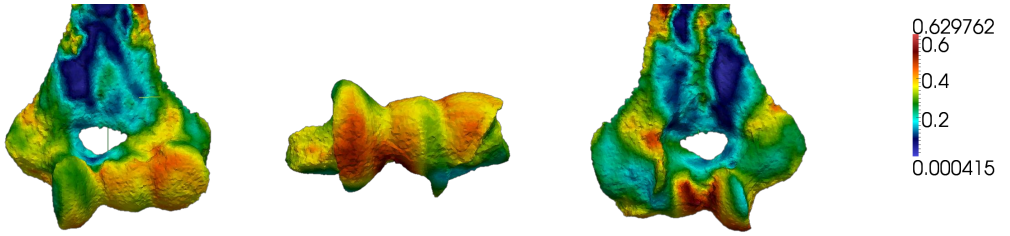

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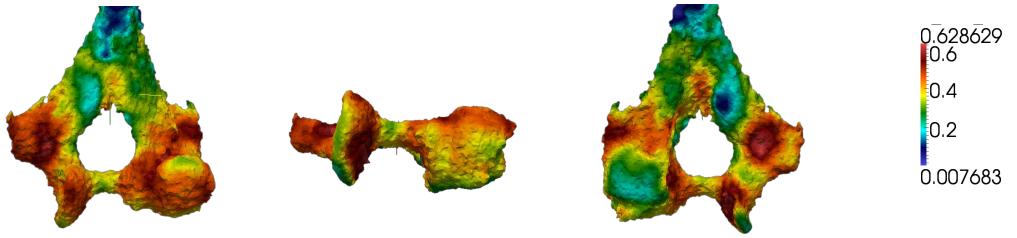

Symphalangus syndactylus

Anterior Distal Posterior

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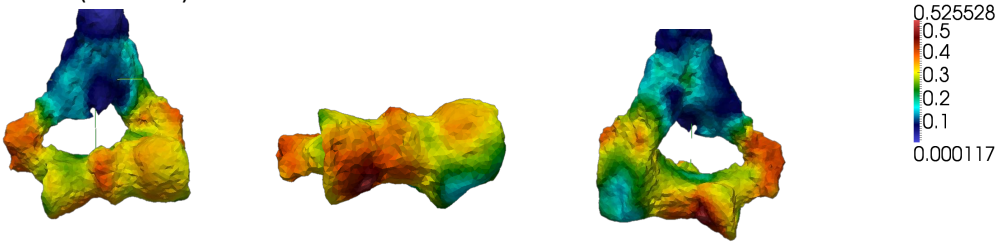

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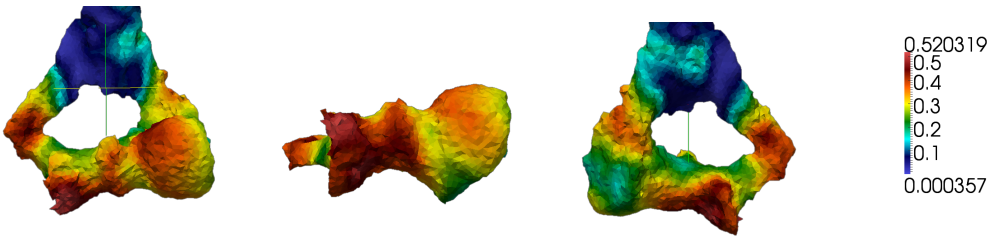

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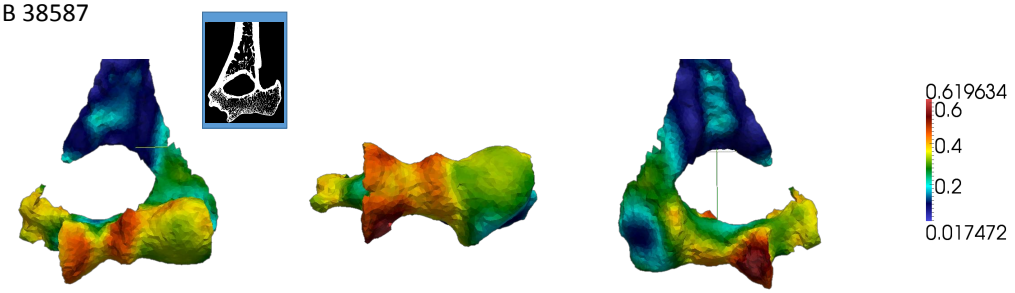
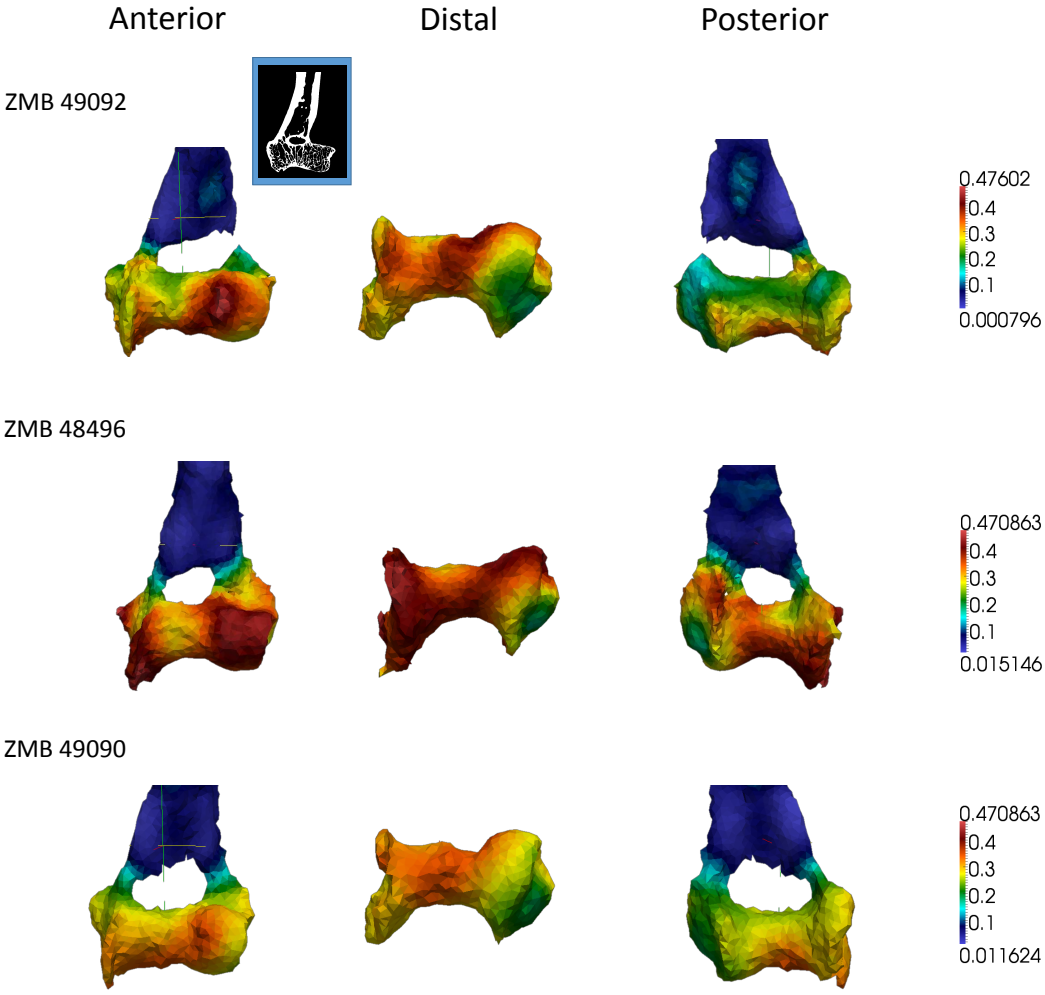


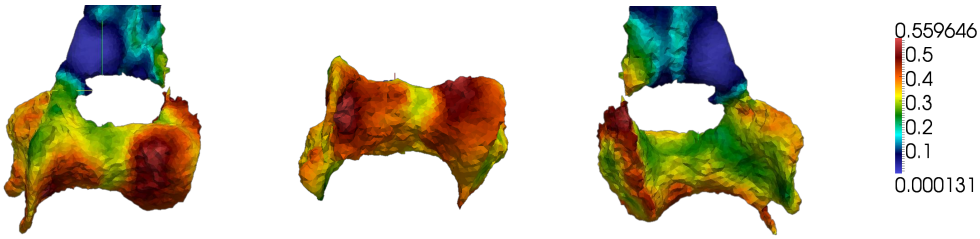
Macaca fascicularis



Papio hamadryas

Anterior Distal Posterior

ZMB 65265



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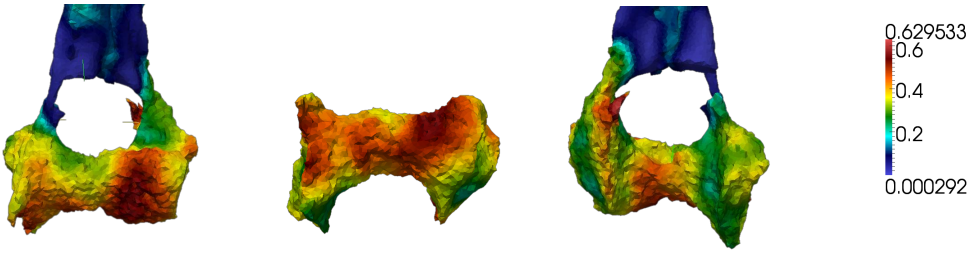
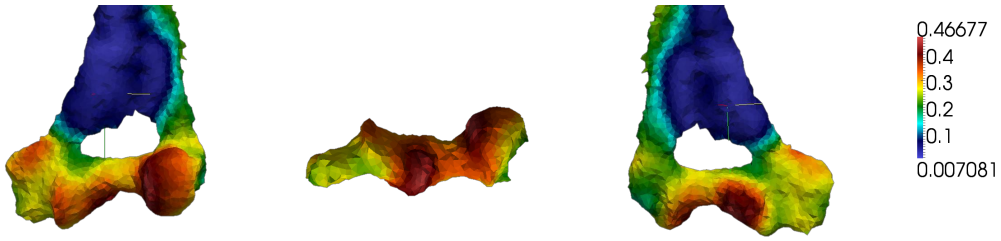


Alouatta sp.

Anterior Distal Posterior

ZMB 35764



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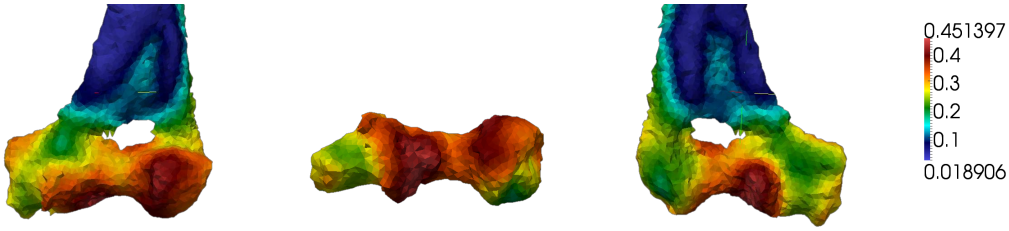

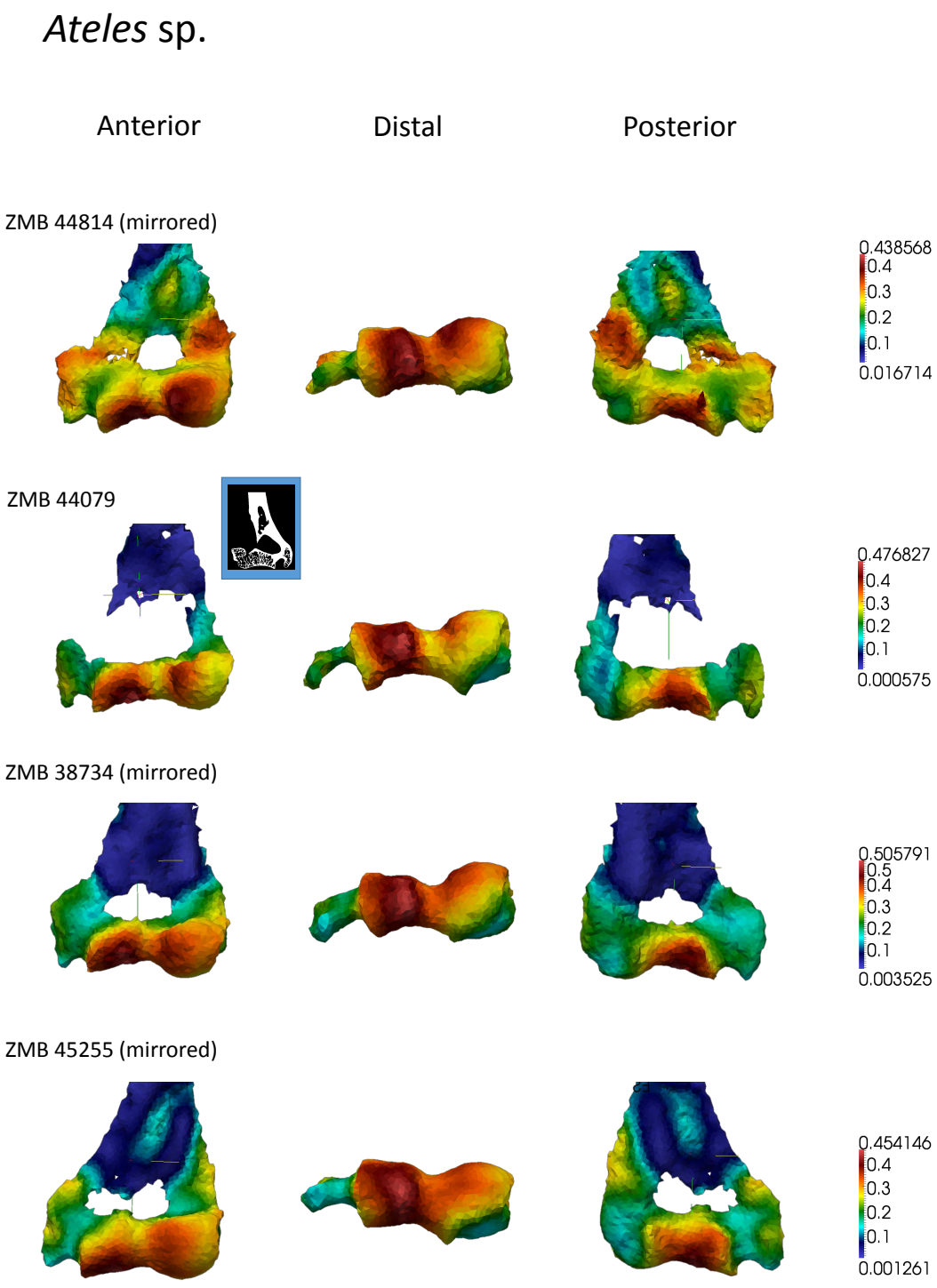

SI Figure S4. Bone volume fraction (BV/TV) colour maps of all specimens of each species.

SI Appendix S1. Additional tests were performed on the chimpanzee, lowland gorilla and mountain gorilla sample given their distinct trabecular patterns. Kruskal-Wallis tests between the three groups were conducted. Pairwise Wilcoxon rank sum test post-hoc analysis was conducted to further explore the significant differences between groups found. A caveat regarding the fact that the sample sizes are very small should be mentioned. Results from the Kruskal-Wallis test found significant differences in DA for the whole epiphysis, and the pairwise Wilcoxon rank sum test reveals differences between *Gorilla beringei* (mountain gorilla) and *Pan troglodytes* (chimpanzees). Additional individuals of the species analysed plus individuals from the pygmy chimpanzee species (the bonobos, not available for this study) should be included to further test and interpret these results.

SI Appendix Table 1. Kruskal-Wallis results. Significant *p* values are marked with an asterisk.

	X^2	*p*
BV/TV whole	2.23	0.33
BV/TV capitulum	0.20	0.90
BV/TV trochlea	1.28	0.53
DA whole	9.05	0.01*
DA capitulum	5.82	0.054
DA trochlea	5.82	0.054

SI Appendix Table 2. Results of the Wilcoxon rank sum test post-hoc with Bonferroni correction performed on DA values for the whole epiphysis (DA whole) from the Kruskal-Wallis test. Significant *p* values are marked with an asterisk (Alpha was set at ≤ 0.05).

	Gorilla beringei	*Gorilla gorilla*
Gorilla gorilla	0.69	-
Pan troglodytes	0.050*	0.07