3D GM Study of Effects of Age on Cranial Shape in Large-Bodied Papionins, Using Molar Wear as a Proxy for Age

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An adult Hamadryas Baboon (Papio hamadryas hamadryas, male).

Introduction

Ontogenetic changes to skull shape, specifically centering around juvenile development into adulthood, are well studied. Age related changes to skull shape throughout adulthood, however, are less well known. In this study, we used geometric morphometric methods (GM) to investigate the effect of age on cranial shape after reaching adulthood. The effects of adult aging on cranial shape are important for forensics studies, for a better comparison of individual fossil specimens, and for understanding the aging process in general.

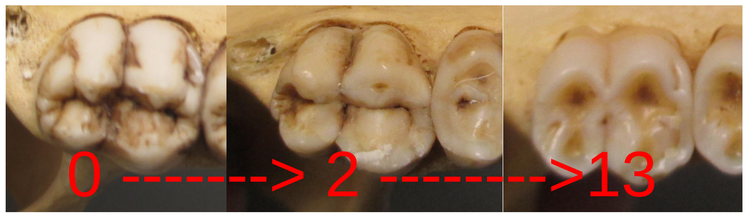

Fig 2. M3 wear from left to right: Specimen #216251, Specimen #169141, Specimen #161734. Specimens located at the American Museum of Natural History.

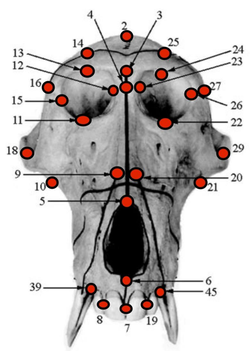

Fig 1. Baboon Skull (Papio hamadryas ursius, male) with 29 of the 45 landmarks, indicated by the red dots.

Methods

Forty-five landmarks were digitized using a Microscribe-3DX, for 347 baboon crania. Molar wear was used as a proxy for ontogenetic age. The upper third molars were rated on a scale of 1 to 16 based on the amount of wear to the tooth. We used a generalized Procrustes analysis in the Geomorph package in Rstudio, which superimposed the data and standardized the geometric size of the specimens while still leaving the shape differences. Because allometry has been shown to be a large factor for shape variation in baboon crania (Frost et al 2003), we adjusted for size and sex through a multivariate regression analysis. Then we regressed the adjusted coordinates against wear stage, in order to test for a significant age effect. Finally, after putting it through a principal components analysis (PCA), we were able to summarize the resulting shape space.

Taxon	Males	Females	Both
Papio hamadryas anubis	85	39	124
Papio hamadryas cynocephalus	14	9	23
Papio hamadryas hamadryas	21	2	23
Papio hamadryas kindae	5	7	13
Papio hamadryas papio	15	1	16
Papio hamadryas ursius	80	68	148
Total	221	126	347

Table 1. The number of specimens in each taxa used in the project

Results

The resulting ANOVA found that age has a corelation with cranial shape, even after we accounted for sex and size differences between the species. That being said, the effect is subtle. Size/allometry accounted for approximately 42% of variance, sex accounted for approximately 4% of variance, sex and size together accounted for 0.4% and age accounted for 6% . This left 47% of the variance unexplained.

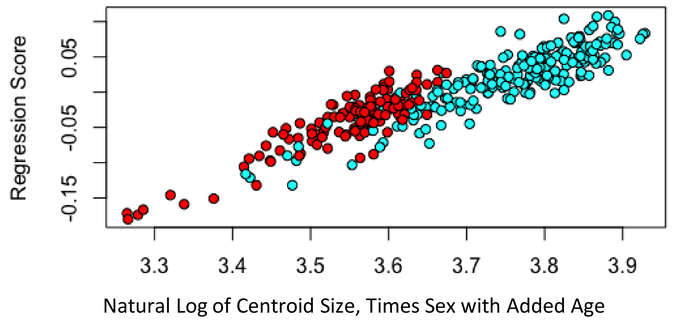

Fig 3. A regression plot with sex-specific taxon and mean centroid size on the x-axis,(what is Y axis). Females are in red and males are in blue.

Table 2. The proportion of total Procrustes distance accounted for by different factors.

Factor	Procrustes sum of Squares	Pr (>F) Valvues	Percentage of Total (%)
ln(Centsize)	0.92468	0.001	42.363
Sex	0.08284	0.001	3.795
ln(Centsize) & Sex	0.00965	0.004	0.442
Age	0.13077	0.001	5.991
Unexplained	1.03483	NA	57.409

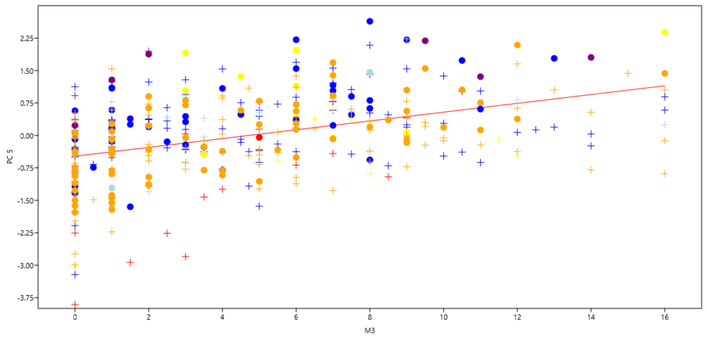

Fig 4. A PCA analyzing the correlation of age and shape variation. The specific landmark, located on the supraorbital torus, shows that the brow shape can change throughout adult age.

Conclusions

With these results, we can begin to understand that age does in fact effect shape changes on the skull during the adult stage of life. What's not as clear is what exactly causes these age-related shape differences.

Further exploration with this project plans to focus on this question of what. Are these causes genetic, shaped by environmental factors, or could they be shaped by something else? What could the processes of these shape changes be, and why do they happen? This project in the long run looks towards answering these questions.

Acknowledgments

This project couldn't be possible without the University of Oregon Department of Anthropology's Geometric Morphometrics Laboratory and their resources. We'd like thank Aileen Fernandez and Hailay Reda, both graduate students under Dr. Stephen Frost' mentorship. I'd like to personally thank everyone from the Geometric Morphometrics Lab for their patience and support for this project, as well as the lab members from the Primate Osteology lab for their insight. Last but not least we'd like to offer our thanks to the various institutions who granted us acces to their specimens: University of the Witwatersrand, Johannesburg; Transvaal Museum, Pretoria; British Museum (Natural History), London; Powell-Cotton Museum, Birchington; Muse´e National d' Histoire Naturelle, Paris; Lehrstuhl fu¨ r Spezielle Zoologie, Universita¨t Tu¨ bingen; American Museum of Natural
History, New York.

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