Felidae Prey Preference and Skull Morphology: How Do Sabertooth Cat Skulls Compare Against Their Extant Relatives?

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Background

Felidae is a family within the order Carnivora, which is comprised of entirely hypercarnivore species. Due to this homogeneity of diet, felid skull shapes tend to vary by prey size selection (Meachen-Samuels & Van Valkenburgh, 2009). Felids that hunt larger prey relative to their body size have morphologically distinct skulls from those that hunt small prey. The purpose of this project was to quantify the variation in shape with respect to diet in extant felids. Additionally, we hoped to classify the sabertoothed cat, *Smilodon fatalis,* based upon skull shape to determine prey size preference.

Materials & Methods

Images were taken from 18 3D meshes of crania from 13 different felid species from MorphoSource.org. These images were used in the landmarking process. A TPS file was created using tpsUtil v 1.81. Stationary landmarks were applied using tpsDig v 2.32. Generalized Procrustes Analysis was applied to the data to remove the effects of rotation and scale. Principle components analysis was performed to assess the shape variation between specimens. To analyze phylogenetic signal, branch lengths and phylogeny were included using data from Sakamoto & Ruta, 2012.

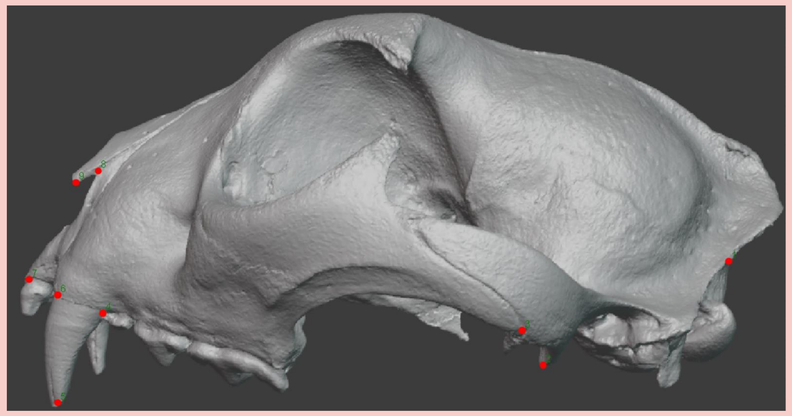

Figure 1: Lateral view of a *Panthera uncia* (Snow leopard) cranium with stationary landmarks placed at replicapable points on the skull.

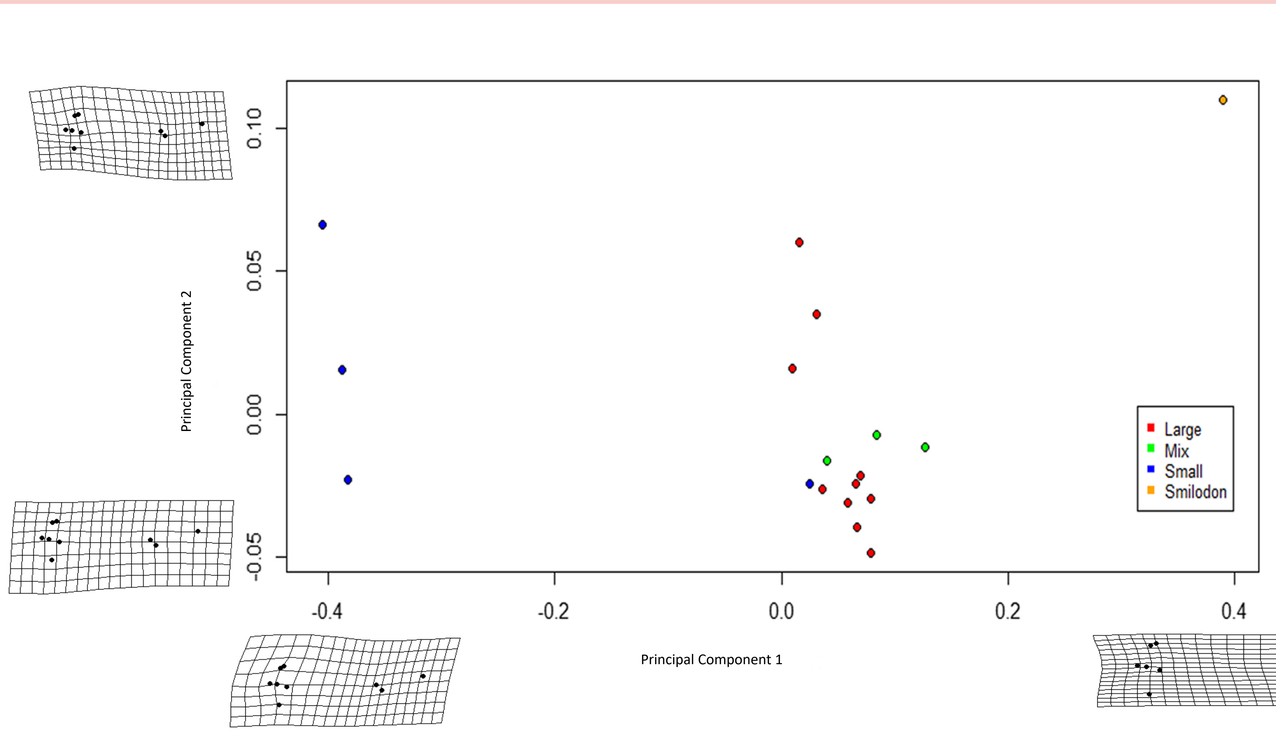

Figure 2: A plot of principal component 1 against principal component 2 that shows the distribution of felid species based on prey preference. The color coordination of the legend refers to prey preference. On the X and Y axes are the relative warps for PC1 and PC2 respectively. Small prey specialists are clustered away from mixed and large prey specialists. *S. fatalis* is separate from both groups at the top right-hand corner of the graph.

Results

Principal component (PC)1 described 87.4% of the variation found in the data while PC2 described 5.55%. PC1 shows separation of taxa based on dietary preferences. Generally, small prey specialists are clustered around the minimum of PC1 whereas mixed prey and large prey specialists clustered around the middle of PC1. *Smilodon fatalis* lies at the maximum of PC1.

PC2 does not separate the extant felid taxa. Only *S. fatalis* is distinct on PC2.

Conclusion

Small prey specialists tend to have skulls that are compressed dorsoventrally while large prey specialists and mixed prey specialists have skulls with deep snouts. This variation in depth may be an adaption for force dispersion when biting since bite force scales with body mass and a larger bite foce is required for larger prey (Christiansen & Wroe, 2007). *Smilodon fatalis* falls beyond the distribution of large prey specialists. This suggests that *S. fatalis* may have been adapted for a niche that is no longer present today.

Acknowledgments

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Citations

Meachen-Samuels, J., Van Valkenburgh, B. (2009). Craniodental indicators of prey size preference in the Felidae. Biological Journal of the Linnean Society, 96(4), 784–799. https://doi.org/10.1111/j.1095-8312.2008.01169.x

Sakamoto, M., Ruta, M. (2012). Convergence and divergence in the evolution of cat skulls: Temporal and spatial patterns of morphological diversity. PLoS ONE, 7(7). https://doi.org/10.1371/journal.pone.0039752

Christiansen, P., & Wroe, S. (2007). Bite forces and evolutionary adaptations to feeding ecology in carnivores. *Ecology*, *88*(2), 347–358. https://doi.org/10.1890/0012-9658(2007)88[347:bfaeat]2.0.co;2