

Evolution of skull and mandible shape in cats

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In a new study published in the online-open access journal *PLoS ONE*, Per Christiansen at the Zoological Museum in Copenhagen, Denmark, reports the finding that the evolution of skull and mandible shape in sabercats and modern cats were governed by different selective forces, and the two groups evolved very different adaptations to killing.

The cat family comprises some of the most specialised carnivores in the history of mammals, all exclusively eating flesh. The cat family consists of two major sub-groups: the feline cats (including all modern species) and the sabertoothed cats (which are all extinct). Skeletons from the two groups look broadly similar, but their skulls are often remarkably different, and suggest that members of the two groups underwent radically different adaptations to predation during the course of evolution.

Sabertoothed cats have been a particularly difficult group to understand because their anatomical features are often radically different from those of modern cats. However, new techniques for anatomical comparison using digital methods have facilitated a more detailed comparison of the anatomy of the entire skull and mandible, and the new results add significantly to our understanding of the evolution of the cat family.

Modern cats appear to have quite different-looking skulls depending on their size, and small cats appear all to have rather abbreviated, tall and domed crania, whereas the skulls in large cats, such as lions, tigers, or leopards, are much more elongated and rectangular. Previously these

criteria have been used to divide the modern cats into two distinct sub-groups, the small and large cats, which were inferred to differ in terms of evolutionary anatomy. However, no such sub-groups exist, and the actual shape of the skull shows a gradual transition from the smallest to the largest species.

The most powerful evolutionary selective driving factor behind skull shape in modern cats appears to have been the need to administer a powerful, precise killing-bite, irrespective of body size – this is a very important part of prey capture and killing in all cats. A cat's brain size decreases, relative to the size of its body, as the size of the cat increases and thus takes up less room in the back of the skull. Since a powerful killing bite entails large, powerful jaw muscles, this imposes strict limits on skull shape, suggesting that big cats simply need more elongated skulls with large muscle crests in order to maintain the ability to deliver a very powerful killing bite.

Sabertoothed cats were subjected to very different evolutionary driving forces. The most important factor governing their evolution seems to have been the need to administer a precise killing bite with a shearing action to the throat of large prey that will kill it very quickly. This led to a major re-organisation of the shape of the entire skull and mandible in the advanced species compared to all extant cats, and also to smaller, more primitive sabertoothed cats. The advanced sabertoothed cats had an entirely different skull and mandible shape from any modern cat, and they also differ a lot from more primitive sabertoothed cats, which have smaller upper canines. But this happened at the expense of powerful bite forces.

Primitive sabertoothed cats were capable of administering powerful killing bites, roughly of comparable force to modern cats of the same size, but derived species were only capable of much weaker killing bites. Such a killing style is probably very effective for killing large prey

quickly, and this would be advantageous in ecosystems with high predator competition (which appears to have been the case in many extinct ecosystems).

However, this probably caused the derived sabertoothed cats to prey on only a limited variety of large prey species, putting them at risk of extinction if the ecosystems changed too much or too rapidly.

Interestingly, the modern clouded leopards are anatomically similar to the primitive sabertoothed cats, and Christiansen suggests that, in time, they may become more specialised and truly sabertoothed.

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