Morphological integration between the fore- and the hind limb in saber-tooths: is there any evidence of decoupled evolution?

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Introduction

One of the most characteristic features of saber-tooth carnivorans are their powerful forelimbs, which have been traditionally interpreted as an adaptation to immobilizing their prey[1-3].

According to this interpretation, forelimb bones should be more robustly built than hind limb ones, as the latter were not directly involved in prey capture.

Here, we compare patterns of shape and size covariation between fore- and hind limb bones in conical-toothed and saber-toothed predators.

In these comparisons, we use landmark based methods of geometric morphometrics and phylogenetic comparative methods (Fig. 1; Fig. 2) .

Bone shapes were compared using two-block partial least squares (2B-PLS) .

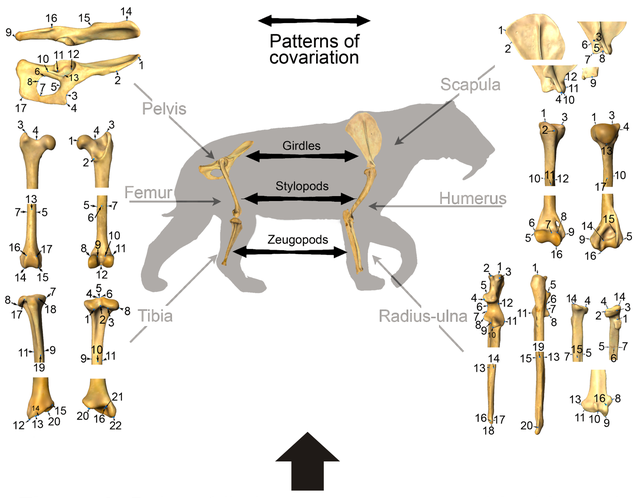
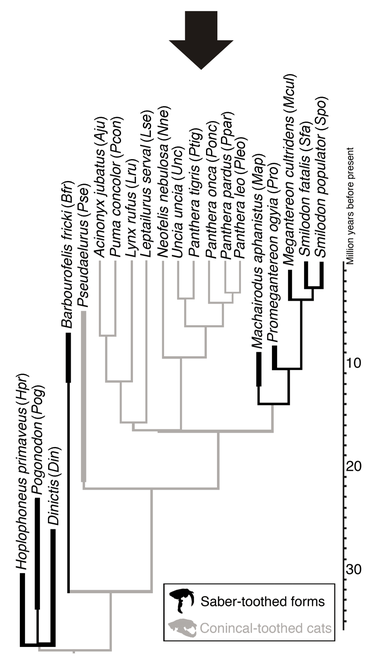


Figure 1. Pairs of limb elements compared in this study and 3D landmarks located .

Figure 2. Phylogenetic tree of living and extinct taxa analyzed.



Results & discussion

Shape covariation

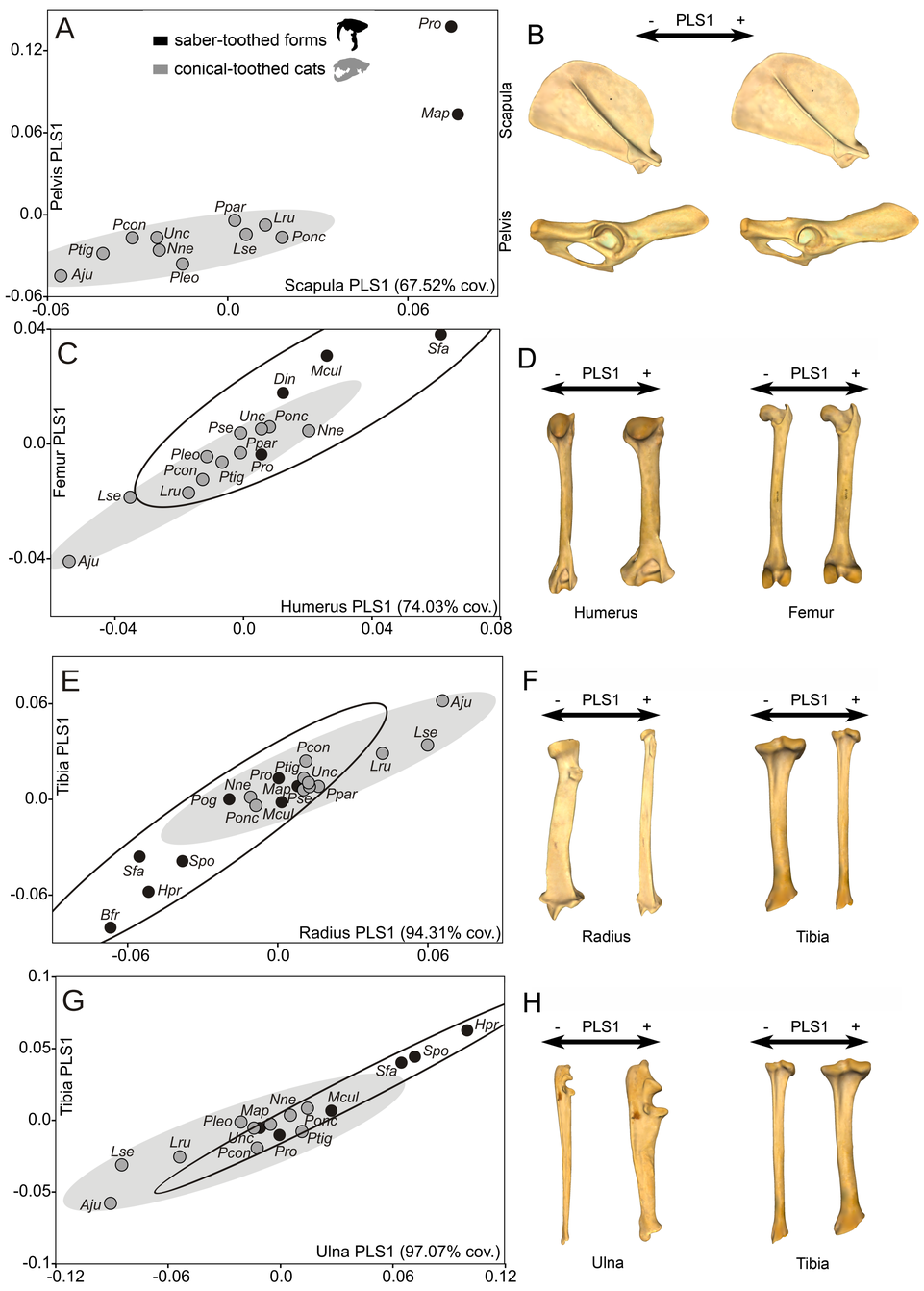


Figure 3. Bivariate graphs depicted from the first PLS axes calculated from between-bones comparisons and their associated shape covariation.

The first PLS axis accounts for >90% of shape covariance in the distal elements (Fig. 3; pairwise plots).

Except for the scapula-pelvis comparison, the first PLS axis is associated with changes in bone robustness (Fig. 3; models).

The same general pattern is present in conical- and saber-toothed predators, which indicates that both ecological groups follow a similar trend.

Our results do not seem to support that saber-tooths showed a greater difference of bone robustness between their fore- and hind limbs than conical-toothed carnivorans.

Size covariation

We compared also bone size between equivalent elements for testing if saber-tooths had more powerful forelimbs due to size differences.

Size regressions (Fig. 4) showed that most saber-tooths lie within the 95% CI´s of the trend of conical-tooths with the only exception of *H. primaevus.*

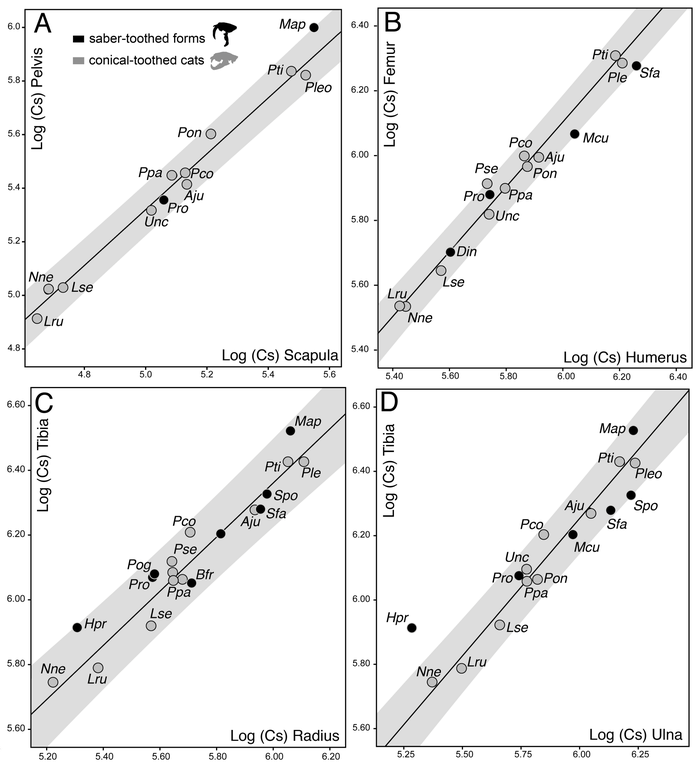


Figure 3. Bivariate graphs showing the linear regressions between the Log-centroid sizes of the fore- and hind limb elements. Grey areas represent the 95% CI`s of conical-tooths.

Conclusions

Our results indicate that the morphological evolution of fore- and hind limbs is not decoupled in saber-tooths, at least not to a greater extent than in conically-toothed predators.

There are two possible explanations to this pattern: (*i*) forelimb robustness is an adaptive trait, but hind limb robustness is the outcome of developmental constraints; and, alternatively, (*ii*) both fore- and hind limb robustness are adaptive. A more in-depth research is necessary to solve this.

References

1- Anyonge W. 1996. J Zool, 238:395-413. **2-** Meachen-Samuels JA, Van Valkenburgh B. 2010. PLoS ONE, 5:e11412. **3-** Lewis ME, Lague MR. 2010. In: Goswami A, Friscia A, eds. Carnivoran evolution: new views on phylogeny, form and function. Cambridge University Press, Cambridge, 411-465.