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Investigating niche evolution using skull morphology in fossil & modern Antelopes (Bovidae): a geometric morphometric approach

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Modern bovid species are distributed from equatorial rain forests to arctic tundra, where they are intimately adapted to climatic regimes and vegetational habitats. In Africa, bovids dominate the modern landscape and are prolific in the fossil record, providing important ecological information on the paleoenvironment of human evolution. Niche competition has often been used to explain the range of skull shapes seen in bovids today but has been little investigated in the past.

We here present the preliminary results of a study looking at the evolution of skull shape disparity in Bovidae over the last ∼18 million years, and its implications for biotic competition in African communities.

The dataset contains 46 cranial landmarks for 72 extant species and 21 fossil specimens representing 17 species. Landmarks were collected digitally using 3D models produced using a combination of CT and Artec 3D surface scanning. This, in conjunction with African community data and a newly calibrated phylogeny, allows us to examine drivers, rates and modes of phenotypic evolution along with exploring phenotypic disparity in relation to community diversity.

Bovid skull shape is dominated by a strong phylogenetic signal, seen in both the morphospace convex hulls and the trait evolution along the phylogeny. Moreover, fossil forms are predominantly more primitive and reside within the confines of the modern morphospace. This implies a gradual and unconstrained radiation to more extreme morphologies within the group, reflected in the selection of Brownian motion as the best fit evolutionary model for the data.

There is a statistically significant increase in the morphological distance with increasing community size in real African communities, but not in randomly drawn ones. This confirms that real communities follow specific rules of assembly and differ significantly from random associations of species.

It is also shown that the African communities are significantly more clustered morphologically than randomly drawn communities of the same size. This means that co-existing species in real communities are more similar that predicted by chance, suggesting that mutualism or facilitation may be just as important as competition in structuring African herbivore communities.

This work – using 3D techniques to study skull shape in living and fossil antelopes – provides data on the importance of inter-species interactions in the Neogene and African fossil record, with implications for human evolution.