

Lagomorph cranial evolution: A morphometric study

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In comparison to other mammals, the lagomorph skull is highly transformed, exhibiting characteristics whose adaptive significance are unclear. Among the most prominent features of the lagomorph skull are a high degree of facial tilt, elongated diastema, and facial fenestration. Overall, the morphology of the lagomorph skull shows a dramatic arching (facial tilt), in which the basicranium and the facial regions have rotated ventrally away from one another, causing an expansion of the skull roof. There is significant variation in all of these features among living leporids, such that the skull of the African hare (*Pronolagus*) is slender overall, and shows a high degree of facial tilt relative to the more robust and flattened skull of the hispid hare (*Caprolagus*). Previous workers have suggested that these three morphological features evolved as locomotor adaptations. Additionally, the fossil record of Lagomorpha suggests there is strong independence between the evolution of the basicranial and facial regions, as indicated by exceptionally preserved fossils of the mimotomid *Gomphos elkema*. For this study we build on previous qualitative observations related to the evolution of cranial morphology within Lagomorpha, and test them quantitatively with a detailed morphometric data set that spans most of crown Leporidae. We specifically test 1) whether the lagomorph skull exhibits strong modularity, where the basicranium shows independent variation relative to the facial region, and 2) whether there is correlation between the degree of facial tilt, and locomotor style, where lagomorphs that are more cursorial tend to increase the amount of facial tilt. We test these hypotheses using a data set of 114 leporid skulls, which includes measurements of skull length, nasal width, degree of facial tilt, parietal length, and basioccipital length. We also utilize phylogenetic comparative methods by integrating our data set with recently published molecular phylogenies for crown leporid. All of these analyses are interpreted within the context of the lagomorph fossil record. Our results suggest support for many earlier functional interpretations of the lagomorph skull, but also suggest that the relationship between form and function is highly complex.