Abstract:

Ontogenetic studies are crucial for understanding functional morphology, origin and adaptation of skulls in vertebrates. However, very few studies have so far released complete embryonic series focusing on skull embryonic development in species showing diverse and extreme cranial morphologies such as snakes. The wide distribution and unique reproductive and ecological behaviors of venomous vipers, including the heterogeneity in breeding and egg incubation periods in oviparous species, make this group an excellent new model for studying the diversity of skull developmental processes in snakes. Here we present the first complete description of osteocranium development in a viperine snake, Cerastes cerastes, using detailed analysis of the ossification pattern of individual bones across different embryonic stages based on high-resolution microcomputed tomography data. Particularly, we describe in details the development of the laterosphenoid from its dorsal and ventral components, dividing the trigeminal foramen into maxillary and mandibular foramina. Furthermore, our data help clarifying some controversy concerning the presence and/or origin of structures related to the snake basicranium and braincase roof. For example, our detailed description of supraoccipital development suggests that this bone derived, at least in part, from the tectum posterius, although the involvement of the tectum synoticum cannot be totally excluded. Similarly, the epiotic centers of supraoccipital ossification are confirmed during braincase development, and the ancestral lacrimal bone primordium is observed as a ventral element at the early stages of prefrontal development. Finally, our embryonic Cerastes cerastes data highlight a plausible asymmetry in snake skull development, mostly occurring in the basicranium region, but further investigations of embryonic samples and viper species would be required to confirm such phenomenon.