Using 3D reconstruction techniques to investigate intraspecific and ontogenetic variation within endocranial structures, quantifying relative cognition, sensory capabilities and anatomical evolution along the cynodont-mammal lineage.

ONE UPON A TIME...

Fossils had to be destroyed to make a model of the brain, but thankfully virtual palaeontology has come to the rescue, utilising non-destructive modeling techniques to reveal soft tissues lost to time. Such methods are of particular interest for the understudied Cynodontia, a group of therapsids that survived the end-Permian extinction event to radiate during the Triassic, with later Mammalian origination.

Cynodont brains are yet to be comprehensively studied for morphological evolution and as such, no known attempts have been made to identify intraspecific (between members of a species), ontogenetic (life cycle) and sexually dimorphic variation. With Thrinaxodon larinus exhibiting the most abundant cynodont fossil record, it thus facilitates study of brain, inner ear and neurovascular anatomy (figure 1) to identify these changes and permit further understanding of the evolution of sensory capabilities and subsequent behavioural patterns.

Moreover, the methodology provides opportunity to discover biases in digital reconstruction techniques resulting from the software used and the subjectivity of the model maker.

PAINTING THE PAST

High resolution CT scans of cynodont skulls facilitate 3D endocranial reconstruction within Avino (and comparative software, including SPIERS, VG Studio and Mimics). Linear and volumetric analyses within Avino and CloudCompare assess size and shape changes for individual parts of the brain and inner ear, with calculation of encephalisation quotients (a measure of relative cognitive ability) and best hearing frequencies possible for comparison with more recent cynodont genera and the modern Monodelphis domestica (figure 2).

CONCLUSIONS

The lack of basioccipital bones in the braincase and subjectivity during the modelling process pose some of the greatest challenges to studying cynodont endocranial anatomy. Yet analysing a larger dataset of skulls over a plethora of sizes ranges and temporal distributions will provide new insights into the evolution of the mammalian brain from its ancestral forebears.

REFERENCES


