Morphometric analysis on the bony labyrinth of Canidae (Carnivora, Mammalia)

SCHWAB, J., KRIWET, J. & PFAFF, C.

University of Vienna, Faculty of Earth Science, Geography and Astronomy, Institute of Palaeontology, Geozentrum, Althanstraße 14, A-1090, Vienna, julia.audrey@gmx.at, juergen.kriwet@univie.ac.at, cathrin.pfaff@univie.ac.at

The family Canidae exists for approximately 40 Million years and is divided into three subfamilies, Hesperocyoninae, Borophaginae and Caninae. Only the last one, the Caninae, survived to the present and is subdivided into the Canini, the dog-like canids and the Vulpini, the fox-like canids. The first dog, *Hesperocyon*, belongs to the subfamily Hesperocyoninae and existed from the Late Eocene to the Middle Oligocene in North America. They differ completely from the extant ones, in their small size and arboreal lifestyle (WANG, 1993, 1994). In the Middle Oligocene the Borophaginae evolved, represented as big hyena-like dogs with bone crushing teeth, including the biggest canid ever lived, *Epicyon*, which could have reached the size of a Grizzly bear (WANG, 1999). Extant Canidae are distributed in all habitats and nearly on all continents except of Antarctica and some oceanic islands.

The bony labyrinth is surrounded by the petrosal bone, which is one of the densest and hardest bones in the mammalian body. Therefore, the bony labyrinth can be preserved very well in the fossil record. The inner ear is divided into two main parts, the cochlea and the vestibular system for the perception of the linear acceleration. For the sense of hearing there is the cochlea which consists of three liquid filled chambers and in the mammalian ear the coils and the length of the cochlea represent a phylogenetic signal. The vestibular system is responsible for the sense of balance and consists of the three semicircular canals. These three fluid filled ducts are orientated approximately perpendicular to one another for detection of angular acceleration and movements of the head. For the spatial orientation there are the sacculus and the utriculus in the vestibular system.

Due to the fact that the bony labyrinth, with its location in the auditory bulla of dogs, has the function of sound detection and balance, this study focuses on the reconstruction of the locomotion mode and lifestyle of canids. The aim of this study is the investigation of the functional morphological signal in the bony labyrinth and whether the bony labyrinth of Canidae is conservative in its anatomy, which is quiet common in vertebrates. The anatomy of the semicircular canals is correlated with locomotion and agility in mammals, larger semicircular canals indicate a faster respectively more agile locomotion of the species, relative to their body mass. Whereas these with smaller canals have a more sluggish and slow mode of locomotion(e.g. DAVIS, 2010, SPOOR, 2007). Therefore is a correlation between the shape of the bony labyrinth and locomotion mode as well as the habitat. Just as the food

habits in connection with the speed of extinct canids can be retraced relating with the bony labyrinth.

In total, the bony labyrinths of 20 canid specimens were investigated, 12 extant and 8 extinct canids. These specimens were scanned non-invasively with a high resolution CT device. The scanning images were visualized with the software Amira and the bony labyrinths were reconstructed three-dimensionally. Measurements were taken directly on the segmented 3D labyrinths: the height, width, length and diameter of the semicircular canals; the height, width and length of the cochlea; the angle of the ducts; the length of the crus commune and the secondary crus commune These measurements were taken following previous studies (EKDALE, 2010; PFAFF et al., 2015, 2016). Prior to the statistical analysis, the measurements were standardized to have size independent values. In addition, a principal component analysis (PCA) was established to define different morphospaces and the phylogenetic influence was calculated.

Delimitable morphospaces are to be expected with some parts of overlapping regions. In connection with the shape of the semicircular canals the locomotion mode in context with habitat and speed of movement can be shown in these morphospaces and are interpreted in phylogenetic context.

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