UNIVERSITY OF LIFE SCIENCES "KING MIHAI I" FROM TIMISOARA
"YOUNG PEOPLE AND MULTIDISCIPLINARY RESEARCH IN APPLIED LIFE SCIENCES"

5-6 November 2026

Bone histology of the mandible and radius of the Black Sea harbour porpoise (Phocoena phocoena relicta)

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Abstract: The microstructural architecture of cetacean skeletal elements exhibits reduced bone density compared to terrestrial mammals, reflecting functional adaptations to high hydrostatic pressure during diving. The present study aimed to investigate the histological characteristics of the mandible and radius in the Black Sea harbour porpoise (*Phocoena phocoena relicta*), employing hematoxylin and eosin (H&E), Masson's trichrome, and van Gieson staining techniques. Morphologically, the porpoise mandible is characterized by a slender profile, a hollow caudal segment, and the absence of a distinct mandibular ramus; in contrast, the radius consists of compact bone lacking a definitive medullary cavity. Our preliminary findings demonstrate significant histological divergence from terrestrial mammalian homologs. H&E staining revealed bone trabeculae populated by osteocytes situated within osteocytic lacunae and surrounded by a collagenous matrix. Masson's trichrome staining demonstrated active osteogenesis in the deep cortical/inner layers—indicated by a high density of osteoblasts actively synthesizing collagen fibrils—whereas the superficial layers exhibited an abundance of osteocytes, indicative of higher mineralization. Subsequent investigations will extend this histological assessment to other skeletal regions of this subspecies.

• Introduction

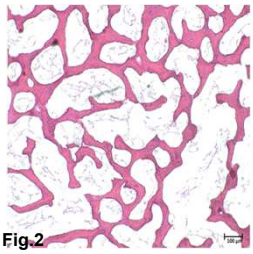
The bones of dolphins have a very high fat content, wich is useful for an increased buoyancy and display no medullary cavity in the long bones. The present study aimed to investigate the histological characteristics of the mandible and radius in the Black Sea harbour porpoise (*Phocoena phocoena relicta*)

• Material and method

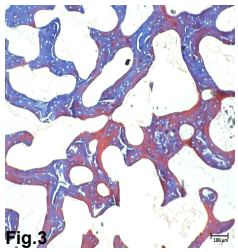
To investigate the microstructure of the radius and mandible of the Black Sea harbour porpoise (*Phocoena phocoena relicta*) we employed the following histological stainings: hematoxylin and eosin (H&E), Masson's trichrome, and van Gieson

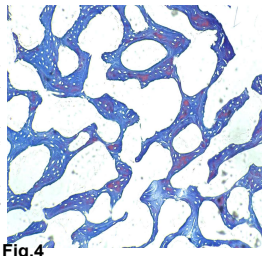
• Results and discussions


Fig.1

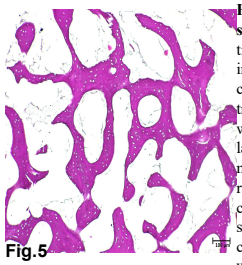

Fig.2

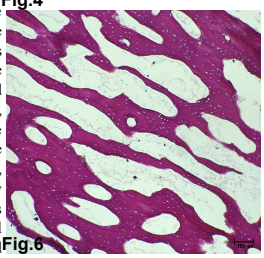
Histological section of porpoise radius (Fig.1) and mandible (Fig.2). The micrograph of cancellous (trabecular) bone stained with Hematoxylin and Eosin (H&E) reveals a network of interconnecting, eosinophilic bone trabeculae separated by wide narrow spaces. Active osteocytes can be observed embedded within their lacunae throughout the lamellar structure (Fig.1). Fig.2 micrograph exhibits a dense, highly structured network with robustly thickened bone spicules and a rich distribution of osteocytes within a continuous matrix.


Fig.3


Fig.4

Histological section of porpoise radius and mandible stained with Masson's trichrome. Fig.3 micrograph of cancellous bone tissue illustrates interconnected bone trabeculae showing differential blue and reddish-orange staining, highlighting the organization of the bone matrix and collagen distribution. Osteocyte lacunae are clearly visible scattered within the mineralized trabecular framework. Fig.4 section is marked by thinned, disconnected trabeculae and significantly widened marrow spaces with less collagen.


Fig.5


Fig.6

Histological section of porpoise radius and mandible stained with van Gieson's. In the cancellous bone tissue he mineralized bone matrix of the trabeculae is intensely stained in red/fuchsia, highlighting the dense collagenous framework of the bone. The interconnected trabecular network encloses wide, clear marrow spaces, with distinct osteocyte lacunae embedded within the lamellae (Fig.5). Compared to the radius (Fig.5), in the mandible (Fig.6) bony spicules are thicker and robust, reducing the volumetric space of the bone marrow cavities. The deep fuchsia-red matrix demonstrates superior collagen packing and advanced structural consolidation, with visible vascular channels embedded within the thickened lamellae."

Conclusions

Overall, the spatial transition from active osteogenesis in deep layers to advanced mineralization at the surface highlights a specialized skeletal architecture that markedly diverges from terrestrial mammalian homologs.