

Viability of Tympanic Bullae for Stable Isotope Research

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EPSCoR, Honors Program

Introduction

- Cetaceans
 - Odontoceti (toothed)
 - Mysticeti (baleen)



- Teeth of a stranded pilot whale

http://www.educapoles.org/multimedia/picture_gallery_detail/whales_and_dolphins_cetaceans/5/



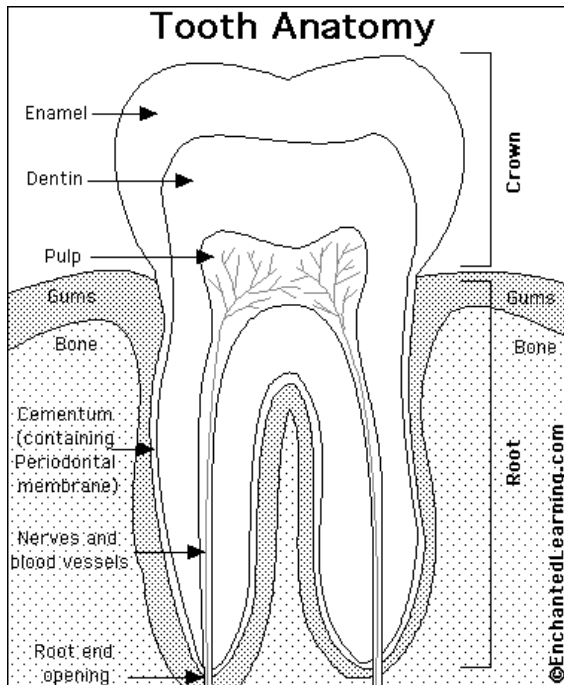
39. Whaling—Whalebone. J. V. Regd.

Baleen

http://www.coolantarctica.com/gallery/whales_whaling/0024.htm

Stable Isotope Analysis

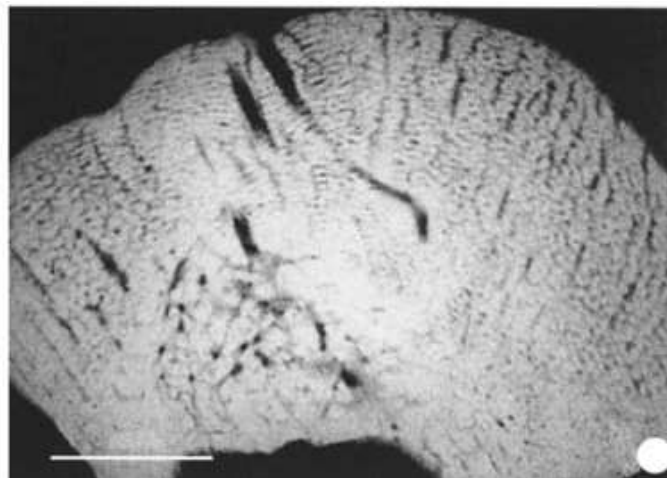
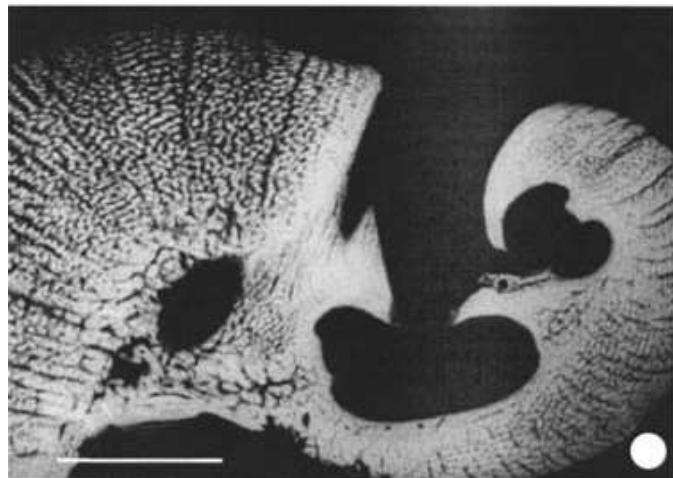
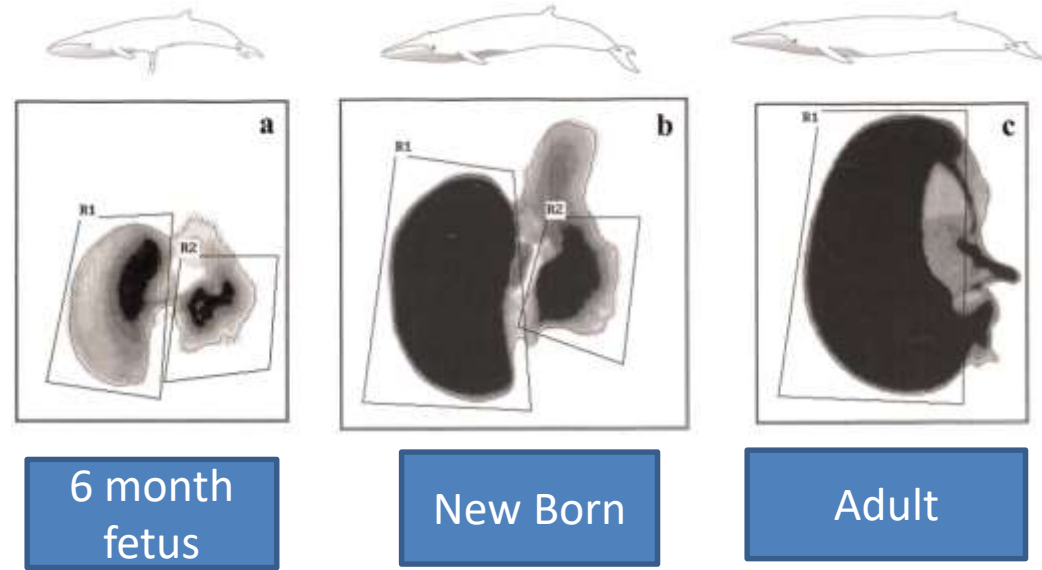
- Carbon (^{13}C , ^{12}C)-
measured from
carbonate in bioapatite
- Oxygen (^{18}O , ^{16}O)-
measured from the
carbonate and
phosphate in bioapatite



- Diet and Habitat
- Bone vs. Enamel
 - Reworking
 - Time-averaged signal

Tympanic Bullae

- Part of the cetaceans' ear
- Development

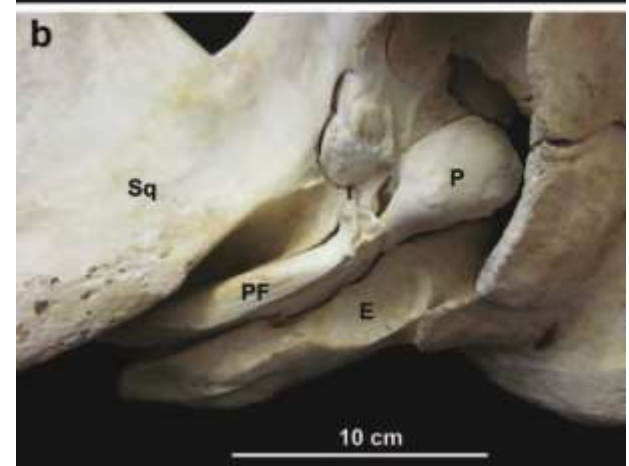
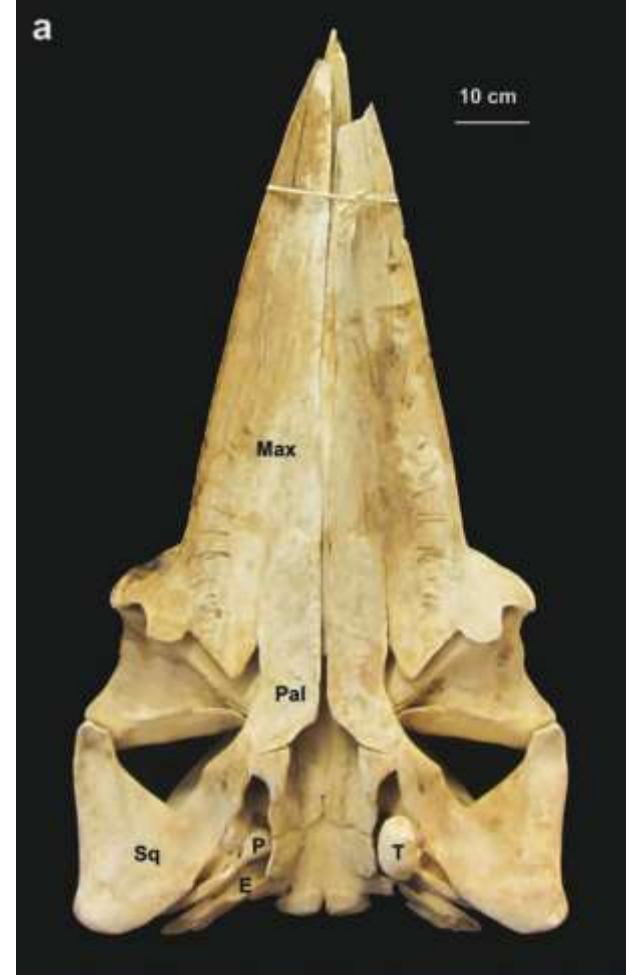


Age 0 Age 6 months

- (Cozzi et al., 2012)
- (de Buffrenil et al., 2004)

Purpose

- Comparison of bioapatites
 - $(Ca_{10}[PO_4,CO_3]6[OH,CO_3]_2)$
- Affects of marine burial conditions on bioapatite
- Paleoecological significance



- Minke whale skull(a) Ventral view of the skull, mandibles removed
- T= tympanic; P= periotic; E= exoccipital; Sq=squamosal; Pal=palatine; Max= maxilla; PF= posterior flange of the periotic.
- (Yamato et al., 2012)

Comparison

Bioapatite	Mineral Content	Organic Content	XRD CI Index	Crystal Size (A)	Porosity
Enamel	93.1±0.5%	3.3±0.3%	1.47	300-400 A	< 4%
Dentin	69.4±0.4%	24.7±0.1%	0	130-140 A	~21%
Bone (normal)	64.5±3.7%	29.0±4.4%	0	70-180 A	>18%
Bone (pachyost-eoscleritc)	66.0±2.3%	24.1±2.2%	0	90 A	~4%
Tympanic Bullae	78.0±3.3%	24.1±2.2%	0	80-100 A	~2%

Comparison of different biogenic apatites
(Churchill et al., in review)

Bone Standard

- Bone ash (Innorganic)
- Acetanilide standard (C_8H_9NO) (Organic added by weight)
 - 0%,10% and 30% by weight
- Log time scale with 1M Acetic Acid w/ Ca Acetate buffer
 - 0,2,4,8,16 and 32 hours



Burial Conditions



- Trail run
- Cow specimens
 - Bone
 - Teeth
- Temperature dependent
- Pressure dependent
- Pressure and Temperature variables
- Bullae

Application

- Sampling method
- Apply methods to well known sites
- Compare fossil tooth enamel and bullae
- Preservation quality of fossil bullae



Conclusion

- Promising results for bullae
- Mysticete evolution
- Shows insight to isotopic alteration during diagenesis
- Provides a base for using bullae in paleoecological studies

Works Cited

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