University of Zurich[UZH]

Zurich Center for Integrative Human Physiology (ZIHP)

ZIHP Special Seminar

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Wednesday, August 21, 2013, 17:00h
University Hospital Zurich, small lecture hall Pathology
PATH C22 (Entrance left at Notfall USZ)

Acoustic fatheads: Parallel adaptations for underwater hearing in whales, turtles, and sea birds

Underwater noise is a growing concern. Anthropogenic noise in the oceans is doubling per decade [1], and concerns for oceanic noise pollution parallel those for human noise induced hearing loss (NIHL).
Hearing is the most critical sensory ability for many marine animals, but we have audiometric data on very few species. Virtually nothing is known about hearing in the majority of cetaceans (whales and dolphins), sea turtles, or seabirds. Conventional audiometric studies are not possible for many marine species because of practical issues, including size, difficulty of access, and legal limitations on experiments on endangered species. Consequently, understanding hearing in marine species requires a synergy of physiology, anatomy, and biomechanical modeling.
This talk will present the latest findings from studies of ear and head tissues in whales, dolphins, sea turtles, and birds on critical adaptations for underwater hearing. Computerized tomography (CT) and magnetic resonance imaging (MRI) were used to map tissues associated with outer, middle, and inner ears. The data show bundles of specialized fatty tissues chemically differentiable from other body fats and with sound speeds consistent with sea water. In turtles, the fats form a discrete cone connecting to the columella. In birds, a fat column contacts the tympanum during dives. In whales and dolphins, the fats form bundles that connect to the tympanic membrane. These findings suggest that each group evolved soft tissue pinnal analogues that are low impedance channels for underwater sound.
The middle and inner ears of these taxa are similar to terrestrial counterparts, but in the Cetacea, we see extremes of basilar membrane development and inner ear architecture related to exceptional infra and ultrasonic hearing abilities. While these are in some ways, "super" ears, with 10- 12 octave ranges, narrow tuning and high noise tolerance, we also have found they are not impervious to hearing loss from all multiple causes, including trauma, disease, NIHL, and presbycusis.

1. Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, Ocean Noise and Marine Mammals. (2003) National Research Council, 204 pages.

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