

## Session 2pAB

## Animal Bioacoustics: C. Scott Johnson Session: Whale and Dolphin Acoustics I

Sam H. Ridgway, Chair

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## Chair's Introduction—1:00

*Invited Papers*

1:05

**2pAB1. A window into the acoustics of whales and dolphins.** C. Scott Johnson (1876 Sefton Pl., San Diego, CA 92107)

The evolutionary history of dolphins and whales is revealed through extensive adaptation of their sensory systems. Their auditory capabilities were hinted at through their acoustic repertoire after development of the hydrophone. The echolocation capabilities of dolphins, first induced by McBride in 1956, were demonstrated behaviorally in 1958, but nothing was known about their biosonar signals until technology caught up. The revelation that dolphins interrogated their environment using ultrasonic sonar pulses was complemented by demonstration of ultrasonic hearing acuity and sensitivity extending over 6 oct above that of humans. Our understanding of dolphin auditory-filter shapes and receiver-operating characteristics advanced apace with development of instrumentation for underwater acoustics. These findings formed a basis for contemporary research on cetacean psychophysics, anatomy, and acoustical ecology, which continues to reveal the intricacies and elegance of the auditory systems and capabilities of dolphins and whales.

1:25

**2pAB2. The slippery slope of a Johnsonian ear: Natural variability versus natural loss.** Darlene R. Ketten (Biol. Dept., Woods Hole Oceanograph. Inst., Woods Hole, MA 02543 and Harvard Med. School, Massachusetts Eye and Ear Infirmary, Boston, MA 02114), Patrick W. B. Moore (Naval Command, Control and Ocean Surveillance Ctr., San Diego, CA 92152-6254), Lois A. Dankiewicz (Sci. Applications Intl. Corp., San Diego, CA), Randall L. Brill, and William Van Bonn (NCCOSC, San Diego, CA)

The normal audiogram of the bottlenosed dolphin, first established by Johnson [C. S. Johnson, in *Marine Bio-Acoustics*, edited by W. N. Tavolga (1967), pp. 247–260], has been pivotal to nearly three decades of underwater echolocation research, most of which focused on the mechanisms and analytical limits of dolphin sonar. One important aspect of dolphin hearing that has escaped investigation is what are normal audiometric ranges, or, more important, how to determine whether differences seen in audiometric responses of a new animal represent normal variants or a pathologically impaired ear. In this study, radiologic data and audiograms from animals tested by Brill *et al.* (this session) were compared with results from postmortem histologic analyses of ears from dolphins with known hearing losses. Structural alterations in the ear x rays of the older, male dolphins were consistent with obstructive disease processes and demineralization of temporal bones from dolphins with conductive and progressive sensorineural loss. These findings imply that specific features of the older male's audiogram, such as the relatively flat, elevated, midfrequency thresholds and the rapid decrement of high-frequency responses, are diagnostic correlates for chronic infection and age-related retrograde neural loss. [Work supported by ONR N000149310940.]

1:45

**2pAB3. Evidence of hearing loss in an Atlantic bottlenose dolphin (*Tursiops truncatus*).** Randall L. Brill, Patrick W. B. Moore (NCCOSC RDTE DIV. D351, 49650 Acoust. Rd., Rm. 108, San Diego, CA 92152-6254), Lois A. Dankiewicz (Sci. Applic. Intl. Corp., San Diego, CA 92121-1578), and Darlene R. Ketten (WHOI, Woods Hole, MA 02543)

Auditory thresholds were behaviorally measured for two Atlantic bottlenose dolphins (*Tursiops truncatus*); a 14-year-old female, and a 33-year-old male. Stimuli were delivered directly to the lateral sides of the lower jaw via jawphones as opposed to free-field broadcasts. The female's audiogram clearly reflects the standard for this species [C. S. Johnson, in *Marine Bio-Acoustics*, edited by W. N. Tavolga, pp. 247–260 (1967)]. Previous thresholds for the male measured at age 26 indicated a hearing loss in the left ear of approximately 2 to 3 dB [*re*: 1  $\mu$ Pa] between 4 to 10 kHz, which were considered unremarkable. At age 33, the same male demonstrates distinctive losses. The right ear shows a 16–33-dB loss over 10–40 kHz, the range of best sensitivity. Above 55 kHz, the right ear is 2–3 dB more sensitive than the left. Both ears then decline to an upper frequency cutoff of approximately 70 kHz below the standard 120 kHz. Hearing losses due to age have been reported for this species [S. H. Ridgway and D. A. Carder, *J. Acoust. Soc. Am.* **101**, 590–594 (1997)]. The data reported in this paper suggest both uni- and bilateral hearing losses in the male which may be the result of age, impairment of the auditory system, or both.