29. The sonar equation. Comparison of bat and whale sonar

Peter T. Madsen, Dept. of Zoophysiology, University of Aarhus, Denmark

Annemarie Surlykke, Biology, SDU, Odense, Denmark

Echolocating animals ensonify their surroundings with ultrasonic sound pulses and listen for returning echoes to navigate, avoid obstacles and find food. Biosonars can, like all sonar systems, be evaluated by the sonar equation to estimate at what range an echolocating animal can detect a backscattering object with sound. Detection of an ensonified target is either limited by noise or by overlap with echoes arriving from other unwanted targets, so-called clutter. The sound pulses emitted by biosonar systems are directional and have high source sound pressure levels (SL), that, when propagating away from the vocalizing animal, are attenuated by geometric spreading and frequency-dependant absorption that, in combination, makes up the transmission loss (TL). The backscattering properties of the ensonified target determine how much of the incident sound energy impinging on the target will be reflected back to the echolocating animal. The ratio between the sound level impinging on the target and the backscattered sound level at a range of 1 meter on the same acoustic axis defines the target strength (TS) of the target. The generated echo is further attenuated (TL) when propagating back to the auditory system of the animal where detection depends on the detection threshold (DT) given by the received echo to noise/clutter ratio. This talk will outline these concepts and provide examples of how echolocating whales and bats have adapted their biosonars to the different physical properties of air and water while displaying a striking convergence in their echolocation behaviour during prey capture.