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T. Aran Mooney: Cephalopod Hearing

Cephalopod Hearing Research

We are currently looking at the hearing and neuroanatomy of squid and cuttlefish including their sensitivity to near-field particle motion stimuli. Upon discovery that squid can detect sounds we are investigating if and how they might use this cue.

Sound detection in squid

Abstract

Although hearing has been described for many underwater species, there is much debate regarding if and how cephalopods detect sound. Here we quantify the acoustic sensitivity of the longfin squid (Loligo pealeii) using near-field acoustic and shakergenerated acceleration stimuli. Sound field pressure and particle motion components were measured from 30 to 10,000? Hz and acceleration stimuli were measured from 20 to 1000? Hz. Responses were determined using auditory evoked potentials (AEPs) with electrodes placed near the statocysts. Evoked potentials were generated by both stimuli and consisted of two wave types: (1) rapid stimulus-following waves, and (2) slower, high-amplitude waves, similar to some fish AEPs. Responses were obtained between 30 and 500? Hz with lowest thresholds between 100 and 200 ?Hz. At the best frequencies, AEP amplitudes were often >20 µV. Evoked potentials were extinguished at all frequencies if (1) water temperatures were less than 8°C, (2) statocysts were ablated, or (3) recording electrodes were placed in locations other than near the statocysts. Both the AEP response characteristics and the range of responses suggest that squid detect sound similarly to most fish, with the statocyst acting as an accelerometer through which squid detect the particle motion component of a sound field. The modality and frequency range indicate that squid probably detect acoustic particle motion stimuli from both predators and prey as well as low-frequency environmental sound signatures that may aid navigation.

Mooney, TA, Hanlon, RT, Christensen-Dalsgaard, J, Madsen, PT, Nachtigall, PE Ketten, DR. 2010. Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: sensitivity to low-frequency particle motion and not pressure. Journal of Experimental Biology. 213: 3748-3759.

Sedating cephalopods

Enlarge image

Abstract

Long-duration anesthetization of squid (*Doryteuthis pealeii*)

Cephalopods, and particularly squid, play a central role in marine ecosystems and are a prime model animal in neuroscience. Yet, the capability to investigate these animals *in vivo* has been hampered by the inability to sedate them beyond several minutes. Here we describe methods to non-invasively anesthetize *Doryteuthis pealeii*, the longfin squid, for up to 5 hrs using a 0.15 M magnesium chloride ($MgCl_2$)-sea water solution. Sedation was mild, rapid (< 4 min) and duration could be easily controlled by repeating anesthetic inductions.. The sedation had no apparent effect on physiological evoked potentials recorded from nerve bundles within the statocyst system, suggesting the suitability of this solution as a sedating agent. This simple, long-duration anesthetic technique for the squid, *D. pealeii*, opens the possibility for longer *in vivo* investigations on this and related cephalopods, thus expanding potential neuroethological and eco-physiology research for a key marine invertebrate group.

Mooney, TA, Lee, WJ, and Hanlon, RT. 2010. Long-duration anesthetization of squid (*Doryteuthis pealeii*). Marine and Freshwater Behavior and Physiology. 43(4): 297–303

Reviewing hearing

Book chapter in press

We reviewed the definitions of hearing reminding folks that:

"There is no inherent reason why the definition of 'hearing' should be taxon specific. It arguably should be based on the ability to detect acoustic stimuli per se and on the ability to analyze acoustic properties of a stimulus. Thus, this should not be a discussion about whether hearing fits squid perceptual mechanisms but whether squid perceptual abilities fit the broader scope of 'hearing.' "

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