THE EFFECTS OF PHOTIC ENVIROMENT ON MARINE MAMMAL MELANOPSIN

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Abstract

Studies of the retina from cetaceans (dolphins and whales) have revealed that it is quite different from its terrestrial counterparts in that its visual pigments are strongly blue-shifted (Fasick et al., 1998; Fasick & Robinson, 2000). The blue-shifted rod and cone pigments, as well as the lack of color vision found in the cetacean eye, are believed to be associated with the relatively monochromatic blue light available to the animals at foraging depth. A recently discovered class of retinal photopigment, melanopsin, has been shown to be closely associated with photoreception as well as directing the pupil response to light (Provencio et al., 1998). Our study is designed to determine which photic environment, surface or depth, is responsible for the spectral tuning properties of cetacean melanopsins. To date we have sequenced approximately 900 bp of the dolphin melanopsin cDNA. Alignments with mammalian melanopsin nucleotide sequences show that dolphin melanopsin, like the dolphin retinal visual pigments, is most closely related (90 % identity) to melanopsin from even-toed ungulates, such as the domestic cow (Bos taurus). Once the full length dolphin melanopsin cDNA is cloned, we will express, reconstitute and purify the resulting pigment to determine its absorption spectrum and compare it to the absorption spectrum determined from R. aurora melanopsin.

Background

- Melanopsin is a novel photopigment found in specialized photosensitive ganglion cells of the retina.
- Although melanopsin is not involved with image formations, it is responsible for the light activation of the G-protein Gq typically found in invertebrates photoreceptors.
- Melanopsin is composed of an opsin protein covalently attached to the light absorbing chromophore 11-cis retinal.
- Melanopsin, when activated by light, sends signals through the axons of ganglion cells, to specific parts of the brain including the olivary pretectal nucleus (a center responsible for controlling the pupil of the eye) and the suprachiasmatic nucleus of the hypothalamus (the master pacemaker of circadian rhythms).
- Studies of the retina from cetaceans (dolphins and whales) have revealed that it is quite different from its terrestrial counterparts in that its visual pigments are strongly blue-shifted.
- The blue-shifted rod and cone pigments and lack of color vision found in the cetacean eye are believed to be associated with the relatively monochromatic blue light available to the animals at foraging depth.

Materials and Methods

- Align subsets of known vertebrate melanopsin amino acid and nucleotide sequences
- From these alignments, design degenerate oligonucleotide primers for use in PCR amplification of marine mammal melanopsin polynucleotide sequences
- PCR amplify from a dolphin retinal cDNA library and dolphin gDNA to determine if a) the dolphin possess a melanopsin-like gene and b) is so if the gene is transcribed into a functional mRNA transcript
- Sequence positive PCR products
- Incorporate sequence data into blast searches for identification based on homology
- Perform sequence alignments and construct phylogenetic trees to determine the evolutionary relationships to other vertebrate melanopsins
- Clone, sequence & express full-length & truncated carboxyl-tail dolphin melanopsin cDNAs
- Perform phylogenetic analyses of full-length dolphin melanopsin nucleotide and amino acid sequences with those of other vertebrate melanopsins to determine relatedness and evolutionary distances
- Perform sequence analyses to compare the evolutionary rates between the dolphin melanopsin nucleotide and visual pigment opsin nucleotide and amino acid sequences
- Clone, sequence and express full-length & truncated melanopsin cDNA from cetaceans occupying different photic environments to understand which selection pressure, photoreentrainment or pupillary light response, most influences the melopsin protein
- Compare marine mammal melanopsin sequences and absorption maxima to each other, as well as with bovine melanopsin, to identify candidate sites for site-directed mutagenesis in order to determine the amino acids involved with spectral tuning of the melanopsin pigments

References
