Seeing in a New Light: Adaptive Changes in Opsin Proteins in Antarctic Icefish

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Vision, one of the most important senses for survival, depends on the detection of light by the eye. Antarctic icefish live in an environment where there is no sunlight for six months of the year, and where surface ice or deeper depths limit exposure to the longer wavelengths on the electromagnetic spectrum. The wavelengths of light detectable by the eye are defined by proteins in the rods and cones of the retina called opsins. Changes in specific amino acids, or “tuning sites”, in opsin proteins have been shown to shift their sensitivity to shorter or longer wavelengths, affecting what colors of light the eye is able to perceive. I hypothesized that Antarctic icefish have evolved changes at opsin tuning sites that shift their sensitivity to detect the shorter wavelengths of light that are more abundant in the Antarctic environment. To test this hypothesis, I analyzed the amino acid sequences of three different opsin proteins (SWS1, SWS2 and LWS) across 13 Antarctic icefish species, compared to related, non-Antarctic fish. I found that three icefish species have key tuning site changes in two different opsins that shift their sensitivity towards shorter wavelengths of light. These results increase our understanding of how animals evolve new sensory functions to adapt to their environments. Furthermore, since Antarctica is warming faster than the global average, my project may help make important predictions about the effects of climate change on Antarctic ecosystems.

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