The Black Dragonfish

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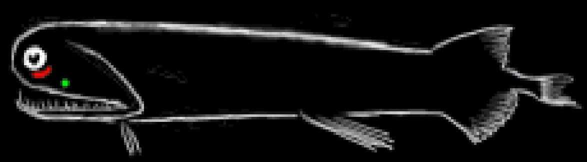
One special family of deep-sea fishes carries around its own "night vision" ability. This page explains how and why it uses this amazing adaptation.



Almost all marine bioluminescence is blue in color, for two related reasons.

First, blue-green light (wavelength around 470 nm) transmits furthest in water. The reason that underwater photos usually look blue is because red light is quickly absorbed as you descend.

The second reason for bioluminescence to be blue is that most organisms are sensitive only to blue light -- they lack the visual pigments which can absorb longer (yellow, red) or shorter (indigo, ultraviolet) wavelengths.

A notable exception to this "rule" is Malacosteid family of fishes (known as Loosejaws), which produce red light and are able to see this light when other organisms can not.

The light produced by species like *Malacosteus, Aristostomias,* and *Pachystomias* has such long wavelengths that it is nearly infrared and is barely visible to a human eye. In addition, they can produce typical blue-green light from a separate organ.

Why Red Light

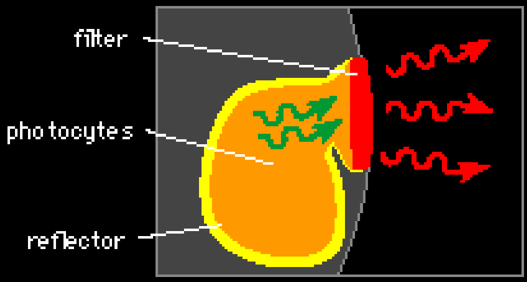
The ability to produce red light, gives the Malacosteidae a huge advantage in the deep sea. Although the light doesn't travel very far, it lets them see their prey, without alterting the prey or any potentially curious predators. So these fish produce a red signal meant only for themselves, and a blue-green signal, perhaps used as a warning to others.

There are two problems that need to be solved for the fish to make use of its "night vision". First, it has to produce red light, and then it has to be able to see it.

Making the Light

To produce red light, the Malacosteidae use a combination of filters and fluorescent material.

Cross section through the red light organ of Malacosteus. Photo ©1998 Peter J. Herring



After Denton, et al. (1985)

Light in the photophore (a light-producing organ) doesn't start out deep red. Initially the light has a short wavelength (red is long-wavelength light). This light is absorbed by a fluorescent pigment inside the photophore, which takes the energy and re-emits it as red light (wavelength = 626 nm). Before it shines out into the sea, the light is also filtered until it has a wavelength of around 705 nm.

Seeing the Light

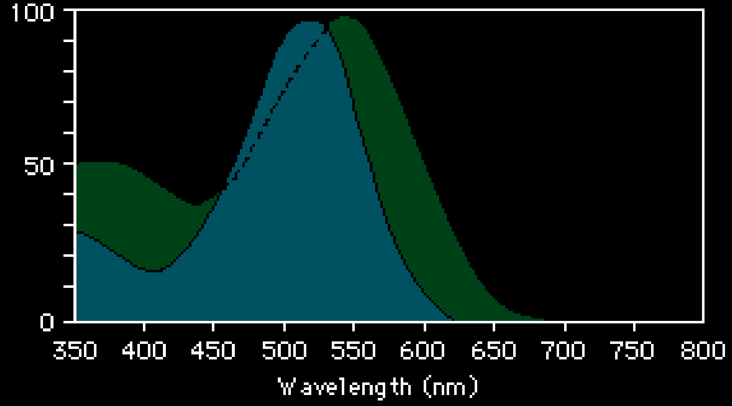
Because most fish do not have a visual pigment which is sensitive to red (705 nm) light, the Malacosteidae must have an additional adaptation to make them sensitive to the red light. It turns out that even this specialized problem has been solved in two different ways.

In the genus *Aristostomias* the solution is perhaps what you might expect: the fish bears an additional set of photosensitive pigments, which can pick up light in the red region.

Fish in the genus *Malacosteus,* however, show no sign of having these special pigments. Their eyes only have pigments capable of detecting blue and green light (the blue and green graphs below). So the way they see the red light is even more complicated.

Malacosteus solves the problem by converting the red light back into visible light by a sort of "reverse fluorescence", illustrated below.

If the image is not animated, try reloading it.



In this figure (adapted from Douglas, et al., 1998) the sequence of events moves from right to left. Each colored area shows the wavelength of light which is either emitted (red) or absorbed (yellow, green, blue). First, the red light emitted by the fish is absorbed by a pigment which acts like an antenna. By capturing the energy in this way, the sensitizing pigment can transfer the energy to the visual pigments, which are usually only sensitive to blue-green light.

Not only does the antenna pigment function like a plant's chlorophyll, harvesting energy from photons, but it actually **is** a derivative of chlorophyll!

References and Additional Reading:

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