Dim-light photoreceptor of fish and the photoresponse upon illumination with LEDs of different wavelengths

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The visual systems of the fish living under different light environments seem to have evolved to adapt photoreceptor cells, of which an absorption maximum of the photoreceptors matches the ambient light conditions available in their habitat. To study the spectral characteristic of the visual pigments, a major determinant in eliciting a response to light in fish, rod outer segments (ROS) were purified from the chub mackerel *Scomber japonicus*, a coastal pelagic species found to depths of 300 m, as well as from the rock bream *Oplegnathus fasciatus* inhabiting in shallow coastal regions. Difference spectral analysis of the lysates indicated an absorption maximum of the rhodopsin around ~500 nm in both fish. To furhter examine the spectral sensitivity of the photoreceptors and its association with photoresponse, monochromatic light-emitting diode (LED) modules with different wavelengths (*e.g.* violet, 405 nm; blue, 465 nm; cyan, 505 nm; green, 525 nm; amber, 590 nm; and red, 627 nm and 655 nm) were constructed. Chromophore decay analysis upon illumination with each LED showed the highest sensitivity of the photoreceptor upon illumination with the 505-nm cyan LED, followed by LEDs with wavelengths of 525 nm > 465 nm > 405 nm > 590 nm > 655 nm. Behavioural responses of the fish were monitored by an underwater acoustic camera and a video tracking system analysing the speed and frequencies of the fish acclimated in the dark and upon LED illumination. Compared to an average speed of mackerel movement in the dark (set at 100%), increases of 103.48 ± 1.58, 109.37 ± 5.29, 118.48 ± 10.82, and 109.43 ± 3.92 %, respectively, were noticed in the relative speed of the fishes upon illumination with red, blue, cyan, and white LEDs. Similar rate of wavelength-dependent responses was also observed in a frequency analysis. All the results indicate that an LED emitting a peak wavelength close to an absorption maximum of rhodopsin is more effective at eliciting a response to light.