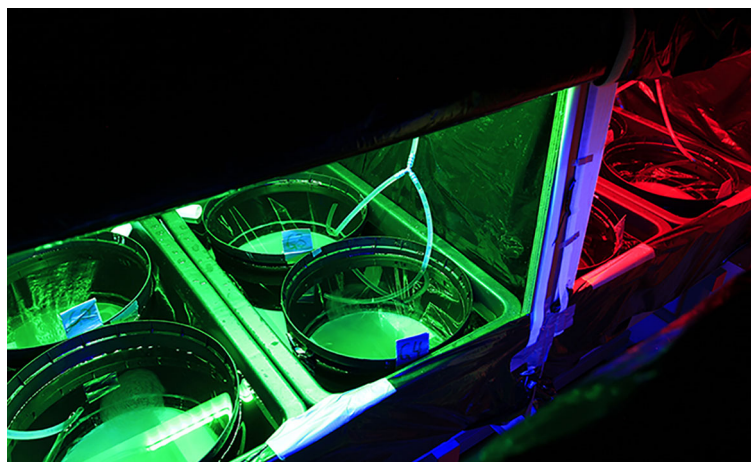


## INSIDE JEB

### Cod eyes don't change their expression



Experimental setup of different wavelength lights using narrow wavelength LED lights. Photo credit: Christian Irgens.

Aquatic light is a fickle lover. Wavelengths of light hit the water and are swiftly absorbed and scattered. The angle of incoming light, the chopiness of water, the murkiness, the depth – these alter how objects are perceived by aquatic animals. The Atlantic cod feeds near the water's surface when young and descends to pursue ever-larger prey as it gets older. Consequently, one might think it necessary for the cod's eyes to adapt throughout time to these dramatic changes in the quantity and quality of light. Ragnhild Valen, at the University of Bergen, Norway, and her collaborators found in previous studies that cod had lost the genes encoding the photoreceptor proteins (opsins) that allowed them to see UV and red light, and the genes that allowed them to see blue and green light had duplicated in their genome. And yet, even without the genes encoding the UV and red light opsins, cod are still able to see well enough to feed and mate in a range of light conditions. Valen was intrigued: 'Although cod had lost major genetic potential for absorbing the

extreme parts of the light spectra', she explains, 'it used different subsets of its remaining opsins depending on life stage.' So, how were the cod accomplishing this ocular feat?

Valen and her colleagues set out to decipher the cod's stunning ability to see without the full complex of opsin genes found in many other ray-finned fishes. Their first objective was to determine whether the light that cod were exposed to as they grew from hatchling to larvae changed the expression of the genes that produce the opsin proteins. They raised groups of young Norwegian coastal cod, a type of Atlantic cod, and exposed each to a different type of light as they were growing: groups that experienced white, blue, green or red light during the day and no light at night and another group that had constant white light and no darkness. Surprisingly, the type or duration of light that the cod were exposed to didn't change what light proteins were present in their eyes. They didn't seem to adapt to their visual environment.

Next, the researchers looked at the eyes of maturing Norwegian coastal cod to see whether males and females had different opsins when they were ready to reproduce. Valen explains, 'We knew from other species that vision could be important in mate selection'. However, there were no differences between males and females, and the opsins present in the eyes of the mature fish were the same as those in the younger fish.

Finally, the team looked at the eyes of another type of cod, the migrating Northeast Arctic cod. They captured these cod in the early autumn, when the cod experience 24 h of sun, and in the winter, when the sun never rises above the horizon. As the number of daylight hours is dramatically different during these two seasons, Valen thought perhaps the cod's eyes would need to adjust in order for the animals to feed efficiently. Although the fish's eyes contained the same amounts and types of opsins during the two seasons, Valen was excited by something else she found. Although the Norwegian coastal cod and the Northeast Arctic cod have the same opsin genes, their opsin expression was different.

Valen hopes to explore the population differences, and its consequences, further. 'We still do not know whether this is caused by genetic differences affecting opsin regulation and/or whether this is triggered by a difference in environment,' she says. For now, the mysteries of cod vision are just out of sight.

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