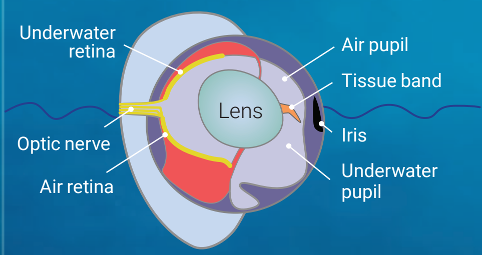
# Aquatic Vision

In the underwater world, where light can be limited and visibility murky, the eyes of several aquatic creatures have adapted—possibly providing advantages over predators and prey. Here we explore some of those adaptations. For a look at special features in insect vision, see this month's cover story (p. 24).

## Split vision

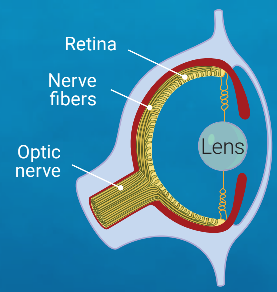
Living at the water's surface, the four-eyed *Anableps anableps* has two eyes that are split in half by a tissue membrane, providing two different optical axes in a single eye and allowing it to see underwater and above the surface at the same time.




*The upper half of the eye is adapted for vision in air and the lower for vision in water. A change in lens thickness accounts for the difference in refractive indices in air and water.*

## Camera vision

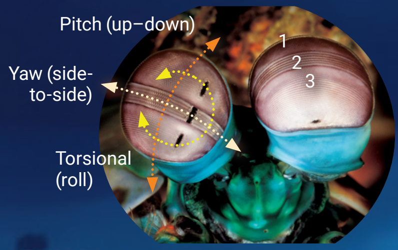
The cephalopod eye, including that of the octopus, is focused through movement similar to a camera lens, allowing it to create a detailed visual assessment of an object's shape, texture and color—perfect for producing accurate skin camouflage.




*The fixed octupus eye lens focuses by musclular contractions, which move the lens closer to or farther from the retina, rather than changing the lens shape as in the human eye. It also has more than double the optic nerves, and the retinal axons pass over the back of the retina, avoiding a blind spot.*

## Dynamic polarization

The mantis shrimp, including *Odontodactylus scyllarus,* has a complex visual system with 12–16 types of photoreceptor cells and the ability to perceive wavelengths of light ranging from deep UV to far-red and polarized light—possibly enhanced by circular polarization.

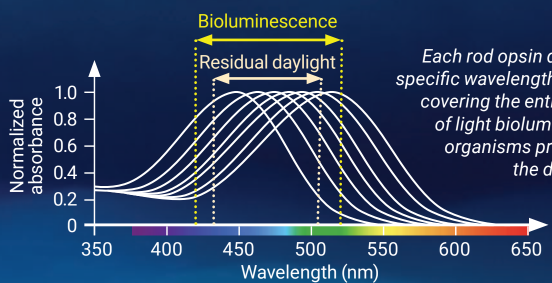



*Left: Rotational degrees of freedom of mantis shrimp eyes relative to the external environment help improve polarized vision.*

*Right: Each eye is divided into three regions, enabling mantis shrimp to see objects with three parts of the same eye for trinocular vision.*

## Bioluminescence

Deep in the dark ocean, 2000 m below the surface, the silver spinyfin, *Diretmus argenteus*, has developed rod photoreceptors with light-sensitive proteins, called opsins, enabling it to see the multicolored bioluminescent light emitted by predators and prey.




*Each rod opsin detects a specific wavelength of light, covering the entire range of light bioluminescent organisms produce in the deep sea.*

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