Elephant Seal Vision

The range of visual environments experienced by the elephant seal – on land and in the water, in daylight and in deep ocean darkness – has led to a number of remarkable adaptations.

Clear vision both on land and in water is a problem because some of the focusing power of an eye occurs at the cornea. Indeed, for humans and other land mammals most of the focusing occurs there, with the interior, adjustable lens used for fine-tuning. It is the difference in the index of refraction (related to the speed of light) of air and of the cornea and the curvature of that boundary that gives rise to that focusing. However, the index of refraction of water and the cornea are nearly identical so we see much less clearly under water without the aid of goggles.

The eyes of seals and sea lions have a much flatter cornea so that little focusing takes place at that surface. Instead, a much more powerful, almost spherical lens internal to the eye does most of the focusing. Thus, while the elephant seal's eye is optimized for underwater viewing, vision is reasonably acute on land as well.

A number of adaptations accommodate the very great difference in the surface and underwater environment. Seals and sea lions have a highly reflective retina, like those observed in cats and nocturnal land mammals, which make their eyes seem to glow at night. This feature causes the light to pass through the sensory cells twice – once on the way in, once after reflecting on the retina. Another accommodation is an enhanced range of pupil size. Northern elephant seals have a 400-fold range in pupil size, greater than that of other seals and sea lions and 25 times that of humans. The retina of seals has relatively few cone cells resulting in limited but observed color vision but greater sensitivity to light because of the high proportion of the more sensitive rod cells. Sea lions apparently have no color vision. The northern elephant seal eye is about ten times as sensitive as the human eye.

Not only does the intensity of light drop rapidly with depth in the ocean but the water filters out much of the red, orange, and yellow light – the longer wavelengths of the visible spectrum. Rod cells of sea lions are most sensitive to blue-green light, but in animals that dive deeper, the maximum sensitivity shifts to shorter, bluer wavelengths, with the northern elephant seal, the sperm whale and the beaked whale having the shortest wavelength of maximum sensitivity. That wavelength of maximum sensitivity is close to the wavelength of the bioluminescence of many creatures that dwell at the foraging depths of the elephant seal. That bioluminescence may not only illuminate its source but other creatures swimming at that depth as well.

Finally, an important difference in elephant seal vision is dark adaptation time. For humans, going from bright daylight to illumination at the limit of human vision requires approximately 24 minutes. The harbor seal, with a little less than twice the sensitivity of humans, requires about 16 minutes; and the California sea lion with three times human sensitivity requires about 14 minutes. The northern elephant seal, with ten times the human sensitivity requires only three to four minutes! Clearly, this rapid accommodation is necessary if a deep diving seal is to reach foraging depth with maximum vision capability.

Prepared by Brandt Kehoe

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