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Early eyes could only see light and shade

The complex, modern eye had simple beginnings, says S.Ananthanarayanan.

A group of cell biologists in Germany have found how the primitive sea creature, zooplankton, shows photosensitivity that marks an early stage in the development of the eye.

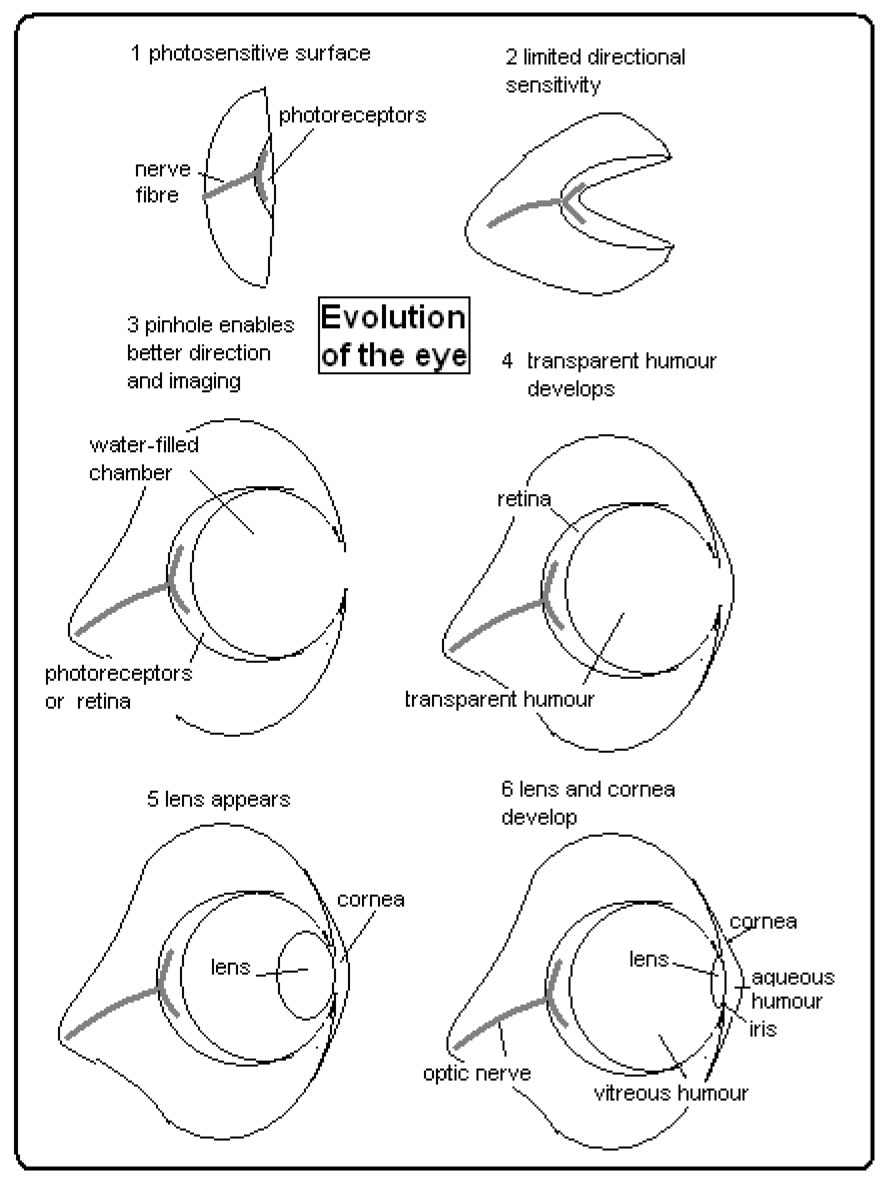
Darwin’s remark

The one question that even Charles Darwin, the father of the theory of evolution conceded was that it was difficult to understand how natural selection could have led to the development of so complex an organ as the eye – and seemingly with the same origin, in so many different kinds of animals. At first glance the idea seems “absurd in the highest possible degree”, Darwin remarked. But still, he did consider that it was feasible and he even suggested the steps by which “an optic nerve merely coated with pigment, and without any other mechanism", could evolve to "a moderately high stage of perfection".

This was over a century ago. Today, the eye is considered to have developed fairly quickly during the ‘Cambrian explosion’, a short period some 540 million years ago. This period, as seen from fossil records, marked a distinct change in the nature and variety of life forms of the earth and has been so named after the region in Scotland where the fossils were found. Before this period, life forms were mostly single-celled and, at best, arranged in colonies. But in just over 70 or 80 million years, there was ‘breakneck’ evolution and life forms began to resemble what we have in modern times. Indeed, this great development over a short time, in evolution terms, was regarded by Darwin as a serious question to be answered.

Arms’ race

In the development of eyes, it is considered that the first appearance of visual ability would have conferred so great a survival advantage, that selection for this ability was quick and decisive, leading to rapid improvements, rather like one nation acquiring arms leads all others to do the same! This would explain the rapidity of the development, which left all species with a similar eye structure and genetic bases. But the question can still be asked of how the development started



In attempting an answer, what we have to start with are the ***proto eyes***, which were just light sensitive spots in unicelular animals.

These so-called. ‘eyespots’ could only make out ambient light and could regulate circadian (ie, night and day) rhythms, but were useless to distinguish shapes or even the direction of the source of light.

But a patch of such spots would get much more effective if it gradually depressed into a cup, which could distinguish the direction of light.

Allow for such a depression, and evolution would force the deepening of the depression and then all the refinements, driven by the ‘arms race’ to develop vision.

The mechanism

The earliest predecessors of eyes were the photoreceptor proteins that react to light. These ***‘opsin’ proteins***, which initiate a nerve impulse when exposed to light, are carried in hairs, or ***cillia***, to maximize their surface area. In higher animals, these photoreceptors are in the retina and they activate the optic nerve, which conveys the signal to the brain.

In lower animals, like the jellyfish, which have elaborate eyes but no brain, the message is passed directly to muscles. During the Cambrian explosion, the development of eyes accelerated with great advances of the lensing and detection systems. One writer even suggests that it was the development of eyes that brought about the evolutionary explosion in the Cambrian period!

Evidence in Plankton

A group of scientists in Germany, who have reported their work this week in ***Nature***, studied aquatic zooplankton, which is known to drift between surface and deeper water in the sea depending on light conditions and represents the biggest transport of biomass on earth. But, for all its importance, the mechanism by which this movement occurs has not been understood.

Detlev Arendt and colleagues found that the action of light on the two-celled 'proto eyes' of the plankton spurred beating of adjacent cilia, or hair-like structures, through release of neruro-transmitter chemicals. This beating increased resistance to water flow and affected the helical swimming trajectories of the plankton, leading to movement towards light.

The species of plankton studied were some of the oldest species known and date back to the Cambrian. The findings thus represent the ancient mechanism that evolution honed into the early eyes of those Cambrian species, which were the ancestors of modern animals and evolved eyes, lenses, opticians, sunglasses, cameras and telescopes!

The box jellyfish has an active visual system, with four sets of eyes, in clusters centered on each of the four lateral faces of its bell

Each cluster consists of six eyes: Four simple photoreceptors that can tell light from dark, and two more sophisticated "camera eyes"--an "upper" and a "lower"-- cornea, lens and retina. The lower camera eye has an iris which expands and contracts in response to light

This camera eye even has a spherical lens which can form an almost distortion-free image, although it does not form a focused image on the retina. We still do not know how this visual information is processed by the ***Cuboza*** jellyfish as they have no central nervous system.

Some scientists have proposed that jellies have a "nerve net" that would allow the processing of visual cues. But the arrangement does help the jellyfish avoid obsacles when it swims!