Your eyes are half a billion years old

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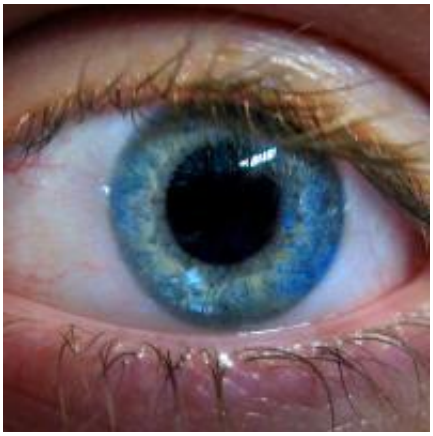

Look after your eyes – they are at least half a billion years old, and a good deal older than your brain. The eyes are one of our most remarkable and precious organs, yet their origins have been shrouded in mystery until quite recently, explains Professor Trevor Lamb of The Vision Centre and Australian National University, who has devoted more than 30 years to investigating their secrets.

Prof. Lamb has just published a major scientific review of the origin of the vertebrate eye and vision, summarising the findings of hundreds of scientists round the world.

"There are profound questions about the eye which are still not easy to answer because it appeared so very long ago," he says. "Why did the eye

develop? Why are there many different kinds of eye, including one for insects and crustaceans – and one for vertebrates like us?

"What kinds of animals needed these incredible seeing machines and how did they use them? How deep into time do the roots of vision go? How has the eye influenced our subsequent development?"

The deep origins of 'sight' go back more than 700 million years when the earth was inhabited only by single-celled amoeba-like animals, algae, corals and bacteria. At this time the first light-sensitive chemicals, known as opsins, made their appearance and were used in rudimentary ways by some organisms to sense day from night.

Ancient cells already had signalling cascades that sensed chemicals in their environment, and the advent of opsins allowed them to sense light. "But these animals were tiny, and had no nervous system to process signals from their light sensors," he explains.

Over the following 200 million years those simple light-sensitive cells and their opsins slowly and progressively became better at detecting light – they became more sensitive, faster, and more reliable – until around 500 million years ago they already closely resembled the cone cells of our present day eyes.

"The first true eyes, consisting of clumps of light-sensing cells, only start to show up in the Cambrian, about 500 million years ago – and represent a huge leap in the evolutionary arms race," Prof. Lamb says. "Creatures that could see clearly had the jump on those that couldn't.

"For example there is Anomalocaris, a metre-long predator like a giant scorpion - the "Jaws" of its day - which had eyes the size of marbles, with which to navigate the ancient seas and locate its prey. This beast, which employed the 'insect eye' model with many facets, had no fewer

than 16,000 facets containing vision cells, in each eye.

"This generates an avalanche of information, known as optic flow, running from the eyes and along the creature's nervous system. This all has to be processed, so we also begin to see the rapid development of a central nervous system able to cope with such immense amounts of data, continually provided by the eyes and other sensory organs from the world around the animal.

"For the first time animals begin to 'see' the complex landscape which they inhabit."

Our type of eye, a single globe packing in millions of photoreceptors, first starts to emerge between 500-600 million years ago. This was the crucial moment for our vision system, Prof. Lamb contends.

"Baby sea squirts have a simple eyespot called an ocellus, which is basically a bundle of photoreceptors. The adult animal loses this, as it becomes immobile, so vision is not important. This organ appears to date back at least 600 million years.

"The hagfish has a patch of translucent skin on each side of the head where you'd expect to see its eyes, and buried beneath are a pair of very simple 'eyes' with light sensing cells and a simple optic nerve – but no muscles, lens or iris. Hagfish ancestors go back more than half a billion years, so this crude light sensing organ seems to have been the start of something big."

Lampreys also appeared around 500 million years ago, and have a pair of camera-style eyes remarkably similar to our own. These appear to be direct forerunners of the vertebrate eye, which we have inherited through our fish ancestry, says Prof. Lamb.

"From this we can say that the vertebrate-style eye has been around at least 500 million years – and although its light-sensors and signalling systems are very similar to those of insects and other invertebrates, its optical system evolved quite independently from the insect-style eye with its many facets."

Paired eyes also appear to feature in the strange 'crest animals' found by Chinese scientists in rocks that are around 500my old. From then on the basic plan of the vertebrate eye becomes more settled, being used with innumerable refinements by fish, amphibians, reptiles, birds, mammals and, eventually, us.

"The advent of spatial vision provided immense survival value to the creature that had it - but the process occurred slowly, over countless steps, with the transition from a simple eye spot to the vertebrate-style camera eye possibly taking as long as 100 million years," he concludes.

More information: His article "Evolution of Phototransduction, Vertebrate Photoreceptors and Retina" by Trevor D Lamb, appears in *Progress in Retinal and Eye Research*, www.sciencedirect.com/science/ … ii/S1350946213000402

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