Gene copies were crucial to evolution of our eyesight

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A new study published in *BMC Evolutionary Biology* sheds light on the evolutionary origin of vertebrate vision and the specialisations in zebrafish to adapt to rapidly changing light conditions. The research was led by Xesús Abalo and Dan Larhammar, the Department of Neuroscience at Uppsala University and SciLifeLab.

Light perception is crucial for the survival of all major animal groups, including our own – the vertebrates. Evolution has favoured selection of the camera eye that arose in the vertebrate ancestor more than 500 million years ago. Light perception takes place in the cone and rod cells

of the retina through a set of proteins. The light information registered by these cells is partially processed in the retina and then forwarded to the brain for further processing and integration with other sensory systems, eventually leading to outputs such as regulation of behaviours.

Twenty years ago, the first studies of the light receptor proteins in birds indicated that colour vision, mediated by cones, arose before the dim light greyscale vision provided by rods. This hypothesis was recently confirmed by the team led by Abalo and Larhammar in a detailed study on the visual opsin gene family, analysing a broad range of vertebrate species (Lagman and Ocampo Daza et al., 2013).

In the current study, the same group presents a detailed analysis on the evolution of the PDE6 proteins, the main effectors of light sensitivity in cones and rods. They show that the genes encoding PDE6 arose from ancestral genes that duplicated in the early vertebrate genome doublings, and further expanded in teleosts due to the extra genome duplication that took place in this lineage. They also identified another ancient vertebrate gene copy that has been lost in amniotes.

To functionally characterize the PDE6 family members, they studied zebrafish and analysed the specific specialisations in its visual system – since zebrafish have three extra gene duplicates that arose after it diverged from the lineage leading to humans. Zebrafish display the same distinction as humans between cone and rod versions of PDE6. In addition to this, the gene duplicates in zebrafish display strikingly different activity during the day–night cycle, presumably to allow efficient regulation of photoreceptor cells under different light conditions.

Altogether, the study reinforces the evolutionary importance of the two rounds of whole genome duplication that occurred in the vertebrate ancestor and sheds light on the different behaviour of gene duplicates

that arose in these events. The large difference in day and night activity for the gene duplicates opens doors to functional studies of behaviours regulated by light in different animal groups.

More information: David Lagman et al. Evolution and expression of the phosphodiesterase 6 genes unveils vertebrate novelty to control photosensitivity, *BMC Evolutionary Biology* (2016). DOI: 10.1186/s12862-016-0695-z