# Evolution of the visual sensory system in cichlid fishes from crater lake Barombi Mbo in Cameroon

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**Author(s)** Musilova, Zuzana; Indermaur, Adrian; Bitja-Nyom, Arnold Roger; Omelchenko, Dmytro; Kłodawska, Monika; Albergati, Lia; Remišová, Kateřina; Salzburger, Walter
**Author(s) at UniBasel** Salzburger, Walter ;
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In deep-water animals, the visual sensory system is often challenged by the dim-light environment. Here, we focus on the molecular mechanisms involved in rapid deep-water adaptations. We examined visual system evolution in a small-scale yet phenotypically and ecologically diverse adaptive radiation, the species flock of cichlid fishes in deep crater lake Barombi Mbo in Cameroon, West Africa. We show that rapid adaptations of the visual system to the novel deep-water habitat primarily occurred at the level of gene expression changes rather than through nucleotide mutations, which is compatible with the young age of the radiation. Based on retinal bulk RNA sequencing of all eleven species, we found that the opsin gene expression pattern was substantially different for the deep-water species. The nine shallow-water species feature an opsin palette dominated by the red-sensitive (LWS) opsin, whereas the two unrelated deep-water species lack expression of LWS and the violet-sensitive (SWS2B) opsin, thereby shifting the cone sensitivity to the centre of the light spectrum. Deep-water species further predominantly express the green-sensitive RH2A$\alpha$ over RH2A$\beta$. We identified one amino acid substitution in the RH2A$\alpha$ opsin specific to the deep-water species. We finally performed a comparative gene expression analysis in retinal tissue of deep- vs. shallow-water species. We thus identified 46 differentially expressed genes, many of which are associated with functions in vision, hypoxia management or circadian clock regulation, with some of them being associated with human eye diseases.
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