PHOTORECEPTION IN AMBULACRARIA
A COMPREHENSIVE APPROACH

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DISSERTATION

Open University of London, UK

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SCIENTIFIC ENVIRONMENT

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SUMMARY

Non-directional photoreceptors are the evolutionary precursors of all animal eyes; they enable the monitoring of ambient light intensity and regulate feeding, movement and reproduction. While the first animals were most likely benthic, they evolved larval stages very early on, thus conquering a new ecological niche: the pelagic. In this realm, the evolutionary pressure to prey but not be preyed upon became stronger. This implied strong selection for better sensory systems, including photoreception. How were the photoreceptor systems of the earliest primary larvae arranged? Did this system mediate vertical migration, the largest movement of biomass on Earth? To try to answer these questions, I chose the pluteus larva of the sea urchin as a model. A comprehensive array of techniques was applied, covering levels of organization from genes to behaviour. The diversity of opsins in Ambulacraria (echinoderms plus hemichordates) has been surveyed to have the first phylogenetic context on this matter (Chapter 1). A non-directional photoreceptor based on Go-opsins has been first described in an invertebrate larva of the deuterostome lineage (Chapter 2). A novel custom built behavioural set up was created to investigate the vertical migration of these pluteus larvae under different light conditions (Chapter 3). Based on these findings, a mechanistic model for understanding simple photodetection is proposed.

Keywords: eye evolution; non-directional photoreception; vertical migration; neuroethology; zooplankton; marine invertebrate larvae; dipleurula; echinopluteus; *Strongylocentrotus purpuratus*; *Paracentrotus lividus*; opsin phylogeny; Go-opsin; in situ hybridization; immunohistochemistry; transmission electron microscopy.