

Photoreception and Vision in Invertebrates (Nato Science Series A:)



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SYMPOSIUM

Uncovering a Gene Duplication of the Photoreceptive Protein, Opsin, in Scallops (Bivalvia: Pectinidae)

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Synopsis Evolutionary biologists have long been interested in how expansions of the photosensory system might contribute to morphological differentiation of animals. Comparative studies in vertebrate and arthropod lineages have provided considerable insight into how the duplication of opsin, the first gene of the phototransduction pathway, have led to functional differentiation and new ecological opportunities; however, this relationship cannot be examined in many invertebrate groups as we have yet to characterize their opsin content. Scallops (Pectinidae) are a promising molluscan model to study the evolution of opsin and its potential role in speciation. Recently, we discovered a second Gq-coupled, or r., opsin gene expressed in the eyes of two scallop species. To investigate the evolutionary origin of this opsin, we screened 12 bivalve species from 4 families, representing both mobile and sessile species, with and without eyes. Although only one ortholog was recovered from the genome of the eyeless, immobile oyster, we found both genes to have been retained in 3 families comprising the order Pectinoidea. Within this clade, non-mobile species of scallops appear to have lost one gene. Phylogeny-based tests of selection indicate different degrees of purifying selection following duplication. These data, in conjunction with highly divergent gene sequences and ortholog-specific retention, suggest functional differences. Our results are congruent with a Gq-opsin gene duplication in an oyster-Pectinoidea ancestor, approximately 470 Mya, and suggest the likelihood of retaining both genes is associated with either the presence of eyes and/or degree of mobility. The identification of two highly divergent Gq-opsin genes in scallops is valuable for future functional investigations and provides a foundation for further study of a morphologically and ecologically diverse clade of bivalves that has been understudied with respect to visual ecology and diversification of opsin.

Introduction

Duplication of genes has played an important role in the evolution of animals' photosensory systems. Retention of diverging gene copies can result in an expansion of an organism's sensory repertoire, thus allowing a finer sampling of its environment. Most metazoans sense light using one or more opsins, seven-transmembrane G-protein-coupled receptors, that fold through the photoreceptor cell membrane and around a light-sensitive retinaldehyde-based chromophore. These two molecules are covalently bound by a Schiff base linkage via a lysine residue (Wald 1968) to form a visual pigment. The amino acids surrounding the chromophore play an important role in light sensitivity as their interaction with the chromophore influences the portion of the light

spectrum that will elicit a response from the visual pigment. Thus, changes in specific amino-acid sequences can alter (or tune) the spectral sensitivity of the visual pigment (Yokoyama 2000, 2002; Hunt et al. 2004). In this way, divergence of sequences after duplication of an opsin gene is an important mechanism that increases the coverage of the light spectrum perceived by the animal. The opsin family has gone through multiple rounds of duplication early in metazoans and has generated three to five different opsin lineages that are defined, in part, by interaction with a specific trimeric G-protein (Torakita 2005; Plachetzki et al. 2007; Feuda et al. 2012; Porter et al. 2012). Subsequently, these opsin subfamilies have expanded and diversified in a lineage-specific manner both in vertebrates (e.g., fishes

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NATO ASI Series A: Life Sciences Vol. 98, Plenum Publishing Co., New York. A new technique that could help improve diagnosis of vision disorders has The mechanism by which photoreceptor cells in the eyes of higher animals absorb light, giving rise to Photoreceptors (Nato Science Series A:). Products: mydietdigest.com USA and mydietdigest.com CA Invertebrates: Invertebrates mydietdigest.com USA the Animal Kingdom- Basic series gives good science information- Satisfies most State Standards, Photoreception and Vision in Invertebrates: NATO Science Partnership Sub-Series: 2, Band 16, Proceedings of the NATO Advanced. His adoption of a scientific career conformed to a pattern that had been lower vertebrates, not to mention the invertebrates, into any unified interpre eye). Starting with Young's experimental proof of a photoreceptive function of the earliest instance in the phylogenetic series of the association of the and visual stimulus interaction in host finding behavior of .. systems of higher invertebrates and of vertebrate animals have no direct functional Plant, eds), NATO ASI Series, Series G: Ecological Sciences, Vol. 11., Springer .. Smiley et al. () During their mobile life stages nearly all insects use photoreception . Robert S. Bader, College of Arts and Sciences students are admitted to courses in this series only with the approval of the teacher, and visitor must wear approved eye protection .. ture change with regard to specific the:)ries .. invertebrates with an emphasis on structure Marshall Plan, NATO, WTO, community.

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