

*Let There Be Light! The Evolutionary Origins of Animal Vision*

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**Abstract** - The evolutionary histories of complex traits are complicated because such traits are comprised of multiple integrated and interacting components, which may have different individual histories. Phylogenetic studies of complex trait evolution often do not take this into account, instead focusing only on the history of whole, integrated traits, for example mapping eyes as simply present or absent through history. Using the biochemistry of animal vision as a model, I will present two case studies to demonstrate how investigating the individual components of complex systems can aid in elucidating both the origins and diversification of such systems. Opsin-based phototransduction underlies all visual phenotypes in animals, using complex protein cascades that translate light information into a nervous signal. First, I will discuss our recent work in the model cnidarian *Hydra magnipapillata*. As the only non-bilaterian lineage to possess functional opsins, our findings in cnidaria allow us to trace the history of various components to the very origin of animal phototransduction. Second, I will discuss the origin of a complex light-producing organ in a cephalopod the Hawaiian Bobtail Squid. I will show that bioluminescent organs possess the molecular, biochemical, and physiological capability for light detection. The same molecular machinery is used in squid eyes and light organ, illustrating a case of co-option of existing components in a new structure. Examining the evolutionary history of cephalopods as a whole indicates that bioluminescence and light organs evolved multiple times, providing a valuable system to address whether similar molecular changes accompany convergent morphological changes.