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RESEARCH NEWS

Another way of seeing things

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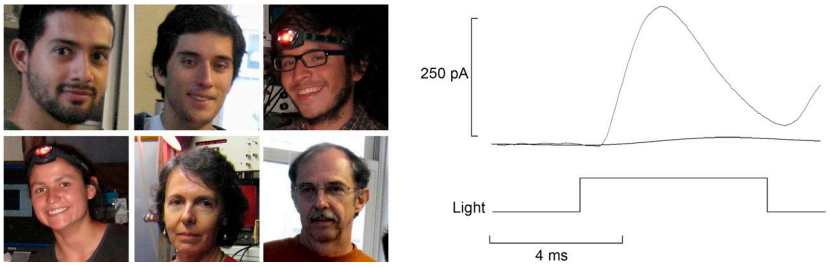
JGP study explores a novel photoreception pathway in a marine mollusk.

The ability to collect information from the environment by sensing light confers an enormous survival advantage on an organism. In this issue, Arenas et al. explore a new pathway used by invertebrates to sense and respond to light, and in the process enlighten our understanding of how vision evolved (1).

"There has been a persistent dogma in vision research that postulated that the vision mechanism in invertebrates and vertebrates had evolved separately. This is because, if you look at the photoreceptor cells of these two groups, there are two large classes that do everything differently," explains Dr. Enrico Nasi, a Professor at Universidad Nacional de Colombia in Bogotá. The differences are profound: vertebrate photoreceptor cells are morphologically different from those of invertebrates and rely on a different chemical cascade to generate an electrical response to light (2). In vertebrate photoreceptor cells, light triggers destruction of cyclic GMP to cause hyperpolarization of the cell membrane, whereas in invertebrates, light stimulates phospholipase C activity to prompt membrane depolarization. According to one interpretation, these distinctions could mean that vertebrate and invertebrate vision systems developed independently, through convergent evolution.

However, the two vision systems also have features in common. In both groups, light sensing begins with plasma membrane proteins called opsins, which undergo a conformational change upon photon absorption that prompts activation of G proteins (G_t in vertebrates and G_q in invertebrates). Furthermore, some invertebrates may straddle the visual divide. For example, the marine mollusk *Pecten irradians* has one retinal layer made up of typical invertebrate photoreceptors and a second containing a novel type of photoreceptor cell that both physically resembles vertebrate photoreceptors



(Top left to bottom right) First author Oscar Arenas and co-authors Tomás Osorno, Gerardo Malagón, Camilia Pulido, María del Pilar Gomez, and Enrico Nasi demonstrated that pScop2 is a bona-fide photopigment; knocking it down eliminates the current shift that accompanies photoisomerization (graph, bottom trace). Headshots courtesy of the authors.

(3) and responds to light with membrane hyperpolarization (4). The molecular composition of this third photoreceptor cell type remained murky until researchers identified a novel putative opsin, termed Scop2, in a close relative of *P. irradians* (5).

"They had suggested that Scop2 may signal light through the G protein G_o, but direct functional evidence was lacking," says Nasi. "We wanted to see whether we finally had a handle on the molecules that drive the transduction cascade in these unusual photoreceptor cells."

At the Marine Biological Labs in Woods Hole, MA, Nasi's group, led by master's students Oscar Arenas and Tomás Osorno, identified and cloned an orthologue of Scop2 (which they called pScop2) in *P. irradians*'s second retinal layer. Then, they examined whether pScop2 signals light absorption by knocking down the protein using siRNA. However, to ensure no photon is missed, opsins are extremely abundant in the cell; even very efficient knockdown leaves enough protein behind to produce strong cellular hyperpolarization. Therefore, the researchers had to measure something else to tell whether pScop2 signals light absorption to the cell.

If pScop2 is a photosensitive opsin, then it should change conformation when it absorbs light, producing a small shift in membrane current. Arenas et al. observed this current and found that it was reduced by pScop2 knockdown. Then, to demonstrate that pScop2 ties into a cellular response, they showed that pScop2 knockdown reduces the strength of signaling enough to allow photoreceptor cells to clear away the residual effects of light stimulation more quickly. Finally, Arenas et al. cloned and then knocked down *P. irradians* G_o and found that this impaired light-induced hyperpolarization, suggesting pScop2 does rely on G_o to transmit its signals.

"Now we have to consider that there is a greater diversity of lineages and of underlying vision mechanisms," and whether these share an evolutionary origin, says Nasi. Other molecular details of this third photoreception pathway remain to be illuminated, but presently, Nasi's group is exploring leveraging pScop2's unique biochemical properties as a research tool to introduce light-controlled G protein signaling into other cell types.

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