Blind beetles and underground regressive evolution

It is remarkable that two seafaring adventurers, Alfred Wallace and Charles Darwin, could conceive how evolution operates without any prior knowledge of genetics. Equally remarkable was the discovery of genetics by a land-lubbing, pea-obsessed, man-of-the-cloth, Friar Gregor Mendel, who failed his entrance exams to become a teacher – twice! It wasn't until the next century that the modern synthesis of evolutionary biology occurred, combining Darwin and Wallace's concept of natural selection with Mendelian genetics. And while this combination can elegantly account for the vast majority of diversity among organisms that we observe today, some animals just don't fit the mould. It is these evolutionary oddities that attract the attention of biologists.

Convergent evolution is where similar features evolve independently in distantly related species. This can also happen in reverse when different species independently lose the same trait. A textbook example of this regressive evolution is the loss of eyes among animals that live in total darkness – think cavefish, mole rats and yes, subterranean beetles.

Seemingly sensible suggestions have been made about how this might occur. Natural selection could favour eye-loss in caves because life is more efficient without them (eyes being energetically expensive to maintain), or that life is less dangerous without them (eye retention is more likely to lead to injury/infection). These ideas do make intuitive sense, but there is a surprising lack of evidence to support them.

An alternate and controversial explanation, known as Neutral Theory, is that eye regression is the by-product of the complete absence of selection. This theory is based on the fact that when random genetic mutations occur, they are more likely to be neutral or undesirable than be advantageous, and if natural selection is absent, then these bad mutations remain in the gene pool and accumulate from generation to generation. By chance alone, the odds are in favour of this process eventually leading to gene malfunction, which is bad news for eye genes.

We investigated this theory with the help of some very special water beetles. We compared the genes of different species of subterranean blind-beetles from underground aquifers in the Western Australian desert with those of their close surface relatives (ancestral species with eyes). We found evidence for a lack of eye gene expression in some species of underground beetles, but in one instance a light-activated vision gene (opsin) was expressed in an eyeless beetle in a habitat with no light.

This finding raises two questions. Does the opsin protein have multiple functions (aside from vision) that would account for its presence in a blind organism, or has there been insufficient time for the absence of selection to take its deleterious course? We don't yet have all the answers, but these beetles might just help us uncover them.

This research was a collaboration between biologists in the School of Biological Sciences at the University of Adelaide, the Evolutionary Biology Unit of the South Australian Museum, and Terrestrial Biology at the Western Australian Museum.

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For an expanded lay summary please see news article in *The Conversation*: **[+]** www.theconversation.com/what-blind-beetles-can-teach-us-about-evolution-36838

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Caption	Blind beetles from aquifers under the Western Australian desert.
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