The pleiotropic effects of melanin loss in cave snails *Physella* sp.

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Abstract

A traditional explanation for the loss of pigmentation in cave dwellers is the absence of negative selection acting on surface species to remove all albinos from the population. Recently, however, evidence has been accumulating that albinism in the cavefish *Astyanax mexicanus* has several beneficial pleiotropic effects. Albino cavefish have higher catecholamine levels due to a loss-of-function mutation in the oca2 gene, higher resistance to anesthesia, and sleep less than their pigmented, surface-dwelling conspecifics. All of these traits are beneficial to cavefish, given the scarcity of food and the availability of mates in caves. To understand whether pleiotropy might be a general mechanism for the loss of melanin pigmentation in cave animals, we use *Physella* sp., a freshwater snail from SW Illinois, USA. Within one cave *Physella* sp. occurs in several different morphs, ranging from completely albino to fully pigmented individuals. Using melanogenic substrate assay, we demonstrated that the first step of melanin synthesis is blocked in *Physella* sp. To investigate the pleiotropic effects of this blockade, we tested anesthesia resistance (AR). Similar to *A. mexicanus*, albino morphs of *Physella* sp. exhibited higher AR levels compared to pigmented morphs, with AR being controlled by the noradrenergic system in both morphs. AR and the noradrenergic system are linked to melanin synthesis via a common precursor L-tyrosine, which can be redirected between melanin and catecholamine pathways. Using RNA sequencing of albino and pigmented morphs of *Physella* sp. we aim to gain further insight into other pleiotropic effects of melanin loss. Our results suggest that pleiotropy may be involved in the evolution of albinism in both cave vertebrates and invertebrates.

Keywords

cave adaptation, albinism, loss of pigmentation, melanin, pleiotropy, adaptive evolution

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