The role of phenotypic plasticity in the evolution of cave-dwelling animals

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Abstract

The surface ancestors of subterranean species are often hypothesized to possess pre-adaptations that enable them to successfully initiate colonization of caves. Nocturnal habits and the use of microhabitats such as the underside of rocks or leaf litter are two simple examples. However, there are many exceptions, and a mechanistic explanation for the evolution of a whole range of troglomorphic adaptations has yet to be found. To shed light on the phenotypic and molecular changes that accompany the early stages of cave colonization, we experimentally exposed the most closely related surface species or population of several cave-dwelling species including fish and crustaceans, from the earliest embryonic stage possible, to constant darkness, the single environmental condition characteristic of all subterranean habitats. Our results show that darkness induced a surprisingly large number of phenotypic changes, many of which resembled troglomorphic adaptations found in their respective cave-dwelling relatives (for example changes in fat content). However, some changes were contrary to what is considered adaptive in darkness, such as increased body pigmentation and enhancement in visual system, opposite to the two iconic features of troglomorphy. Overall, we conclude that phenotypic plasticity is an important mechanism for the rapid initiation of changes that may be favored or targeted by natural selection during critical initial steps in the evolution of cave-dwelling species.

Keywords

adaptive evolution, cave colonization, cavefish, cave isopod

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