A NEW USE FOR USELESS EYES IN CAVE CRUSTACEANS

BY

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ABSTRACT

Cave animals show various adaptations to survival in their unusual environment, involving their physiology, behaviour, life history, and morphology. The morphological adaptations include enlargement of the sensory and ambulatory appendages, reduction or lack of pigment in the integument, and reduction or loss of eyes. In general, the eyes of cave animals show only non-constructive adaptations: however, we have found setae on the corneal surfaces in three different genera of cave decapods (Potamalpheops, Macrobrachium, and Procambarus) where setae are normally never present. We suggest that this constitutes the development of a new function for the obsolescent eyes, either tactile or chemosensory. This obviously underscores the general hypertrophy of non-visual sensory systems in cave organisms.

RESUMEN

Los animales cavernícolas muestran singulares adaptaciones para sobrevivir en sus ambientes, involucrando principalmente características de su fisiología, comportamiento, historia de vida. Las adaptaciones morfológicas frecuentemente comprenden el alargamiento de los apéndices sensoriales y ambulatorios, reducción o carencia total de pigmentos en el integumento, así como una disminución o pérdida total de los ojos. En general los ojos de los animales cavernícolas solo tienen adaptaciones no constructivas; sin embargo, nosotros hemos encontrado setas sobre las superficies de la cornea en tres géneros diferentes de decápodos cavernícolas (Potamalpheops, Macrobrachium, y Procambarus) donde las setas normalmente nunca están presentes sobre la cornea. Sugerimos que esto constituye el desarrollo de una nueva función para los ojos obsoletos, ya sea táctil o quimio-receptora. Esto obviamente subraya la hipertrofia general de los sistemas sensoriales no visuales en los organismos de cueva.
INTRODUCTION

Caves have been considered as natural laboratories in evolutionary biology, since the organisms inhabiting them show diverse adaptations to survival in this environment (Culver, 1982; Culver et al., 1995; Wilkens, 1996). These adaptations can involve changes in physiology, behaviour, life history, and morphology: they predominantly comprise evolutionary responses to the scarcity of food, which is the major selective force in this dark and oligotrophic environment (Barr, 1967; Poulson & White, 1969; Hobbs et al., 1977; Culver, 1982). These morphological adaptations frequently include enlargement of sensory and ambulatory appendages, reduction or lack of pigment in the integument, and reduction or loss of the eyes (Barr, 1967; Poulson & White, 1969; Hobbs, 1977; Culver, 1987; Guinot, 1988; Wilkens, 1988; Allegrucci et al., 1992; Gillieson, 1996; Cooper et al., 2001).

Obligate cave inhabitants (stygobites) particularly express the above adaptation, which may be either constructive or regressive. Elongation of the antennae and legs for improved tactile sensitivity is an example of the former, and reduction or loss of the eyes an example of the latter. However, the two forms of adaptation do not normally occur in the same organ.

Crustaceans are among the commonest aquatic cave organisms, especially copepods, ostracodes, amphipods, isopods, mysids, and decapods (Botosaneanu, 1986). In cavernicolous copepods and ostracodes, the nauplius eyes are reduced to small areas with little pigment, and distinct facets are lost. This resembles the changes in the sessile compound eyes of amphipods and isopods (Schram, 1986). In mysids and decapods, the eyestalks are reduced to small basal bodies, and there is a subsequent reduction and loss of visual structures such as ommatidia (Wilkens et al., 1991; Mejía-Ortíz & Hartnoll, 2005). The eyes of cave Crustacea are considered a prime example of regressive evolution. In the absence of light they progressively become smaller, loose pigment, and loose their ommatidia or other visual structures (Poulson & White, 1969; De Mellon, 1977; Culver, 1985; Botosaneanu, 1986; Wilkens, 1986).

Here we examine the existence of setae on the corneal areas of the eyes from three genera of decapods with different stygobite origins, from two caves in Mexico. This perhaps confounds the above trend. Their eyes are compared with those of geographically close epigean congeners.

MATERIAL AND METHODS

The eyes of the following species were analysed by SEM (Hitacchi, Scan Electron 2460). Two cavernicolous cave shrimps were examined, Potamalpheops stygicola (Hobbs, 1973) and Macrobrachium villalobosi Hobbs, 1973, as well