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Spectral transmittance of the spectacle scale of snakes and geckos

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Abstract

The spectral transmittance of the optical media of the eye plays a substantial role in tuning the spectrum of light available for capture by the retina. Certain squamate reptiles, including snakes and most geckos, shield their eyes beneath a layer of transparent, cornified skin called the 'spectacle'. This spectacle offers an added opportunity compared with eyelidded animals for tayloring the spectrum. In particular, the hard scale that covers the surface of the spectacle provides a unique material, keratin, rarely found in vertebrate eyes, a material which may have unique spectral properties. To verify this, shed snake and gecko skins were collected and the spectral transmittance of spectacle scales was spectrophotometrically analyzed. The spectacle scale was found generally to behave as a highpass filter with a cut-off in the ultraviolet spectrum where taxonomic variation is mostly observed. The spectacle scales of colubrid and elapid snakes were found to exhibit higher cut-off wavelengths than those of pythonids, vipers, and most boids. Gecko spectacle scales in turn exhibited exceptional spectral transmittance through the visual spectrum down into the UV-B. It is suggested that this is due to the absence of beta-keratins in their spectacle scale.

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Introduction

The optical media of the eye play a crucial role in tuning the spectrum of light incident upon the retina. For example, tissues may filter out short wavelengths of the blue and ultraviolet (UV) ranges to increase image contrast or block harmful radiation, such as occurs with the yellow crystalline lenses of some squirrels (Walls, 1931; Chou and Cullen, 1984), squamate reptiles (Walls, 1942; Röll *et al*., 1996; Röll, 2000) and fishes (Walls and Judd, 1933; Kennedy and Milkman, 1956; Muntz, 1973).

The spectral transmittance and absorption of various ocular media (*i.e*. the cornea, lens, neural retina, and aqueous and vitreous humours) have been studied in all vertebrate taxa (reviewed in Douglas and Marshall, 1999), although data on reptiles remains somewhat limited (Ellingson *et al*., 1995; Bowmaker *et al*., 2005), and the reptilian spectacle, despite its unique position in the optics of squamate eyes, has received surprisingly little attention (Safer *et al*., 2007; Hart *et al*., 2012).

The spectacle is a layer of transparent skin that covers the eyes of many squamates, including all snakes and most geckos (Fig. 1; Walls, 1942). Despite being the primary window through which these animals see, very few studies have investigated the spectral properties of the spectacle. Hart *et al*. (2012) and Safer *et al*. (2007) respectively reported on the transmittance of hydrophiid sea snake spectacles and rattlesnake spectacle scales, the former measuring in the visible and UV range while the latter focused on the infrared spectrum, which is not of visual relevance. Given the unusual nature of the reptilian spectacle as an extra layer in the