Opsin divergence and retinal regionalization in the visual system of the cricket (*Gryllus bimaculatus*)

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Most adult insects possess two eye types: three ocelli and a pair of compound eyes. The concomitance of different kinds of visual organs in one organism makes insects an interesting model for visual pigment evolution. Whereas the spectral sensitivities of the compound eyes (Briscoe and Chittka, 2001, Annual Review of Entomology 46, 471-510) and the ocelli (Mizunami, 1995, Vision Research 35(4), 443-452) have been investigated in many insect taxa, studies on the sequence and expression pattern of opsin genes have concentrated on only a few, highly derived, holometabolous insect orders. Spectral sensitivities do not necessarily mirror phylogenetic relationships and, based on the limited molecular data set available so far, general conclusions on the evolution of insect opsins are questionable. We have therefore investigated retinal opsins in the cricket *Gryllus bimaculatus*, a comparatively primitive, hemimetabolous insect. Combining electrophysiological and molecular methods, we provide evidence for two ocellar photopigments, a green- (λ_{max} = 511 nm) and an ultraviolet (UV)-sensitive one (λ_{max} = 350 nm). In the compound eyes, three spectral classes of photoreceptors with peak absorbances in the green (515 nm), blue (445 nm) and UV (332 nm) range have previously been identified (Zufall et al., 1989, Journal of Comparative Physiology A 164(5), 597-608). We show that the respective opsins differ from those found in the ocelli. According to the opsin expression pattern, the retina of the compound eyes can be divided into three parts: (1) the so-called dorsal rim area, which is specialized to detect skylight polarization, with blue- and UV-opsin, (2) a newly-discovered ventral area of unknown function with blue- and green-opsin and (3) the remainder of the compound eye with UV- and green-opsin. These results indicate that regionalization in the visual system of the cricket is more complex than assumed earlier.