Visual receptor optics

Stavenga, Doekele Gerben

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SUMMARY

The main theme of the present study has been the elucidation of the pupil mechanism of fly photoreceptor cells.

It is argued in chapter 0 that essential elements in this system must be: the waveguide properties of the rhabdomeres, the visual pigment, the change in membrane potential generated by photopigment conversion, the resulting potential gradient in the sense cell and finally the properties of the retinula cell pigment granula, the latter effectuating the pupil action.

A number of relevant topics has been tackled. First from waveguide optics it is inferred that the refractive index of fly rhabdomeres as well as that of other invertebrate photoreceptors can be taken as 1.365 ± 0.006 (chapters 1 and 2). This value is achieved through the application of a simple method by which experimental refractive indices can be corrected for waveguide effects (chapter 1).

Furthermore it is concluded that the contribution of the absorbing visual pigment chromophore to the refractive index can be neglected in fly photoreceptors on the ground of waveguide optical considerations (chapter 3).

That fly visual pigment is a photochrome, i.e. that it can exist in two thermostable states, is shown in chapters 6 and 7. It hence is accessible to a general method developed in chapter 4, with the aid of which the absorption spectra of the two states of a photochrome can be derived from experimental difference spectra.

The experimental set-up and the applied methods and procedures are presented in chapter 5.

Difference spectra obtained from different rhabdomeres, after correction for waveguide effects, indicate that all fly photoreceptor cells contain one and the same visual pigment, described by $P495 \rightleftharpoons M580$ (chapter 7).

The spectral properties of the two states, rhodopsin and metarhodopsin respectively, are thought to be closely related to the absorbance spectrum of the pupil, which peaks in the blue (chapter 6). At high illumination intensities

the pupil is activated owing to the influence of the pupil on the spectral composition of the light flux in the rhabdomeres; the photoconversion of rhodopsin P495 into metarhodopsin M580 is more hampered than the reverse transformation (chapter 6). This effect must be of prime importance for the visual process since a high rhodopsin conversion rate severely obstructs subsequent dark adaptation, as follows from the time course of the pupil. Dark adaptation on the contrary is accelerated by metarhodopsin conversion into rhodopsin (chapter 8).

Next to the function of the pupil for light-dark adaptation there is the high probability that it improves the colour-vision system of flies (cf. chapters 6 and 7).

Finally we like to point out that the evolvement of the pupil in the photoreceptor cells of flies may exemplify Robert Boyle's statement "that the eye of a fly is a more curious piece of workmanship than the body of the sun" but even so the latter's radiation ever is needed to give the visual system of flies its sense.