Photoreceptor performance in the blowfly

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SUMMARY

The two central questions in this study are:

How does a visual response mechanism, in our case a blowfly retinula cell perform? and
How does it manage to do so?

The first question is relatively easily answered by means of intracellular recording of the electrical potentials forming the response to adequate light stimuli.

It appears that within certain limits retinula cells behave in a linear way when maintained in a fixed state of adaptation, i.e. at a fixed mean intensity level. However, the same stimulus amplitude yields a greater response at low than at high intensity levels. Thus, a predominantly linear performance at each separate adaptation level is realized together with an adjustment of sensitivity resulting in useful response amplitudes over a large range of intensity levels. We have described the latter in terms of gain-control.

This gain-control is performed partly by the pupil mechanism; that is by the pigment granules present in the cytoplasm, which with increasing light intensity cause a progressive loss of light from the retinula cell's light-conducting structure, the rhabdomere, by moving closely against it. However, it is argued that the transducer mechanism also contributes to the changes in gain displayed by the retinula cells, when the transducer mechanism is defined as being responsible for all that happens between light quanta actually gaining access to the photopigment molecules and the appearance of a receptor potential.

These observations form the substance of chapter 6 and part of chapter 7.

The second question: "how does it manage to do so" is a good question but it is far too ambitious to expect to find an answer to it as yet.

Attempts towards solving it have been provided in the past in several ways. For instance, for several different experimental objects, models have been put forward by several different authors, both purely descriptive ones and ones endowed with physiological meaning.

Two models are described in chapter 1, namely the

Fuortes-Hodgkin model developed to fit the step response of the Limulus retinal cells on the one hand; and, for the understanding of human flicker data on the other hand, the idea of a diffusion process, as shared by Veringa and Kelly. The physiological visualizability of this diffusion model is one of its chief charms; its other charms and - in our eyes - shortcomings are discussed in chapter 7.

Also in this chapter, having established the compatibility of the diverse features of blowfly retinula cell performance as observed by us, a model of our own is described which, developed to reproduce these features, is an extended version of the Fuortes-Hodgkin model. We claim descriptive value for it only.

Chapter 2, 3 and 5 are informative chapters devoted to anatomy, methods, and choice of stimuli respectively, while chapter 4 offers the motivation for our belief that our recordings represent the properties of single retinula cells influenced by any other structure or activity located elsewhere.