The Dark Adaptation in Single Visual Cells of the Compound Eye of *Aeschna cyanea*

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Summary. 1. Light and dark adaptation in single visual cells of *Aeschna cyanea* were examined by intracellular recording of the receptor potentials. A description of the characteristics of the receptor potential is given in Figs. 3 and 4.

2. A light stimulus of several seconds (light adaptation) is succeeded by an afterpotential of the receptor potential. In most cells, this afterpotential represents a decrease of the depolarization (Fig. 5) until the resting potential is recovered. Some cells, however, show temporary hyperpolarization during the afterpotential (Fig. 7 a).

3. The course of the dark adaptation was determined by test stimuli. This means that the sensitivity of the receptor was measured during the dark adaptation period. The afterpotential cannot be regarded as standard for the sensitivity of the receptor. The sensitivity will as well increase during the hyperpolarization period of an afterpotential. Even if after light adaptation the receptor potential has returned to the level of the resting potential, the sensitivity may still be lower than at maximum dark adaptation. Receptor potential and sensitivity for light stimuli do not correlate.

4. The maximum change of the sensitivity of a visual cell, caused by adaptation, is given by the factor $10^3$.

5. The dark adaptation is accelerated if the test stimuli during the dark adaptation are of higher intensity (Fig. 14). This is probably connected with reisomerization of the visual pigment by light, but limited, however, to stimuli of an intensity which is not high enough to cause light adaptation for its part (Figs. 9, 10).

6. The visual cells of the ventral eye region are slightly more sensitive than the dorsal ones (Fig. 14).

Introduction

Previous investigations concerning the adaptation of the compound eye used the ERG to prove the change of sensitivity (e.g. bees: Goldsmith, 1963; Seibt, 1967; *Dixippus, Tachycines, Calliphora*: Autrum, 1950; Hamdorf and Kaschef, 1965; *Drosophila*: Cosens, 1971). The ERG, however, yields only summated effects; the adaptation rate of single visual cells cannot be examined by means of the ERG. Nevertheless, the results show that the eyes of certain insects (*Apis, Calliphora, Drosophila*) adapt very quickly.

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In the following section the adaptation of single visual cells in the imaginal eye of *Aeschna cyanea* will be described. The spectral sensitivity of these visual cells is known (Autrum and Kolb, 1968; Eguchi, 1971). The most frequent maximal sensitivity of receptors in the ventral region of the eye is $\lambda_{\text{max}} = 494/519$ nm, in the dorsal region $\lambda_{\text{max}} = 445/458$ nm.

Methods

Animals. Most of the experiments were made on imagines of *Aeschna cyanea* hatched from their larvae the day before. Only occasionally 2 to 5 days old individuals were used. Up to their imaginal molting, the larvae were kept in aquaria.

Preparations were carried out according the method described in detail in Autrum and Kolb (1968); in case pulsations still occurred, one drop of nicotine salicylate dissolved in Ringer solution (0.002 g/100 ml) was dripped upon the cerebral ganglion.

Technical Equipment (Fig. 1): The light source is a Xenon high pressure lamp (900 W). The light is focussed by means of a quartz lens system $L$ and conveyed to the eye through a flexible light guide $L_1$ (Schott & Gen.). In the optical path are placed: 1. A cold mirror (Balzers) and a KG-glass (Schott & Gen.) for the absorption of heat radiation; 2. An interference filter (Schott & Gen.) generating monochromatic light and calibrated neutral filters (Balzers) regulating the intensity. 3. The adaptation unit (see below); 4. A diaphragm immediately in front of the eye in order to be able to work with a very narrow light beam.

The adaptation unit $G$ (Fig. 1, bottom left) always works with the whole diameter of the light beam. Fig. 1 shows it in the position for light adaptation. The light enters through an opening next to the shutter lid $V$. During light adaptation the magazine $Mag$ is situated in the upper position, whereas it is situated in the lower position (arrow) during the application of test stimuli. The magazine contains the holding inserts $E$ for the neutral density filters. The intensity of the test stimuli is determined by the neutral filters in the upper opening of the insert. If stimuli are applied during light adaptation, no filter is positioned in the lower opening. -- The duration of the test stimuli is 50 msec.

To examine the course of adaptation in a visual cell, above all the quick phases of dark adaptation must be registered immediately after the end of a light adaptation. The adaptation unit $G$ allows the application of the first test stimulus just 40 msec after the completion of the light adaptation. The change from adapting light to dark adaptation as well as the duration and sequence of the test stimuli during the first 30 sec of the dark adaptation is electronically controlled by means of the control unit $StG$ (Smola, 1965), via the solenoids $S_p$. The first 7 test stimuli are released automatically within the first 31 sec of dark adaptation in the following sequence: 0.5, 1, 2, 4, 8, 16, 31 sec after the end of light adaptation. When this automatic sequence is completed, further test stimuli are released manually every 30 sec. All these test stimuli are of equal intensity.

The eye is positioned in the center of a sphere (Fig. 2). A cap of this sphere, made of highly polished steel, lies in the corresponding recess of a magnet $M$ in a gliding manner. This magnet retains the spherical cap in any position. By turning or tilting the cap, the head and the eye can be adjusted to the light beam in any direction required, without the distance between eye and light guide being changed.

Recording. Intracellular recording through capillary glass tubes (3 mol KCl), diameter of tip opening 0.5–0.1 $\mu$m; resistance 35–70 megohm. Indifferent electrode connected to the thorax muscles.