Optics of compound eyes and circadian pigment movements studied by pseudopupil observations in vivo

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Published in:
Biological Bulletin

Publication date:
1977

Increasing the temperature speeds up closing and opening of the pupil. For example, in *Nymphalis*, a temperature increase of 10° C decreases the half-time of closing by 25%, and that of opening by 15%. In general, closing-speed is more temperature-sensitive than opening-speed. This feature is very pronounced in pierids. For example, in *Eurema*, a temperature increase of 10° C decreases the closing half-time by 55%, but there is no measurable change in the opening half-time. Similar results were obtained in *Pieris rapae* and *Colias eurydice*. This differential effect of temperature suggests that closing and opening are mediated by different mechanisms.

It has been hypothesized in the literature that the light-attenuating granules which mediate the pupillary response are in continuous, random motion within the retinular cells, and that this brownian motion mediates opening of the pupil in the dark. We have observed small, random fluctuations in the intensity of eyeshine, which have a power spectrum restricted to the range 0–2 Hz. This observation supports the existence of brownian motion. However, the importance of brownian motion as a mechanism for pupil opening is questionable. The finding that opening-speed is independent of temperature in pierids suggests that other mechanisms must be involved.

Research supported by NEI grants EY-01140 and EY-00785, and by the Netherlands Organization for the Advancement of Pure Research (ZWO) and the Rijksuniversiteit Groningen.

Optics of compound eyes and circadian pigment movements studied by pseudopupil observations in vivo. DOEKELE G. STAVENGA.

Important structural and functional qualities of compound eyes can be inferred by studying pseudopupil phenomena. The (principal) pseudopupil of apposition eyes marks the ommatidia that are aligned with the direction of observation. When illumination and observation are not aligned, the oblique illumination pseudopupil, hitherto undescribed and unexploited, marks the direction of illumination. Principal pseudopupil and corneal reflection do not coincide when ommatidial axes are skew to the eye surface, if viewed with epi-illumination. It can be shown, *e.g.*, in damselflies, that skew ommatidia are utilized effectively to construct foveas and to achieve broader visual fields. Circadian movements of distal pigment are easily observed by examining the pseudopupil, *e.g.*, in crab, praying mantis, katydid, and *Limulus*. These pigment movements cause the ommatidial aperture to be enlarged at night. The day-adapted state can be established at night by either illumination or cooling.

The usually black color of the principal pseudopupil is due to the primary pigment cells, which absorb over a wide spectral range, and so act as an optical screen for the photoreceptors. The secondary pigment determines the eye coloring and, when this is different from black, hides the primary pigment from the attentive predator and/or prey. The red primary and secondary pigments of many red-eyed flies provide a means of photoregenerating the visual pigment. Still, the flower fly *Lathyrophthalmus aeneus* seems to follow the general characteristic that the eye's coloring is part of the animal's display features; the head resembles that of a heavily pollinated bee due to a yellowish coating over the red eye pigments.

This study was supported by grants from the Netherlands Organization for the Advancement of Pure Research (ZWO) and the Rijksuniversiteit Groningen.

Primary structural differences distinguish cytoplasmic and central pair from outer doublet tubulins. R. E. STEPHENS.

Previous studies of the α and β subunits of sea urchin flagella outer doublet tubulins, utilizing comparative amino acid composition and peptide mapping, showed that the more strongly-associated tubulin of the A-tubule contained 2–3 more (lys + arg) residues in each chain than did the homologous subunits of the B-subfiber, with a correspondingly higher amount of certain small, hydrophilic, cathodic peptides being found in tryptic digests of A-tubulin subunits. This work has been extended to the tubulin of sea urchin sperm flagella central pair, derived by limited, low ionic strength dialysis of the 9 + 2 axonemes, and to cytoplasmic, vinblastine-precipitated tubulin from unfertilized eggs of the sea urchin *Strongylocentrotus*