Modulation of reproductive output in *Drosophila* by spectral properties of ambient light

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The net reproductive output was determined for two strains of *Drosophila melanogaster*, wild-type (+) and white-eyed (*w*), under conditions of varied wavelength and intensity of illumination. The reproductive output of wild-type flies raised under blue light (max. 470 nm) was significantly lower ($p < 0.01$) than that of organisms grown under red (max. 630 and 660 nm) or green (max. 530 nm) illumination, or under conditions of total darkness. In contrast, blue light did not depress the reproductive output of white-eyed flies. The differential reproductive response of the two strains, then, appears to be related to genetically determined properties of the eye. Changes in the radiant fluence rate over a 10-fold range were not found to significantly modify reproductive output of wild-type flies, and if flies were illuminated with red, green, or blue light at identical fluence rates, those under blue, again, had a significantly lower ($p < 0.01$) reproductive output than the other two. The data suggest that the emission spectrum, not the radiant light intensity, significantly affects the number of offspring produced per parent.

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La production nette de rejetons a été déterminée chez deux souches de *Drosophila melanogaster*, type sauvage (+) et type yeux blancs (*w*), dans des conditions variées de longueur d'onde et d'intensité de la lumière. La production des mouches de type sauvage élevées à la lumière bleue (max. 470 nm) est significativement plus faible ($p < 0{,}01$) que celle des drosophiles élevées à la lumière rouge (max. 630 et 660 nm) ou verte (max. 530 nm), ou à l'obscurité totale. En revanche, la lumière bleue ne diminue pas la production des mouches aux yeux blancs. Il semble donc s'agir là d'un phénomène relié à des propriétés visuelles déterminées par la génétique des souches. La modification de l'intensité lumineuse par un facteur de 1 à 10 n'affecte pas significativement la production de rejetons chez les mouches de type sauvage et si les mouches sont gardées à la lumière rouge, verte ou bleue à des taux d'intensité identiques, ce sont encore les mouches élevées à la lumière bleue qui ont une production significativement plus faible ($p < 0{,}01$) que les deux autres. Il semble donc que ce soit la longueur d'onde et non l'intensité de la lumière qui affecte significativement le nombre de rejetons produits par parent.

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Introduction

Light influences a diverse variety of structural and functional changes in the reproduction of animals, particularly vertebrates and insects. It is unclear whether the reported effects of light on reproductive physiology can be attributed to the specific properties of light, such as wavelength and intensity, and whether variance in these parameters of ambient light can differentially affect reproductive output. For example, gonadal mass in rats (Wurtman and Wiesel 1969) and in fowl (Woodward et al. 1970) has been shown to vary with different spectral environments when light intensity is held constant. However, in similar experiments on deer mice, Vriend and Lauber (1973) found that the significant differences in ovarian and testicular weights observed under red, green, and blue light and under dark conditions could be attributed to the number of quanta irradiating the subject, rather than to the differences in wavelength of the ambient light.

The wavelength of ambient light under which animals are maintained has been associated with changes in the tissue mass of various endocrine glands: the pituitary, adrenal, thyroid, and pineal in mice (Sartarelli and Coppola 1969); the adrenal and pineal in rats (Cardinali et al. 1972; Ozaki and Wurtman 1979); and the pituitary in fowl (Foss and Arnold 1969). In these reports, no obvious pattern emerges correlating specific wavelengths with increases or decreases in organ size.

The capacity to distinguish between specific wavelengths of light has been convincingly demonstrated in insects, particularly bees. Other insects have been reported to respond specifically to different light spectra, as for example, in the entrainment of circadian activity in the cockroach, *Periplaneta* (Mote and Black 1981), in the phototactic responses of the silk moth, *Bombyx mori* (Kitabatake et al. 1983), and in *Drosophila* jumping behavior (Nadashima-Tanaka and Matsubara 1977), the latter of which is found to be dependent both on the intensity and the wavelength of ambient light. And in insects as well as vertebrates, light influences aspects of insect reproduction, such as mating behavior in *Drosophila* (Cook 1980; Willmund and Ewing 1982) and eclosion in *Bombyx* (Shimizu and Matsusi 1983). In mammals, transducing and mediating the environmental light signal controlling reproductive physiology involves the eye, pineal body, hypothalamus, and pituitary in the central pathway (Reiter 1980); in insects regulatory pathways have not been elucidated.

This study was undertaken to determine whether the spectral properties of ambient light have a role in the net reproductive output of *D. melanogaster*, an organism whose environment can be manipulated with ease and whose reproductive rate is high.

Methods and materials

Experiments were carried out in a bank of four light chambers placed in an environmentally controlled room. The ambient temperature in the light chambers was maintained at 26 ± 1.5°C by regulating venting of air with rheostatically controlled box fans. All inside surfaces of the chambers were painted flat black to minimize light reflection.

In each chamber the light sources were two 40-W fluorescent tubes. The emission spectra between 400 and 750 nm of all light sources

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