Fruiting of *Coprinus congregatus*. Interacting effect of radiant flux density and temperature

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Summary. Illumination during the photoinhibited phase of the development of *Coprinus congregatus* reduced fruiting. This inhibitory effect of light was dependent on the radiant flux density and on temperature. Radiant fluxes far lower than the flux provided by moonlight elicited photoresponses.

Fruiting of the Basidiomycete mushroom, *Coprinus congregatus* is controlled by environmental factors[1-3]. At 25 °C, light is required for basidiocarp initiation and development. Nevertheless basidiocarp maturation does not occur under continuous light. A photoinhibited phase is found during development. Recently, light and temperature interactions on the photoinhibited phase have been studied[2]. The dark requirement varied with the temperature during the inductive dark period. A minimum requirement of 2.5 h was found at 15–20 °C. Darkness always promoted maturation of fruit-body primordia but was not an absolute necessity until the temperature exceeded 17.5 °C. Normal development of the primordia under continuous light (300 mW m^{-2}) was obtained by lowering the temperature from 25 °C to 10 °C for 6 h. This effect of temperature could be defined as a low temperature inductive process. The present paper reports the interacting effect of irradiance level and temperature on this low temperature inductive process.

Materials and methods. Coprinus congregatus Bull. ex Fr. was cultured on test tube agar slants. Each tube was filled with 6 ml of medium of the following composition: 10 g malt 'Cristomalt Difal'; 0.7 g casein hydrolysate 'Fluka'; 1.47 mM KH_2PO_4; 0.26 mM $(Mg\ CO_3)_4\ Mg\ (OH)^2 \cdot 5\ H_2O$; 0.41 mM $Mg\ SO_4 \cdot 7\ H_2O$; 0.01 mM $Ca_5\ (PO_4)_3\ OH$; 12 g agar 'Serlabo'. After inoculation with 2 compatible monokaryons, the cultures were placed for 10 days in continuous darkness at 25 °C in order to allow vegetative growth and mating. Then the cultures were placed in light-tight boxes located in temperature controlled rooms. Only small variations (±0.2 °C) could be observed on a multipoint recorder with a thermocouple placed in 1 control culture tube. After 3.5 days of continuous illumination (25 °C, 300 mW m^{-2}) the primordia reached the stage of sensitivity to darkness or low temperature. Cultures were then exposed to a 6 h treatment at different temperatures and different radiant fluxes of white light. At the end of these treatments, the cultures were returned to continuous light (300 mW m^{-2}) at 25 °C. The end of basidiocarp development (sporulation and autolysis) occurred about 30 h after the beginning of the different inductive treatments.

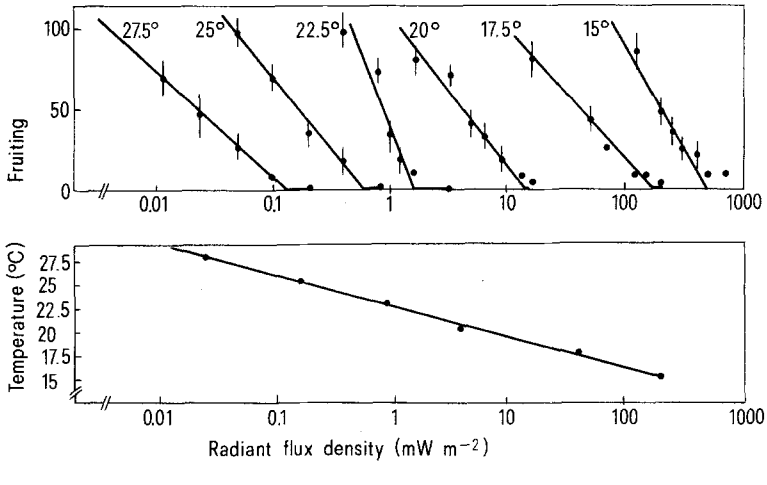
White fluorescent light was provided by Mazda Fluor TF 40 LJL fluorescent lamps. Measurement of radiant flux density was made with a photovoltaic cell calibrated against a Kipp and Zonen CA 1 thermopile on line with a Kipp and Zonen Microva Al 4 μVm.

The effect of different treatments on the fruiting response was expressed as the average number of sporulating fruit-bodies per culture (mean of 50 cultures) and calculated as a percentage of the dark control at each temperature.

Results and discussion. Giving light all through the photoinhibited phase of *Coprinus congregatus* resulted in the inhibition of fruiting. This inhibitory effect of light was dependent on the radiant flux density (upper part of the figure); at each temperature there was a radiant flux density below which light was no longer inhibitory (like total darkness) and a radiant flux density over which light was always inhibitory. This inhibitory effect of light was also clearly temperature-dependent. The lower part of the figure gives the radiant flux density required to obtain 50% inhibition of fruiting. The higher the temperature, the lower the radiant flux density required to reach the standard effect.

In fungi, the inhibitory effect of light during the dark terminal phase of conidia formation has been reported for several Fungi Imperfecti termed 'diurnal sporulators' by Leach[4]. The inhibitory effect of light upon sporulation was temperature-dependent; it increased with rise in the temperature[5-8] and also with increasing radiant flux[9,10].

Some of the developmental features of *Coprinus congregatus* are similar to the photoperiodic response of extremely sensitive short-day plants which can be induced by a single dark period e.g. *Pharbitis nil, Lemna perpusilla*[11]. *Pharbitis nil* initiated floral primordia under continuous illumination at low temperature[12]. Flowering of *Lemna perpusilla* was observed under continuous illumination if the light energy or temperature was lowered beyond the critical level[13]. The upper limit of flux density which allowed some floral buds



Upper part: fruiting responses to different radiant flux densities during the photoinhibited phase at different temperatures. Lower part: radiant flux density for 50% inhibition of fruiting.

to develop decreased with increasing temperature. It is noticeable that the same kind of interaction between light and temperature was observed during fruiting of *Coprinus congregatus.*

Many photoresponses to threshold light levels are known for fungi[14] and plants[15]. Many of the requirements are less than the flux provided by moonlight. According to Tansey and Jack[14] and Thorington[16] and using the conversion factor of 1 lx = 4 mW m^{-2} to convert photometric units into units of flux density, the radiant flux density calculated for moonlight was respectively 1.5 and 2.7 mW m^{-2}. It was clear from the present results that at a temperature higher than 20 °C, a radiant flux density far lower than the flux provided by moonlight elicited an inhibitory fruiting response in *Coprinus congregatus.*

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An increase in Sendai virus-induced cell fusion of erythrocytes infected with *Plasmodium chabaudi*

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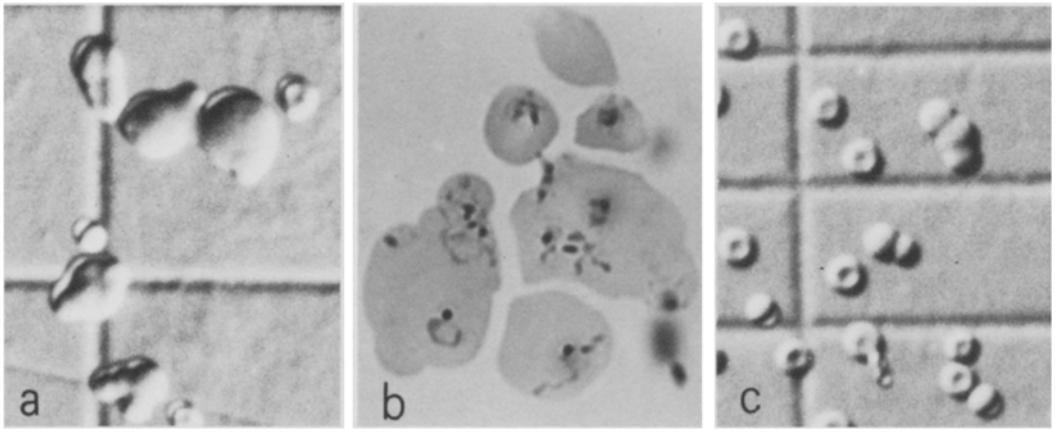
Summary. The extent of cell fusion induced by Sendai virus was examined in erythrocytes infected with *Plasmodium chabaudi.* An increase in cell fusion of erythrocytes with Ehrlich tumor cells and of erythrocytes with erythrocytes was observed with the infected erythrocytes. However, agglutination by the virus was not changed between erythrocytes of normal and malarial mice. These results indicate that the increase in cell fusion occurred in the process of membrane fusion, suggesting that some membrane property of *Plasmodium*-parasitized erythrocytes is changed in terms of Sendai virus-induced cell fusion.

Erythrocytes infected with mammalian malarial parasites have been shown to have a changed membrane structure[2]. Alteration of spectrin and other membrane proteins[3-8] and the appearance in the erythrocyte membrane of parasite-derived proteins[9] have been reported. Changes in protein architecture in the parasitized erythrocytes (PE) are thought to result in the aberrant cell morphology commonly seen in malaria infected blood[3], and in abnormal membrane properties[2]. We investigated whether PE respond differently from normal erythrocytes to an induction of cell fusion by Sendai virus, because it is known that temporal re-organization of membrane architecture is a prerequisite for the virus-induced cell fusion[10-14]. The results showed that PE are more prone to cell-cell fusion.

Materials and methods. Malarial infections were initiated by i.p. injection of 7-week-old male C57Bl/6 mice with 10^6–10^8 *Plasmodium chabaudi* PE. 5 or 7 days after the injection, the mice were anesthetized with chloroform and their blood collected by cardiac puncture with a heparinized syringe (10 units/ml). The plasma of normal or malarial mice was separated after centrifugation of the blood at 650 × g for 5 min and stored at −80 °C. The pellet was suspended in balanced salt solution (BSS: 140 mM NaCl, 5.4 mM KCl, 0.34 mM Na_2HPO_4, 0.44 mM KH_2PO_4,



Polyerythrocytes formed after induction of cell fusion by Sendai virus at 1000 HAU/ml (a and b) and 250 HAU/ml (c). Nomarski differential interference micrographs (a and c, × 570), and light micrograph (b, × 1300) of Giemsa-stained erythrocytes in which many plasmodial parasites are found.