Phototropic and Geotropic Responses During the Development of Normal and Mutant Fruit Bodies of the Basidiomycete *Schizophyllum commune*

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SUMMARY

Tropic responses occur during the development of fruit bodies of the basidiomycete *Schizophyllum commune*. The stipe (stage II) formed from the masses of aggregated cells (stage I), was positively phototropic to light of wavelengths 420 and 540 nm but not 600 or 660 nm. The apical pit (stage III) was positively geotropic and the development of gills (stage IV) occurred in response to gravity so that the gilled surface faced downwards. The expansion of the pileus (stage V) was negatively geotropic.

INTRODUCTION

The formation of fruit bodies from dikaryotic mycelia of the basidiomycete *Schizophyllum commune* normally proceeds through five stages (Leonard & Dick, 1968). Masses of aggregated cells (stage I) form a cylindrical stipe (stage II). After reaching a height of 1 to 2 mm the stipe develops an apical pit (stage III). Gills (stage IV) appear within the pit and there is subsequent growth and expansion to become a mature fruit body (Fig. 1) (stage V). The development of fruit bodies in *S. commune* requires induction by light (Raper & Krongelb, 1958; Perkins, 1969) in the range 320 to 525 nm (Perkins & Gordon, 1969). When grown on complete medium, a short exposure will induce complete fruit bodies. On minimal medium continuous illumination is required. Phototropic and geotropic responses have been observed in the development of many basidiomycetes (Taber, 1966). Jürgens (1958) noted that *S. commune* fruit bodies showed tropic responses. When observing the development of the long stalk *medusoid* mutant (Raper & Krongelb, 1958) we observed a pattern of tropic responses during development of fruit bodies of *S. commune*.

METHODS

Cultures were grown in 100 × 15 mm plastic Petri dishes containing a minimal medium (20 g glucose, 2.0 g L-asparagine, 0.46 g KH₂PO₄, 1.0 g K₂HPO₄, 0.5 g MgSO₄, 120 µg thiamine, 20 g agar, 1 l deionized water). Matings, required for fruit-body initiation, were made by placing agar blocks from previous cultures about 2 mm apart on the agar surface. All white-light experiments were done using fluorescent light at a 430 lux (40 ft candle) minimum intensity unless otherwise noted. Monochromatic light was provided by Klett-Summerson Colorimeter filters with a high intensity incandescent lamp having an initial intensity of 2800 lux.

Fig. 1. Normal mature fruit bodies of *S. commune* grown in an inverted Petri dish. Natural size.

RESULTS

Morphogenesis of the medusoid phenotype

Dikaryons exhibiting the medusoid (*med*) phenotype showed normal development to stage II. The stage II structure did not proceed immediately to stage III, but continued growing to produce structures up to 30 mm in length (Figs. 2 to 5). The exact height was variable and affected by cultural factors, but under appropriate conditions the stage III development proceeded at the tip of the stalk and finally produced a mature fruit body. This was facilitated by removing respiratory CO₂ (Schwalb, 1971).

Response to unilateral light

When *med* cultures were allowed to produce long stalks in continuous white light coming from one side of the culture, the stalks curved toward the light (Fig. 2). It could be demonstrated that the curvature occurred from the tip of the stalk by allowing some development to occur with the light source directly above the culture and then switching to light from one side (Fig. 3).

When *med* cultures were placed in monochromatic light on reaching stage II, the phototropic response was found at 420 and 540 nm but not at 600 or 660 nm. The response was not found at intensities below 11 lux, which was also the point below which stage III structure would not develop. Phototropic responses were not observed during stages III, IV and V.

Response to gravitation

A geotropic response was sought in stage II grown in reduced light to avoid the obscuring of such a response by phototropism, but was not found. When the fruit bodies reached stage III, two modes of growth could be observed. If the stipe was perpendicular, i.e. it had grown in a direction directly opposite to the force of gravity at that point, a conical to hemispherical stage IV structure resulted. When the stipe was not perpendicular the stage III structure at the tip of stage II bent downwards (Figs. 3 and 4). Stage IV growth is asymmetrical so that a fan-shaped structure was produced with the gilled surface (hymenium) facing downwards, i.e. towards the centre of gravity of the earth (Fig. 4).

Developing fruit bodies of *Schizophyllum commune*. Natural size.

Fig. 2. *med* mutant grown with the light source to the left, showing the positive phototropism of stage II.

Fig. 3. *med* mutant first grown with the light source from above and then from the left. Fruit bodies at the top also show positive geotropism of stage III.

Fig. 4. *med* mutant showing positive geotropism of stage III and asymmetrical growth of stage IV.

Fig. 5. *med* mutant with fruit bodies entering stage V.

Accompanying the stage IV growth and expansion to form a mature fruit body (stage V) there was a change in the orientation to gravity and the gilled surface showed a negative geotropic response (Fig. 5). Phototropism is excluded since it would occur whether light came from below or above. Therefore, fruit bodies grown right side up, perpendicular with respect to gravity, did not show any bending back of the hymenial surface.

Responses in normal fruit bodies

Normal fruit bodies gave a series of responses to light and gravity identical to those shown by the *med* mutant, but the phototropic effect was difficult to detect because stage II was very small. However, if the culture dishes were kept closed, some stage II structures became longer and the response was apparent. Both phototropic and geotropic effects were more easily

Table 1. *Effects of light and gravity during fruiting in Schizophyllum commune*

Stage of development	Phototropic effects	Geomorphogenetic effects
I	Not known	Not known
II (stipe)	Positive	None
III (apical pit)	None	Positive geotropism
IV (gills)	None	Asymmetrical growth
V (expansion)	None	Negative geotropism

observed if the culture dishes were kept on their sides. Table 1 summarizes the phototropic and geotropic responses found in *Schizophyllum commune*.

DISCUSSION

Schizophyllum commune is an unusual basidiomycete in that the stipe is not affected by gravity. The phototropic response probably functions in orienting growth from the cracks in logs where *S. commune* is usually found in nature.

The wavelengths of light causing photoinduction (Perkins & Gordon, 1969) and phototropism in *Schizophyllum commune* are in a similar range. In addition, the quantity of light required to complete fruiting in cultures grown on minimal medium or to cause a positive phototropic response are similar. Therefore, photoinduction and phototropism may be due to identical receptor pigments, and related metabolic pathways.

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