MYCOLOGY ANSWERS

MANY FUNGI ARE BRIGHTLY COLOURED; DOES PIGMENTATION PROVIDE ANY ADVANTAGE TO THOSE SPECIES?

Among the important items for note on a foray checklist are size, shape, general characteristics and colour of specimens for identification. Additionally, spore colour is often an aid to identification. Many species of higher fungi (Basidiomycetes and Ascomycetes) produce brightly coloured fruiting bodies in a range of pink, red, orange, yellow, purple, olive-green and grey. Colour is an important characteristic in the identification of some species (especially the Agaricales), indeed colour charts have been compiled to aid standardisation in descriptive work. However, the brightness does fade in sunlight, may be leached out by rain or may change with the age of a specimen and must be interpreted with care. In some cases spore colour is very reliable but in others may be more variable and is therefore less useful.

Under natural conditions, once the growth of a fungal colony is well established, or when supplies of vital nutrients become depleted, parts of the mycelium may switch biochemical activity to pathways of secondary metabolism. Rather than producing new fungal building materials this gives rise to other compounds (secondary metabolites). Fungal pigments are produced in this way and one species may contain a mixture of several different pigments.

The occurrence of carotenoids is widespread throughout the fungi. These pigments are terpenoids, synthesised from mevalonic acid as secondary products. β-carotene (orange) and γ-carotene (orange-red) are the most common, with lesser amounts of α-carotene (orange-yellow) and lycopene (dark red). Oxygenated carotenoids (xanthophylls) are also found and can be present as major components. It is clear that the colouration we see may be due to the inclusion of these pigments at various points within the structure of the fungus. As a component of the hyphal wall for example, particularly in thickened regions, in the spore wall, within the cytoplasm, or contained within oil droplets and associated with membranes. These carotenoids do have a role in the cells, protecting them from the potentially damaging effects of bright sunlight and in particular, some ultraviolet wavelengths.

Other pigments, melanin and sporopollenin (which is a polymer of cross-linked xanthophylls), are often found in many different types of fungal spore and probably enhance the survival of both dispersal spores and resting spores. These pigments are also laid down on hyphal walls and spore walls and provide protection from the damaging effects of radiation and desiccation.

Whether spores have long-term survival properties (thick walled, commonly dormant, requiring specific triggers to initiate germination), or are means for rapid dispersal (thin walled, capable of immediate germination) pigmented spores have been shown to be more resistant than unpigmented spores under most environmental conditions. Experiments with some dispersal spores (conidia) containing β- and γ-carotene have shown that enzymes involved in normal biochemical processes (particularly respiration) remain functional after longer exposure to high light levels than do enzymes in spores lacking carotene. Spores may well be subject to extremes of radiation if carried high into the atmosphere during dispersal, or if deposited at an exposed site, such as a relatively unprotected leaf surface. Indeed species of microfungi (moulds) that inhabit leaf surfaces will receive variable levels or radiant energy at all stages throughout growth and development. The amounts and types of radiation received will depend on altitude, latitude, season and local factors such as weather and sheltering. Ultraviolet radiation may have damaging effects on spores but affects pigmented spores least, although the effects are cumulative and viability can be reduced markedly after a critical dose has been received.

It is interesting that fungi have physiological mechanisms for repairing some forms of radiation damage to vital biochemical compounds and these systems may supplement the protection afforded by pigments. Additionally, some spores are released or extruded from the parent fungus in large quantities of mucilage (extracellular matrix). This mucilaginous matrix also provides protection against ultraviolet radiation. The outer surfaces of spores (spore walls) are chemically different from those of vegative hyphae and are often thicker and more resistant. Melanins absorb radiation and dissipate energy which protects the spore membrane. Additionally, melanin acts as a strengthening component and may physically protect spores from the action of enzymes produced by other microbes.

It is clear therefore that pigments do afford a means for damage limitation from the impact of the environment for some species, particularly in vegetative hyphae and spores where other means of protection are not present.

SUSAN ISAAC

Department of Genetics & Microbiology,
Life Sciences Building,
University of Liverpool,
P.O. Box 147,
Liverpool L69 3BX