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bre *Latest research information and how to apply it*

Mould and its control

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Information is provided on the nature of mould and the factors which govern its growth. The basis for specifying cleaning and re-decoration procedures is discussed.

Difficulties in providing a lasting cure to the problem of mould in dwellings at reasonable cost can often be traced to the specification of inappropriate control measures. Inappropriate specifications, in turn, have often arisen through misunderstandings about the nature of mould and the causes of its growth.

There is rarely any failure to understand that there is no mould growth without dampness. However it is a fact that whereas most occupants will tolerate quite high levels of dampness, especially if intermittent, they will not tolerate even traces of mould growth. Since measures to cure the dampness can often be exceedingly expensive, and sometimes only partially effective, owners have strong cost incentives for adopting measures which aim to inhibit mould without necessarily altering the moist conditions which cause it.

This paper considers what mould is, what conditions cause its appearance and discusses measures for its control.

THE NATURE OF MOULD

Moulds are fungi and can be regarded as very simple plants. They are different in form from higher plants but have similar life cycles and requirements for growth (Figure 1).

The fungus consists of a fine web (the mycelium) of microscopic root-like threads (hyphae) which grow over and into the materials from which they extract nourishment. The mycelium is normally white or grey. Moulds are coloured because of their microscopically small, seed-like spores which are commonly green, blue, brown or black and produced on special threads or hyphae growing vertically from the mycelium (Figure 1). It is the spores which give the powdery, dusty appearance and texture (Figure 2). They are dispersed into the air enabling rapid spread.

Mould fungi are present at all times out of doors on dead and decaying organic matter and in the soil.

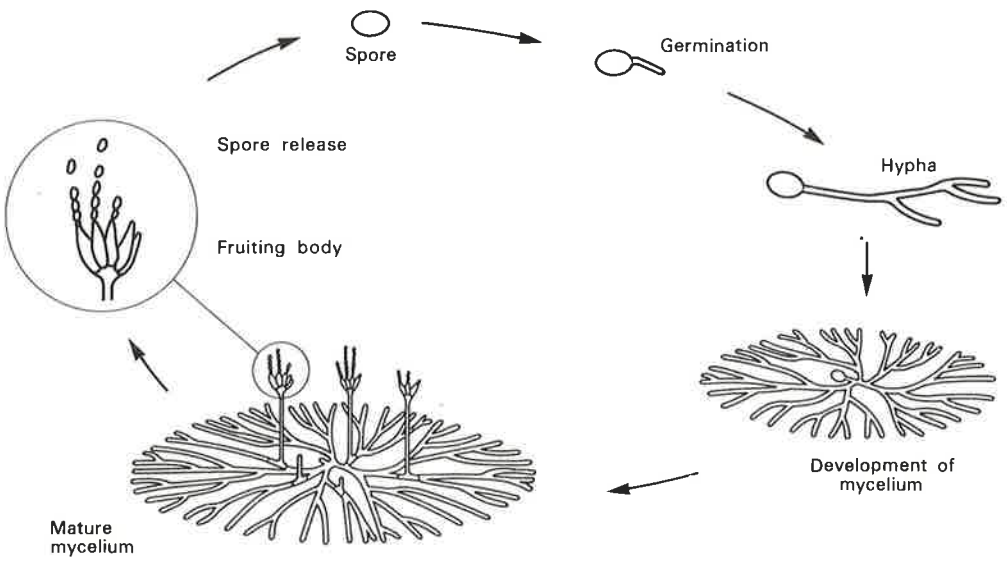

Figure 1 Schematic life cycle of a mould fungus

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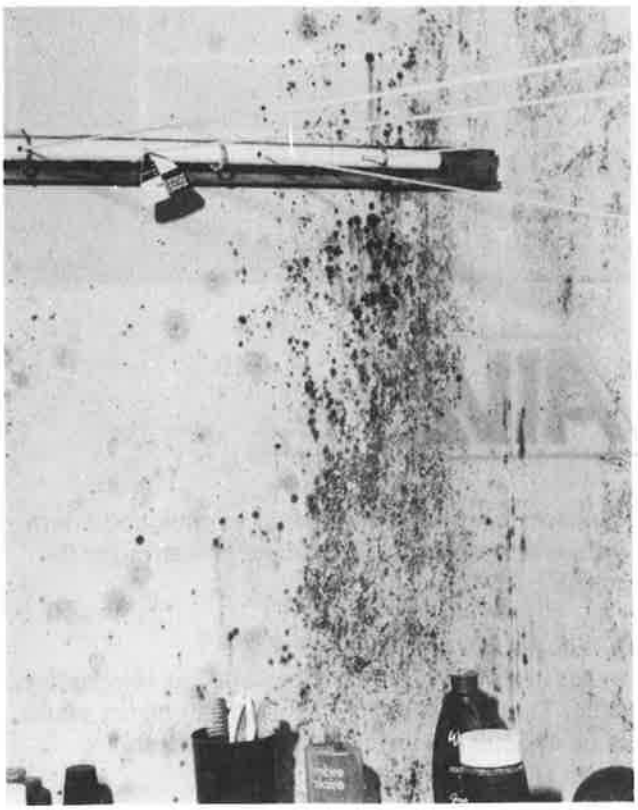

Figure 2 Mould growth on the solid external wall of a bathroom

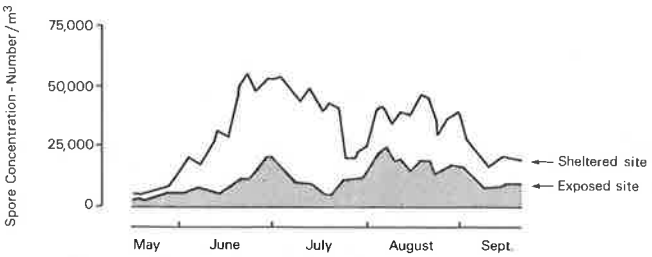

Figure 3 Seasonal variation in outdoor mould spore concentration. From Lacey. (Journal of General Microbiology 29, 485-501, 1962.) By permission of the Society for General Microbiology

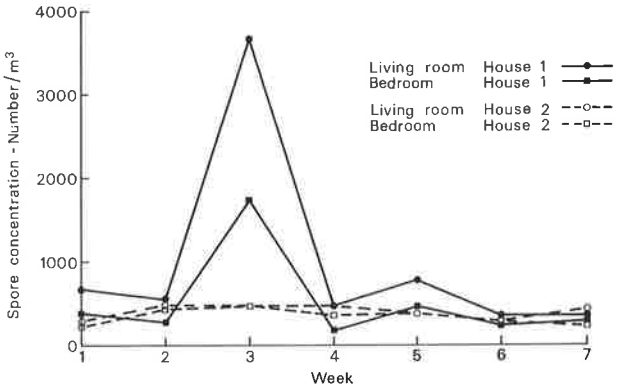

Figure 4 Variation in indoor mould spore concentration

Though numbers vary somewhat seasonally (Figure 3) spores are produced in enormous numbers and released into the surrounding air; typical levels outdoors in the summer are about 50,000 per cubic metre of air.

Recent measurements of winter spore levels inside dwellings not infected by mould, typically show concentrations up to 500 m^{-3} although large fluctuations can occur when, for example, furniture is moved or a vacuum cleaner is used (Figure 4). Spore concentrations within mould infected dwellings are consistently much higher (3,000 to 7,000 m^{-3}). Because of the normal air exchange between outdoors and indoors, a source of mould infection is therefore always present in the air of all dwellings.

CONDITIONS FOR GROWTH

The main requirements for growth of mould fungi are:

— a source of infection
— food
— water
— oxygen
— suitable temperature.

Of these only water is normally limiting in dwellings. This is because the source of infection is always present, mould fungi have a very wide tolerance of temperature (0-60°C) and aeration levels always provide sufficient oxygen; food requirements are minimal and satisfied by normal levels of dust and other deposits even in well cleaned and maintained homes. Although abnormal deposits of food residues etc encourage mould they are by no means an essential pre-requisite.

The susceptibility of materials in dwellings to mould depends mainly upon their moisture content. Different materials adopt different equilibrium moisture contents under the same conditions of relative humidity (Figure 5). Also at a given moisture content the availability of the water to fungi may be different for different materials. It is for these reasons that not all materials are equally susceptible to mould even under the same conditions. For example, whilst mould develops on leather at 76 per cent rh it does not develop on wood below 85 per cent rh nor on glass wool below 96 per cent rh. On brick and painted surfaces it has been found that mould was negligible below 88 per cent rh but increased markedly above 95 per cent rh.

Individual species of fungi have different tolerances of different moisture conditions. For example, several species of *Aspergillus* common in dwellings can survive under very low levels of available water. Other species of *Aspergillus* and most *Penicillium* species have moderate tolerance, whilst those species more commonly encountered on food materials such as bread or cheese require high water availability.

The interaction between temperature, humidity and nutritional properties of the materials and the varying tolerances of different mould fungi are complex. However the consequence of this wide range of tolerance of different mould fungi is that there are always species of mould fungi present which are able to grow on surfaces of buildings under marginally

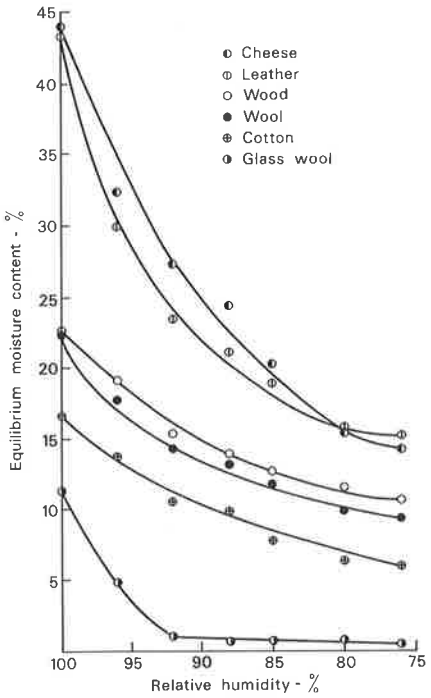

Figure 5 The equilibrium moisture contents of several materials at 29°C (85°F) and different relative humidities (Block, 1953)

damp moisture conditions or worse. As a general rule, marginal conditions occur when the relative humidity is consistently close to 70 per cent rh or if it fluctuates markedly above and below this level at different times. This level is regarded as a significant threshold because above it the probability of condensation occurring at some time on cold surfaces increases noticeably.

BRE RESEARCH

Within BRE, research on factors which influence the development of condensation in dwellings and on methods for preventing and curing condensation is centred at the Scottish Laboratory at East Kilbride whilst work on the biology of mould is carried out at the Princes Risborough Laboratory. Microbiological research is in progress to investigate the precise conditions which determine the initiation and development of mould on building materials within dwellings. This work is being carried out in dwellings in Scotland and London and in the microbiology laboratories at PRL. The effectiveness of control measures involving fungicidal paints and washes is also being studied.

In the microbiological work, BRE has played a leading role in the development of a standardised laboratory test for the mould resistance of paint films and has also co-operated with local authorities, commercial concerns and the Paint Research Association in attempts to establish proving trials for fungicidal paints in the field. Considerable difficulties arose in establishing trials under defined and constant conditions and disconcerting variability was noted between results from laboratory tests and the field trials. As a result a new test facility has been constructed at PRL giving reproducible conditions of high condensation. The facility provides a realistic test environment for the evaluation of fungicidal paints and washes and enables comparisons to be made rapidly under consistent and controlled conditions broadly equivalent to the severest encountered in dwellings (Figure 6). Such evaluation procedures provide a rapid indication of any weaknesses in proprietary and development products under simulated severe service conditions. It is clear that not all products available commercially are equally effective.

FUNGICIDAL CONTROL MEASURES

BRE experience has shown that attempts to eradicate mould which rely solely on cleaning and redecoration, even with fungicidal paints, often have given disappointing results. Improvements are at best short term and at worst are a waste of scarce financial and staff resources.

There is no doubt that the primary control strategy and that most likely to give sustained success is to eliminate or at least reduce the source of water and water vapour and reduce the risks of condensation on the surfaces of the building fabric. Such measures are often extremely costly and are sometimes difficult to achieve because of structural constraints on the lifestyles of the occupants. Where there are major cost constraints or where conditions are marginal and the incidence of mould is slight or intermittent, fungicidal methods of controlling mould may be considered.

Figure 6 The test room at PRL clearly demonstrates the contrast between effective and non-effective fungicidal paints

Fungicidal washes are useful for cleaning down operations and fungicidal paints can be of value for redecoration. Indeed, where damp conditions are slight or intermittent, fungicidal paints alone may give an adequate period of protection.

Cleaning

Removal of mould growth is best undertaken in stages. First ventilate the affected room to encourage drying and to disperse any high concentrations of spores which may exist in the air. Use of a vacuum cleaner is a convenient way of initially removing spores from the surface growths. Next dampen the offending growths with a solution of 1:4 domestic bleach in water containing a small amount of washing-up liquid or of a proprietary fungicidal wash. Only fungicidal wash products cleared under the Pesticides Safety Precaution Scheme are safe for this use (Table 1). The affected area should be wiped thoroughly rinsing out the cloth regularly. It is best to strip off decorative finishes where they are badly affected or damaged.

Table 1 List of active chemicals contained in products cleared under the PSPS as safe for use in toxic washes and masonry treatments

Active chemicals	Number of products available
cetyl pyridinium bromide pentachlorophenol laurate and p-chloro-m-cresol	2
dichlofluanid	2
dichlorophen	11
disodium octaborate hexahydrate	1
dodecylamine salicylate	18
pentachlorophenol	2
quaternary ammonium compounds	5
sodium hypochlorite	2
2 phenyl-phenol salts	5
sodium pentachlorophenate	16
TnBTO/quaternary ammonium compounds	7

Note: A list of proprietary products based on these chemicals is given in BRE Digest 139

After cleaning it is advisable to sterilise the whole surface with a further generous application of the fungicidal wash. The surfaces should be left to dry out and kept under observation for a week or more as convenient. If mould reappears it should be cleaned off with fungicidal wash at an increased concentration. Any further recurrence indicates the need for more stringent measures to cure dampness.

Redecorating

Some manufacturers can supply paints and wallpaper adhesives incorporating fungicides. It is better to use these than attempt to buy chemicals separately and apply them on site. Manufacturers recommended procedures should be followed precisely.

CONCLUSIONS

Mould growth in dwellings is a symptom of dampness. Occupants will often tolerate dampness especially if mild and intermittent but they will not tolerate mould. Cleaning and redecorating alone is unlikely to provide a lasting cure for mould. Fungicidal paints, washes and wallpaper pastes can be useful as part of the overall control strategy and sometimes are adequate in themselves where growths are slight and intermittent though only fungicidal washes cleared under the Pesticides Safety Precautions Scheme should be specified and used. However, products may vary in their effectiveness, especially under the highest hazard conditions. Primary control measures therefore must concentrate on identifying and reducing the sources of dampness.

USEFUL READING

Building Research Establishment. Control of lichens, moulds and similar growths. *Building Research Establishment Digest* 139. London HMSO 1982 Edition.

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