

Mould





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Mould outbreaks in library and archive collections

Collections are predominantly made of organic materials, such as paper, animal skins, textiles, wood, and certain animal and vegetable-based coatings and adhesives. Attack by mould, bacteria, insects and even mammals is inevitable for material that is neglected, exposed to a poor environment or stored in unsuitable conditions. Mould causes irreversible physical and chemical damage to collections and presents a significant health hazard.

- **Mould** is the common name given to the visible growth of various fungi growing on dead material and is usually seen as fluffy spots on the surface of materials such as textiles and cardboard boxes which have been stored in damp conditions.
- **Fungi** are a complex group of organisms that are neither plant nor animal, which obtain their food from living or dead material. Those living on dead material, such as paper or leather, secrete enzymes deep into the foodstuff and absorb the resulting solution, thus breaking it down both physically and biochemically. Different fungi will grow on different materials, but a number of similar types will often be found on an affected area.
- **Foxing** is the term used for the brown spots and stains seen on affected paper which may be fungal in origin but may also be caused by chemical impurities in the paper.
- **Rots** are usually fungi growing in wood, producing 'brown' and 'white' rots, 'wet' and 'dry' rots. Red rot is the name commonly given to a degradation process which causes the leather on certain nineteenth century bindings to crumble to a reddish dust. It is thought to be caused in part by atmospheric pollutants, but is not fungal in origin.

Life cycle

The life-cycle of a mould starts from the spore. Spores are loosely comparable to seeds in the vegetable kingdom. They are minute (typically 1µm upwards in diameter) and ubiquitous in the air. Due to their small size, spores are carried long distances by air currents and only settle on surfaces in very still air. The spores can stay dormant for long periods of time, but when the conditions are right they will germinate. The necessary conditions for germination are generally:

- temperatures of 10-35°C with optima of 20°C and above
- relative humidities greater than 70%
- suitable organic foodstuffs, e.g. paper, leather, wood, dust, dirt and coatings such as leather dressings.

In general, mould growth is encouraged by dark conditions and a lack of air movement, but other factors such as surface pH can influence development. If conditions are suitable, the spores will 'germinate' and produce hair-like hyphae which both penetrate into the material and grow on the surface of the object.

- Hyphae are filaments that are the growing stage of the mould. They secrete enzymes at their tips which dissolve organic material. The resulting solution is absorbed back by the hyphae and used as food for growth. When a mass of hyphae is present, the fungal colony is known as a mycelium.
- Mycelia exist in two basic types: vegetative mycelia which penetrate deep into the material to grow, and reproductive mycelia which grow on the surface as visible mould. When the colony is mature, the reproductive mycelium can change to produce sporophores which are specialised hyphae, containing spores which are dispersed into the air to create new colonies.

Environment

Long-term prevention of mould and control of outbreaks is only possible by effective environmental control to ensure that conditions are unsuitable for growth. In general, organic materials in an environment with a relative humidity (RH) above 70% are vulnerable to mould growth, due to the amount of moisture that they absorb. When RH rises above 65% the threat of mould becomes significant. Where mould is

already present, lower humidities and moisture content may still continue to support mould growth for some time. Temperatures below 10°C inhibit spore germination and slow growth and anoxic environments will slowly kill most moulds. Temperatures above 50°C will dehydrate and kill most fungi within a few hours, but will also damage collection items if the RH is not controlled. The use of chemical fungicides and fumigants, while often temporarily successful, is not normally acceptable as they have limited efficiency, may be toxic, and have the potential for damaging collection items. The use of chemical fungicides and fumigants does not address the underlying problem of poor environmental control or building defects¹.

Storage

- Ensure the building is watertight and do not allow damp to penetrate through the fabric from blocked drains, faulty roofs or other building defects.
- Keep material off floors and away from outside walls, especially cold, north-facing walls, as these may be liable to high humidities and condensation.
- Store and stack books, boxes etc., in such a way as to allow a circulation of air around them.
- Increase ventilation where possible with fans, etc. Opening doors and windows periodically on dry days may be useful in uncontrolled, damp environments.
- Keep material clean and protect it from water, dirt and dust².
- Regularly inspect material, especially leather bindings and collections on lower shelves. Mould visibility is reduced in bright light, so inspect shelves with a torch to provide raking light. The initial stages of mould growth are usually small, circular, grey, slightly fibrous patches, whereas dust is a smooth coating of grey/white/brown/black. On books, mould often appears along the square (the area of the inside cover between the edges of the cover and the textblock). Skin and cloth bindings are favoured over paper, unless conditions are very damp.

¹ Refer to the Preservation Advisory Centre booklet *Managing the library and archive environment* www.bl.uk/blpac/pdf/environment.pdf

² Refer to the Preservation Advisory Centre booklet *Cleaning books and documents* www.bl.uk/blpac/pdf/clean.pdf

Mould outbreaks

- Mould outbreaks should be addressed with caution, as the mycelium and spores are respiratory sensitisers and can cause allergic reactions in some people. Respiratory sensitisers are subject to the Control of Substances Hazardous to Health (COSHH) Regulations 2002. In addition some moulds produce toxins that are harmful to human health.
- In areas where mouldy material is present, and when handling mouldy material, protective equipment should be worn. Staff should wear masks with an FFP2 or FFP3 rating (e.g. 3M 8810 or 3M 8822 disposable dust/mist respirators),³ close-fitting vinyl or nitrile gloves and goggles. For large-scale outbreaks a higher level of personal protection may be required e.g. full face respirators and body suits.
- If affected material is completely dry and the mould inactive, isolate it in sealed bags/containers or areas until it can be cleaned.
- Do not attempt to remove active mould. Active mould is usually damp and will smear when touched or wiped.
- Enclosing or wrapping damp material or material with active mould will encourage mould growth. Material should only be wrapped in preparation for freezing⁴ or as a temporary measure e.g. to allow handling and transfer to a more suitable environment for immediate drying.
- Reduce relative humidity levels to stop active mould growth.
- Do not use warm air to dry out wet organic material, as this can encourage rapid mould growth. Use fans, dehumidifiers and cool air.
- Inactive dry mould can be removed by careful and thorough brushing in a well-ventilated area, in a fume cupboard, or by using a suitable extraction system or document cleaning table. Some robust items may be suitable for cleaning with a conservation vacuum cleaner with variable suction fitted with a soft brush and a HEPA filter which will retain the fungal spores and mycelium fragments. A conventional vacuum cleaner will not do this.⁵

³ The HSE recommends the use of face fit testing equipment for masks
www.hse.gov.uk/pubns/fittesting.pdf

⁴ Mould growth can appear on wet or damp material within 48 hours. Freezing is not a treatment for mould, but it will prevent it growing or getting worse. Not all material is suitable for freezing.

⁵ Refer to the Preservation Advisory Centre booklet *Cleaning books and documents*
www.bl.uk/blpac/pdf/cleaning.pdf

- If necessary, surfaces can be treated with 70:30 ethanol and water which will disrupt and kill mould spores. However, care should be taken as some dyes, inks and other media are soluble in solvents and all use of fungicides and sterilants must be carried out with professional advice and conform to the Control of Pesticides Regulations 1986.

Online resources

Mould outbreak—an immediate response

www.cci-icc.gc.ca/crc/articles/mould-moisissures/index-eng.aspx

Mold (The Abbey Newsletter)

<http://palimpsest.stanford.edu/byorg/abbey/>

An introductory guide to the study of moulds

<http://labs.csb.utoronto.ca/moncalvo/malloch/Moulds/Introduction.html>

Additional reading

Florian, Mary-Lou, *Heritage Eaters: insects and fungi in heritage collections*, London:James and James, 1997

Florian, Mary-Lou, *Fungal Facts: solving fungal problems in heritage collections*, London: Archetype Publications, 2002

Guild, S., Macdonald, M., *Mould prevention and collection recovery*, Ottawa:Canadian Conservation Institute, 2004

Preservation guidance booklets

The following booklets can be downloaded free of charge at www.bl.uk/blpac/publicationsleaf.html.

Free printed copies are also available.

Basic preservation for library and archive collections

Building blocks for a preservation policy

Cleaning books and documents

Damaged books

Guidance for exhibiting library and archive materials

Managing the digitisation of library and archive materials

Managing the library and archive environment

Managing the preservation of library and archive collections in historic buildings

Packing and moving library and archive collections

Photocopying of library and archive materials

Preparing funding applications for preservation and conservation projects

Prevention and treatment of mould outbreaks in collections

Preservation of photographic material

Specifying library and archive storage

Understanding and caring for bookbindings

Using library and archive materials

The Preservation Advisory Centre promotes the benefit of good preservation practice and provides support in the form of information services, training and preservation management tools.

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