ISSN No 1175-5288

CANTERBURY DISASTER SALVAGE TEAM

"Working Towards Saving Cultural Collections"

NEWSLETTER

Number 35 **February 2007** **Cynthia Cripps, Editor**

Mould

CDST News

Mould is everywhere. Their spores (conidia) are tiny, airborne, and may remain viable for any length of time from several minutes to many years. The number of conidia in the air may reach one million per cubic meter under favourable conditions, although levels of 10,000 to 100,000 per m_ are more common. Mould can grow on virtually any surface, as long as there is some organic material around to feed on, like a thin layer of dust or grease, and enough moisture. They like it hot and cold; some species have been found growing at 0° Celsius, while others luxuriate at temperatures as high as 50° Celsius. Of course, mould is not intrinsically evil – no matter how much it may seem so when rounding a corner and coming face to face with a well-established colony. In fact, mould serves a useful and important function by breaking down 'waste' so minerals, nutrients and so on are more available to other species, thus aiding in the recycling process. We humans also make prolific use of these beneficial qualities of mould for fermentation (soy, wine, beer, spirits, bread, cheese); making medicines (penicillin, antibiotics); and digesting wood chips to make paper.

But when it sets up house where it isn't wanted, like in a collection of rare books or textiles, mould becomes a significant problem for those caring for these collections.

The following is an introductory overview of mould in relation to caring for heritage collections. To be able to confidently deal with mould in your institution, I recommend also reading some of the references and websites provided at the end.

What is mould?

Mould is a type of fungus (along with yeasts, mildews, rusts, and mushrooms, to name a few other types). It is a multi-cellular, microscopic vegetable plant that forms cobweb-like masses of branching threads and lacks the ability to photosynthesize. Tiny fertile threads project into the air from the surfaces of these threads and bear the part of the plant (conidiophore) from which the conidia (asexual 'spores' for reproduction) develop. Conidia are typically 5 to 50 m in diameter (Aspergillus fumigatus conidia are among the smallest, measuring about 2.5 m) and are very easily air borne.

The terms "mildew" and "mould", although commonly used interchangeably, are actually used very specifically by mycologists. Mildew technically refers only to those moulds that infect plants, such as downy mildew.

Moulds derive their food from the substance on which they form and as they grow they produce citric, gluconic, oxalic, or other organic acids, that can damage paper, leather, cloth, to name but a few examples. Moulds can also at times produce colour bodies, leading to staining that is difficult or impossible to remove.

Some mould can change at will into a form with a different species name. It can even change into yeast, and back again. Its colour and other visible features depend on the temperature of its environment and what it has been eating. The toxins and volatile organic compounds released by the organism continue to affect competing species, including humans, after the mould itself is dead.

CORRESPONDENCE TO: The Canterbury Disaster Salvage Team, c/o The Christchurch City Art Gallery, PO Box 2626, Christchurch, 8001, Phone (03) 3650 915, Fax (03) 365 3942

Health Issues

Inhalation of airborne microorganisms — and their metabolites — may cause a wide range of respiratory problems and symptoms. Mucous membrane irritation, coupled with a dry cough and eye irritation, are common responses to continuous exposure. Bronchitis and chronic pulmonary disease, while typically associated with smoking, may also be related to such allergic reactions, although the role of airborne microorganisms hasn't been determined. Allergic rhinitis and asthma, particularly among those who are constitutionally predisposed to allergies, is perhaps one of the most severe responses to mould exposure.

Even more potentially toxic are mould glucans — constituents of fungal cell walls — which can cause immune reactions, resulting in mucous membrane irritation, headache, muscular pain, cough, and chest tightness. Mycotoxins are poisonous secondary metabolites of fungi, chiefly produced by *Fusarium*, *Penicillium*, and *Aspergillus* — all of which are common to buildings and collections. Toxicity by inhalation can be 40 times greater than by ingestion.

Generally, health effects fall into the following categories: irritation, allergy, toxicity, and infection. Symptoms that result from exposure to abnormal levels of indoor moulds, including toxigenic moulds, may include the following:

- nasal irritation, burning, itchiness, stuffiness and congestion, bloody nasal discharge, throat irritation and soreness
- cough, shortness of breath, wheezing, chest congestion and tightness
- severe headaches, concentration problems, irritability, dizziness or light-headedness, fatigue
- burning, irritated, blurry vision
- burning rash on skin
- low-grade fever, flu-like symptoms

No one, and particularly those with history of allergies or asthma, should ever be involved in handling or working around mouldy materials without protection. Since it is very difficult to identify what species of mould is present, the best approach is to assume health hazards are present with all mould outbreaks and write all collection related procedures (emergency plan, handling guidelines, etc) to incorporate health and safety regulations.

Exposure can cause increased sensitization and thus increased risk of health effects with any future exposure, even at low levels that previously did not cause any problems.

Identifying Mould

Identifying what species of mould is growing, or was growing is extremely difficult, even for the experts and requires professional laboratory facilities. So, unless there is a specific health concern that warrants the costs and time involved, it is best to not try and get the species identified and treat all mould as if it poses a health risk.
It is more productive to focus on identifying whether or not there is indeed actually a mould problem. There are a few phenomena that to the untrained eye successfully mimic mould growth. One common example is the fatty bloom on leather that during use, was frequently treated with leather dressings containing oils or fats. These are well-known to migrate to the surface of the object as it ages, producing a whitish coating often mistaken for mould.
How can you tell if you do have a mould infestation?

- Often the first indication that a microorganism problem exists is a characteristic musty odour. The smell of mould comes from the volatile organic compounds (VOCs) produced by the organism. Opinion differs on whether they are toxic or not.
- Another means of detection is by the use of ultraviolet (UV) light. Under UV light, a microorganism growth will appear luminescent.

Mould in collections

So far, research results indicate that the mould forming on heritage collections is the same as the common conidia found in the air around them. The two most common "problem" moulds are the Ascomycetes and Fungi Imperfecti. The Ascomycetes include over 29,000 species, many of which are disease causing. The Fungi Imperfecti is the second largest subdivision, containing over 17,000 species and they are very aggressive agents of biodeterioration.

However, each type of building (homes, schools, office buildings) tends to have its own set of typical mould species, most likely because each building type typically has its own characteristic "amplifiers"

or sources and conditions, such as mattress dust and humid bathrooms in homes, leaky roofs and defective plumbing in schools, and poorly maintained HVAC systems in office buildings.

Moulds need organic materials to supply nutrients and, therefore, museum objects composed of organic materials such as paper, cotton, linen, wood, hair, leather are at greatest risk. The organic acids produced by moulds, aside from weaken organic materials, can also etch inorganic materials like metal and marble. And, of course, there is the staining. Counter-intuitively, it isn't the colouring of the powdery conidia mass that causes stains – It is the pigments secreted by the actively growing hyphae of the fungus and/or pigment in the hyphae that stain the substrate.
The following are a few examples of mould species and what they do to heritage collections:

- *Aureobasidium:* commonly cause staining of wood finishes
- *Mucor* and *Penicillium:* frequently associated with stone, producing acids that dissolve silicates and lead to the weathering
- *Aspergillus, Penicillium, Cladosporium, Fusarium*, and *Paecilomyces:* often associated with the discoloration of paint
- *Aspergillus* and *Penicillium:* often found colonizing adhesives and caulks, with *Penicillium* in particular found associated with PVC, plastic, and rubber
- *Aspergillus:* associated with surface discolorations of polyesters
- *Penicillium, Aspergillus, Cladosporium*, and *Mucor:* frequently attack carpets
- *Penicillium, Fusarium, Aspergillus*, and *Cladosporium:* frequently infest library collections

Controlling Mould

Since mould conidia are everywhere, inside and out, it is not feasible to aim for eradicating it from collection areas. The most effective, and cost-efficient approach is to maintain a continuous programme of environmental control and good housekeeping practices that will allow you to prevent serious outbreaks. Realistically, small outbreaks will continue to occur from time to time. Imagine, for example, a small leak, which results in a damp spot on a wall next to a shelving unit, and voila – mould develops nearby. But the outbreak is small, because the area has been cleaned regularly, the HVAC system has kept the humidity from getting too high, the regularly weekly/fortnightly check spotted the problem early, and a response plan was in place to ensure the situation was resolved quickly.

A few comments on controlling mould:

- It cannot be stated too often: a controlled environment in which good air circulation, moderate temperature (18-22 degrees Celsius) and a relative humidity (RH) at an achievable low level (less than 60%, ideally 35-40%) will dramatically aid in preventing large scale outbreaks of mould.
- RH is actually less important than the dew point or the water activity (free water) of the substrate. However, RH is easier to determine and control.
- Requirements for air and light vary. Some fungi prefer a temperature range between 15° and 30°C; others below 0°C; and others prefer 35° to 50°C. But in general, increased air flow and decreased temperature help prevent most mould outbreaks.
- Monitoring or analyzing the conidia load in the air is only of value if being done to answer a specific question as there will always be conidia in the air.
- Filters are good for larger particles and will filter some conidia, but conidia enter buildings via many different routes, one being the collection, another staff and visitors, so trying to use expensive filtering systems is not necessarily a good return on investment of time and money.
- Regular dusting and covering objects to prevent dust accumulation is a very effective preventive measure.
- Most moulds are not poisonous, but since there is always a mix of species, one cannot rule out the presence of toxins in a growth of mould.

Responding to a Mould Infestation

1. Respond quickly: mould grows very fast and can easily go from a minor to a major problem.
2. Determine the cause: check temperature and relative humidity levels in the area; check to see if the material, storage furniture or containers have been wet; is the wall or floor damp, has there been a leak; check heat-exchange coils in air conditioning units, ducting, etc.
3. Isolate materials: place affected items in a dry paper-based box until treatment; if possible, include a desiccant, such as conditioned silica gel packets. This will prevent spores from circulating, but will not encourage the growth potentially created by the tightly sealed microclimate of a plastic bag. For large infestations, it may be necessary to restrict access to the building or room.

4. Do not focus on killing the mould: be sceptical of any firm that suggests treatments based on "disinfecting" for mould or totally eliminating it from your institution – mould is everywhere and you cannot be totally eliminates; instead it is essential to control temperature and relative humidity, creating conditions that don't allow mould conidia to transform into the vegetative form; even dead, mould is still an allergen and can have health consequences.
5. Modify the environment: if the relative humidity is high, adjust system settings if possible or put portable dehumidification units in the affected area(s); set up fans to keep air circulating; turn lights on in affected areas for as long as possible during periods of obvious mould growth; continuously record temperature and relative humidity until they stabilise at an acceptable level.
6. Clean: Once dried, vacuum visible mould from books or papers (methods described below); clean any mould from shelves, walls, floors, air conditioning heat-exchange coils, air vents, etc.
7. Monitor: keep watch on the affected area for several months beyond the mould outbreak and clean-up, even after the environment has been restored to conditions which inhibit mould growth.

Fungicides: No single fungicide possesses all the desired properties of protection, as some of them are mutually exclusive. It may be possible to find a single fungicide that possesses a range of properties suitable for use in virtually any specific case, but many fungicides are highly chlorinated substances and therefore cannot be removed from the object and are very likely to cause more damage in the long-term. Fungicides are also a health risk to humans. In general, their use is no longer recommended.

Freezing

Freezing is a quick method of killing actively growing mould, but the spores are able to withstand the cold temperatures and remain viable.

Freezing is a very good option when there are numerous water-damaged or mouldy objects. This method eliminates the urgency to safely dry all wet objects within a short time frame. The labour-intensive drying process can then be postponed until staff are fully organized and have secured the space, time, resources, and people to deal with the material. But freezing is not appropriate for all material. In general, it is safe for textiles, furs, feathers, leather, paper, and wood. It is not recommended for glass plate negatives, oil paintings, or acrylic paintings. If in doubt, check with a conservator first.

Before freezing, seal the object in a clear polyethylene bag or wrap with polyethylene film and seal with tape. Household chest freezers, which generally operate between -18°C and -28°C, can be used for a small number of objects. Freezing on a large scale requires hiring a larger freezer such as a large walk-in freezer, or a freezer truck.

Cleaning Infested Materials

A conservator should be contacted for assistance in dealing with the infested material. However, as a general procedure, vacuuming is appropriate in most situations.

- Remove the object from any packing material, which should be discarded safely.
- Vacuum surfaces using a vacuum cleaner, fitted with a HEPA filter. HEPA filters are necessary to prevent spores from being exhausted back out into the room. Wear disposable gloves and a suitable mask when handling contaminated materials, but be cautious in using respirators and masks. If not used properly, they will not be effective and can be risky for those with breathing problems, heart conditions or who are pregnant. Masks and respirators must be those specifically approved for use with mould, common paper dust masks are not effective protection.
- Seal the vacuum cleaner bag, gloves and all other contaminated materials in a plastic bag and dispose of them in rubbish containers outside the building.
- If the outbreak is small, and your equipment limited, take the affected materials outside on a calm mild day and brush them off with a soft white brush, away from you, i.e., downwind. Direct sun will help with drying if materials are damp and the mould is "active."
- Contrary to the advice given in some older publications, ultraviolet radiation in daylight has a minimal effect on mould. It may temporarily inactivate, but will not kill or remove mould.

Websites

Conservation Online (CoOL), Mold: http://palimpsest.stanford.edu/bytopic/mold/
Several valuable references available to download.

CORRESPONDENCE TO: The Canterbury Disaster Salvage Team, c/o The Christchurch City Art Gallery, PO Box 2626, Christchurch, 8001, Phone (03) 3650 915, Fax (03) 365 3942

Journal of the American Institute for Conservation online: http://aic.stanford.edu/jaic/
Access online to Volume 16, 1977 to Volume 44, 2005.

Chicora Foundation, Inc: http://www.chicora.org/mold.htm

Canadian Conservation Institute: http://www.cci-icc.gc.ca/headlines/mould/index_e.aspx

Toronto Public Health department: http://www.toronto.ca/health/mould.htm

Allergy New Zealand: http://www.allergy.org.nz/allergies/aZAllergies/mouldAllergy.php

Wikipedia: http://en.wikipedia.org/wiki/Mold

Bibliography

Davis Pamela J 2001. Molds, Toxic Molds, and Indoor Air Quality. Prepared at the Request of Assembly member Alan Lowenthal. California Research Bureau (CRB) Note. Vol. 8, No. 1. ISBN: 1-58703-133-7. California State Library 1. http://www.library.ca.gov/crb/01/notes/v8n1.pdf

Dicus Diana Hobart 2000. One Response To A Collection-Wide Mold Outbreak: How Bad Can It Be—How Good Can It Get? JAIC 39 (1): Article 7: http://aic.stanford.edu/jaic/articles/jaic39-01-007_indx.html

Florian Mary-Lou 2000. Aseptic Technique: A Goal To Strive For In Collection Recovery Of Moldy Archival Materials And Artifacts. JAIC 39 (1): Article 8. http://aic.stanford.edu/jaic/articles/jaic39-01-008_indx.html

Florian Mary-Lou 1997 Heritage Eaters: Insects & Fungi in Heritage Collections. London, James & James (Science Publishers) Ltd.

Deadly Fungus in Museum Basement Prompts Big Lawsuit. 1994. Abbey Newsletter 18 (6): 68.

Managing a Mold Invasion: Guidelines for Disaster Response. Technical Series No. 1. 1994. Conservation Center for Art and Historic Artifacts. Philadelphia, PA. Conservation Center for Art and Historic Artifacts.

Wellheiser Johanna G 1992. Nonchemical Treatment Processes for Disinfestation of Insects and Fungi in Library Collections. IFLA Publications 60. Munchen, K.G. Saur.

CDST News

Membership changes

The team said farewell to Jill Durney in December. We are very grateful for Jill's contributions over the past 8 years, especially her tireless work organising refreshments and arranging for the team to have access to University of Canterbury facilities for various workshops. The team is very pleased to welcome Terri Elder who will be replacing Jill. Terri is the Art Collections Registrar for Canterbury University and has a B.A. Honours in History (Canterbury University), and an M. Phil in Museum Studies (Cambridge University). She has worked as a registrar and collection manager in a variety of museums and art galleries throughout New Zealand.

Also, the team offers a belated welcome to Penny Minchin-Garvin from the Classics Department at the University of Canterbury. Penny is the curator for the James Logie Memorial Collection and has a B.A. and a Graduate Diploma (distinction) in Classics from the University of Canterbury. She has also worked as a journalist and writer for the print media, and has published in both New Zealand and Australia.

Website and Poster

The team has now viewed a preliminary design of both the poster and website. The final version of the poster should be completed by the end of April and will be used at various conferences and meetings around New Zealand. An A4 brochure version is also being planned. The team plans to make both the poster and brochure available and details on how to get copies will be included in the next newsletter.

We are now focussing our attention on the Website and are going over various funding options.