MOLD IN THE LIBRARY: Prevention and Response

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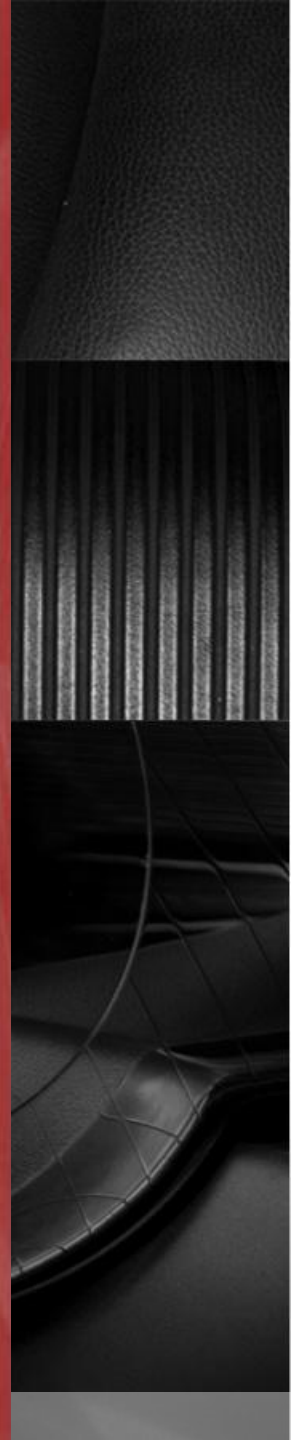
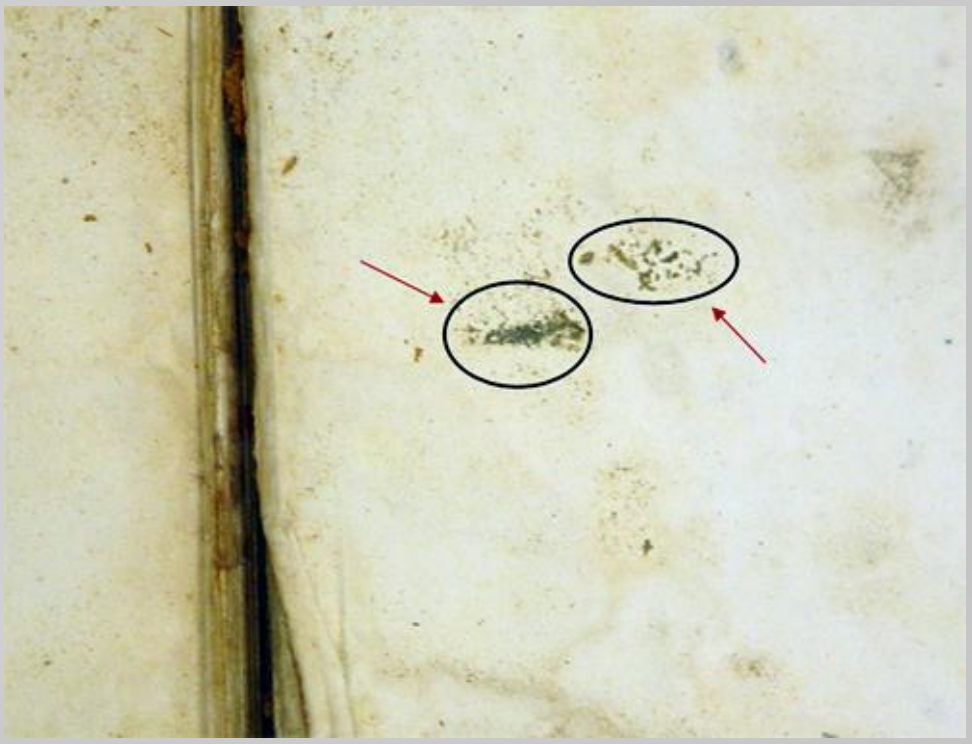


Part I: What is mold? What are the risks to people/collections?



What is mold???

- A general term for a wide variety of fungi
  - Examples are yeasts, molds, mildews, rusts and mushrooms
- Spreads and grows through the propagation of spores
  - Airspora; most fungal infestations are on surfaces
  - Physical contact with moldy materials
  - Internal sources (e.g., contaminants in the papermaking process – “foxing”)
- Moisture provides the necessary condition for growth

How does mold develop?

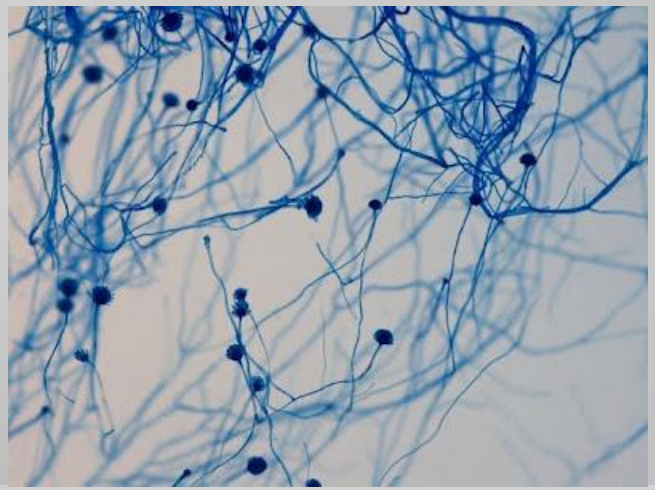
- Visible signs are when the spores (*conidia)* germinate and develop hyphae (mass = *mycelium)*
- Soft, furry spots; larger colonies can appear as “carpets”; mycelium branch out across and INTO the paper or other substrate
- It is through the mycelium that a fungus absorbs nutrients from its environment
- Fertile mycelium (“fruiting bodies”) release more spores into the air

Identifying mold

- Can be any color, depending on the species and substrate on which it is growing
- Active mold is sticky and can smear
- Inactive mold is dry and powdery
- Musty odor (common to damp basements)

Identifying mold

- **Ultraviolet light**: Mold on paper and parchment and tide lines that are not apparent under visible light can often be detected using long-wave UV light. Both mold and tide lines usually appear as a faint yellow fluorescence.
- **Magnification:** Dust, dirt, stains, cobwebs can look like mold
  - Fine webs/filaments on the surface
  - Bushy
  - Fruiting bodies



Aspergillus flavus mycelium & conidiophores (X250)

What are the risks of mold to the collections?

- Molds excrete enzymes and acids that digest paper or whatever material (the substrate) the mold lives and feeds on
- Enzymes break down carbohydrates, proteins and fats into absorbable forms (simple sugars, amino acids, fatty acids)
- Feed on cellulose in paper and cloth, sizing such as starch, glues, leather, etc.

What are the risks of mold to collections?

- Substrates are weakened and can be destroyed (paper becomes thin, soft and spongy)
- Gums destroyed; decorative elements lost
- Image layers in photos can be completely obliterated; the emulsion destabilizes and becomes water-soluble
- Mold may produce pigments which stain the substrate; reducing this staining may be difficult or altogether impossible
- Stains damage and obscure text and images

What are the risks to people?

- Molds enter the body by inhalation and through small breaks in the skin
- Common health concerns are hay fever-like symptoms (nasal stuffiness, eye irritation, wheezing, skin irritation)
- Prolonged exposure to germinating molds in closed areas can damage lungs, mucous membrane, cornea, respiratory tract, stomach, intestines, skin
- Some molds, such as *Aspergillus* species or *Stachybotrys chartarum*, can cause serious illness, even death
- People with allergies may be more sensitive to molds
- People with immune suppression or underlying lung disease are more susceptible to fungal infections

Should I test the species of mold?

- Precautions do not vary with differing species of mold and response is still the same (more on this later when we talk about response)
- Mold can be sampled by an environmental consultant and/or analyzed by a laboratory specializing in microbiology; these tests can be very expensive – from hundreds to thousands of dollars (call a local hospital for a referral); campus – EH&S
- Recommend testing if we have a small to moderate outbreak in the Library that we will try to recover from in-house

Part II: Mold Prevention

Costs associated with mold outbreaks

- Clean up (medium to large outbreaks) will demand professional services to assist with remediation
- Even small to moderate outbreaks (less than 3 m^2) that you can manage in-house will demand resources for recovery, including staff time
- Community does not have access to the library
- Replacement of materials (if they CAN be replaced)
- Building repairs/renovations, as required

The perfect environment for mold growth

- Relative humidity that reaches or exceeds 70 to 75 percent and remains at that level for several days
- High temperatures, poor air circulation, dim light, and accumulated dirt and grime (often a source of nutrients for mold species) can assist and accelerate growth once the mold has germinated, but only high relative humidity and moisture content of the substrate can initiate and sustain mold growth
- If the RH drops and the moisture content of the collection is reduced molds will stop growing but remain viable. They will be active again if the RH rises.
- A lot of dormant mold can turn into a major problem if the humidity can't be controlled

∴ Optimum conditions for mold exists when temperature is above 70° and RH is above 50%

Be vigilant with the environment

- Inspect drip pans for moisture buildup (chiller condensation)
- Cleaning of heat-exchange coils
- Regular inspection of air ducts, especially in summer when the AC is running
- Best quality filters in the HVAC system, replaced regularly
- Environmental monitoring in collections storage areas
- Monitoring and routine inspection of problem areas (water alarms)

Be vigilant with the environment (cont'd)

- Don't shelve or hang collections against outside walls - moisture condensation can be a problem
- Waterproof basements and walls below ground level
- Watch out for damp or stained ceiling tiles
- Keep in mind seasonal issues; extreme weather conditions
- Conduct regular inspection of drains, gutters; ensure rain water is draining away from the building
- Ensure thorough drying and follow-up monitoring of any area affected by leaks/flooding
- Segregate donations, archival acquisitions, gift collections; inspect before shelving

No, old or inadequate heating and cooling

- Use of fans, window-AC units, humidifiers and dehumidifiers require careful monitoring of conditions
- Staff need to be extra-vigilant about controlling humidity levels, especially when the weather is warm
- Dehumidifiers need to be emptied or be self-draining; don’t let water stand, especially in small storage spaces
- Humidifiers can be set too high and moisture levels can spike
- Avoid basement or below-grade storage of collections

Recommendations for the environment

- Keep the RH between 40% and 55%
- Most molds thrive at warmer temperatures. For patron comfort 70° F ± 2 ° is fine as long as you can keep the RH at or below 50%.
- Good air circulation will help prevent mold growth through drying via evaporation
- Good housekeeping (vacuum and dust regularly)
- Use dessicants (such as silica gel) in small, enclosed spaces

Part III. Response

Exercise

- Each team has a scenario
- Choose a recorder/reporter (can be the same person)
- 10 minutes to discuss
- What are the risks? Challenges?
- How will you respond?
- What were the major considerations in deciding on your response?
- Each team has 5 minutes to report
- Karen will summarize the main points. Discussion.

What to do if you discover mold in the Library

- **A mold bloom in the Library indicates that there has been an increase in relative humidity**
  - Changes in the natural environment (consider a very hot, humid summer)
  - Fluctuation in interior environment due to central systems being turned off, down, or not functioning properly
  - Construction/building disaster, e.g., roofing
  - Natural disaster, e.g., tornado, torrential rain, flooding

Verify that the problem is mold

- If you are susceptible to mold and mold is seen or smelled there is a potential health risk
- No matter what type of mold is present, arrange to have it removed
- People with allergies or those with asthma should not be in contact with affected material or where the mold bloom is located

Isolate collections

- Bag or wrap limited numbers of material in heavy plastic; seal
- If they are wet or damp this is just a temporary measure until they can be dried
- If the collection area must be isolated seal the entrances and return air intake vents to prevent mold from entering clean areas of the building; zones for negative and positive pressure
- Control access to contaminated materials and use appropriate Personal Protective Equipment (N95 or N100 disposable respirator, disposable gloves, protective goggles, protective clothing minimum)

Identify and eliminate the cause of the problem

- Determine the cause of the mold outbreak and take immediate action to correct it
- Measures may include lowering the RH, increasing air circulation, lowering temperatures, and removing standing water
- Discard wet building materials such as ceiling tiles, drywall, insulation
- If necessary, employ a company that specializes in desiccant drying and dry the affected facilities and furnishings, such as carpets and drapes
  - Company may do some demolition; should not also be in the business of renovation (referrals only)
  - http://www.youtube.com/watch?v=r7LRtkb-y7o

Deactivate the mold

- Mold is active if it feels damp and smears when brushed
- Deactivation will stop growth and prevent further damage
- Air dry or freeze
- Isolate until it can be cleaned

Air drying

- Lower the RH, circulate the air
- Seal return air vents; vent to outdoors if possible
- Use an isolated room with minimal furnishing that will be easy to clean later
- Direct fans away from artifacts to limit spore dispersal
- Can freeze then thaw to air dry a few at a time
- Drying outdoors is good if the air is clear; use a sheltered spot and bring them in at night

Freezing

- Freezing will kill mold but the spores are still viable
- Good if you have numerous objects – you don't have to worry that you have to dry everything in a hurry
- Not recommended for glass plate negatives, paintings
- A commercial service will freeze then freeze dry collection materials in the event of a larger emergency. Most will clean affected collections.
  - Consider dividing effort between staff and vendor when working with rare and fragile holdings

Clean the space

- Vacuum (HEPA)
- Clean all non-porous surfaces, including book trucks, library shelving, painted cinderblock walls, sealed concrete flooring, etc.
  - Lysol disinfectant diluted according to package instructions, Simple Green (bleach solution - 1 gallon of water/1 cup of bleach)
  - Microban: inhibits the growth of microbes

Clean the space (cont'd)

- Clean or remove carpets and drapes, upholstered furniture
- Clean and disinfect AC coils, filters, drip pans, ductwork for HVAC system
- Monitor the environment 24/7/365. Do you have conditions under control??? (Aqua Boy moisture meter to measure moisture content of books – 7% is considered dry)

Other options for space remediation

- Commercial services
  - *IAQM* – non-toxic treatment options?): MDF-500 is a two-part virucide, fungicide, bactericide, and antibacterial Disinfectant/ Decontaminant - http://www.iaqm.com/
  - Plasma treatment
- Chlorine dioxide? (Only if you are struggling to keep environmental conditions optimized for prevention of mold) – see *Archival Products News* 10, No. 3
- Marine products – see *Practical Sailor* Jan 2009, http://www.practical-sailor.com/issues/35_1/features/Marine-Maintenance-Mildew-Prodcuts_5726-1.html
- Sodium chlorite – odor treatment, “Star Brite MDG Odor Control Slow Release”, etc.

IV. Treating Collections

Fungistatics and Fungicides

- Fungistats prevent mold spores from germinating but do not kill the mold
- Fungicides kill the mold and its spores
- No safe large-scale treatment of collection material imparts lasting or residual control
- Book and papers can be damaged and may be more susceptible to mold after treatment

Fungistatics and Fungicides cont'd

- "A wide variety of fungicidal and fungistatic materials and procedures have been used to control mold. Fungicidal materials and procedures, such as ethylene oxide, kill mold and mold spores with a high degree of effectiveness and reliability. Fungistatic materials and procedures, such as thymol and ortho phenyl phenol, inactivate mold and discourage its growth but do not effectively kill it. Fungicidal materials and procedures, and fungistatic materials have been found to be too toxic and/or too damaging to collection materials to recommend their continued use. Also, none of the materials traditionally used impart any residual protection, so materials returned to situations with high relative humidity became increasingly susceptible to repeated mold damage." *American Institute for Conservation*
- Outside professionals may advise the use of specialized fungicides that must be applied by a licensed professional. None have been tested for their long term effects on collection materials, so their use is a last resort.

Dry cleaning

- If possible, work outside or in a fumehood ventilated to the outdoors or properly filtered; always use PPE!!!
- Vacuum up dry mold spore using a HEPA vacuum (variable speed control/micro-tools)

Dry cleaning - techniques

- Do not contaminate the nozzle with spore
- Brush mold spore toward the nozzle
- Cover the nozzle or brush attachment with cheesecloth when cleaning fragile bindings

Dry cleaning – techniques (cont'd)

- Vacuum mold from flat paper documents through screening
- Thoroughly clean the vacuum cleaner after use – new bags, filters, etc.
- Can use a dry, electrostatic cloth (replace rags frequently; store used cloths in a sealed bag and wash with bleach for re-use)

Cleaning books

- When the soft mold has been removed, the outside of book covers can be wiped with a solution of ethanol solution (70%). This acts as a mild solvent to remove some of the outer staining.
- Care must be taken not to wet the area too much.
- Mold stains may be seen on the inside of the binding, near the joints and at the head and tail. The stains can be gently swabbed with ethyl alcohol, but it is unlikely that they will be completely removed. (…consider rebinding)

Odor

- The musty odors produced by molds are known by scientists as Microbial Volatile Organic Compounds. Some MVOCs produce musty and moldy odors, which result form the chemical changes taking place during the mold life process. They are waste products given off by actively growing molds. Health effects such as headaches, dizziness and nausea have been linked to exposure to MVOC's.

Odor

- Ozone (vendor services)
  - Generally NOT for collections
  - May be a health hazard
  - Causes chemical reactions with collections materials (fading, yellowing, premature deterioration)
  - Treat only if you plan to reformat
  - Many vendors will not accept smelly collections for copy work
- Inert gas (also vendor services; NOT ozone)
- Use of MicroChamber™ paper interleaving tissues from Conservation Resources
  - Activated carbon, molecular sieves and alkaline buffering compounds
- Low-dust cat litter chamber within a chamber; baking soda; charcoal

Retention of mold-affected materials

- General collections: in many cases the best decision is to discard if they have no artifactual value
- Find replacements whenever possible
- Archival collections – vendor services; copying
- Rare and unique items: contract conservation services
- Accept only rare and scarce gifts; ask donor for funding and expedite conservation treatment
- Use in fumehood with PPE and good ventilation

Resources

- **EPA.** ***Mold Remediation in Schools and Commercial Buildings.*** http://www.epa.gov/mold/append_b.html (see *Molds and Moisture Control, http://www.epa.gov/mold/)*
- **Lyrasis.** ***Invasion of the Giant Spore.*** http://www.lyrasis.org/LYRASIS%20Digital/Documents/Preservation%20PDFs/Mold%20leaflet%20revisions0905.pdf.
- **NEDCC.** ***Emergency Management of Moldy Books and Paper.*** *www.nedcc.org/free-resources/preservation-leaflets/3.-emergency-management/3.8-emergency-salvage-of-moldy-books-and-paper*
- **Canadian Conservation Institute.** ***Mould Outbreak – An Immediate Response.*** https://www.cci-icc.gc.ca/caringfor-prendresoindes/articles/mould-moisissures/index-eng.aspx (good info on PPE)

Contact information

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