DHPS | NY

MOLD: PREVENTION, DETECTION, AND RESPONSE

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Documentary Heritage and Preservation Services for New York is a five year initiative to deliver collections-related training, preservation surveys, archival assessments, and other services to the historical records community in New York.

New York State Library

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Documentary Heritage & Preservation Services

FOR NEW YORK

Website: dhpsny.org

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CONSERVATION CENTER

for art & historic artifacts

Let's talk about…

- **Mold origin and growth:** what it is, where it comes from, and why we don't want it growing on our heritage collections;
- **Mold prevention:** how to keep it from occurring;
- **Mold detection:** how to determine if you have a mold problem, and if the mold is active or inactive;
- **Mold response:** how to deal with a mold situation safely (for both objects and people);
- **When to get help:** how and when to get the experts involved.

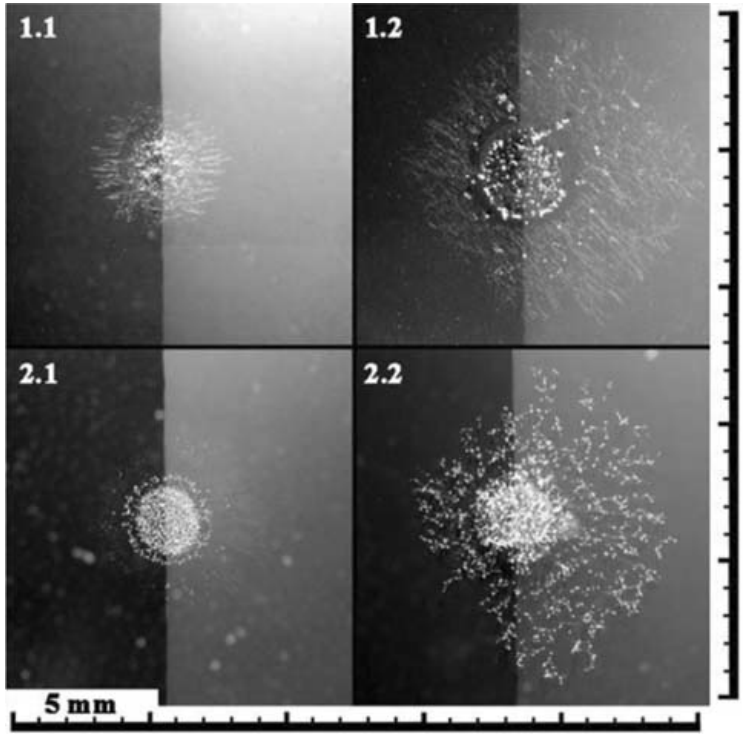


Image: Miguel J. L. Lourenço and José Paulo Sampaio

Mold: What is It?

Mold is everywhere.

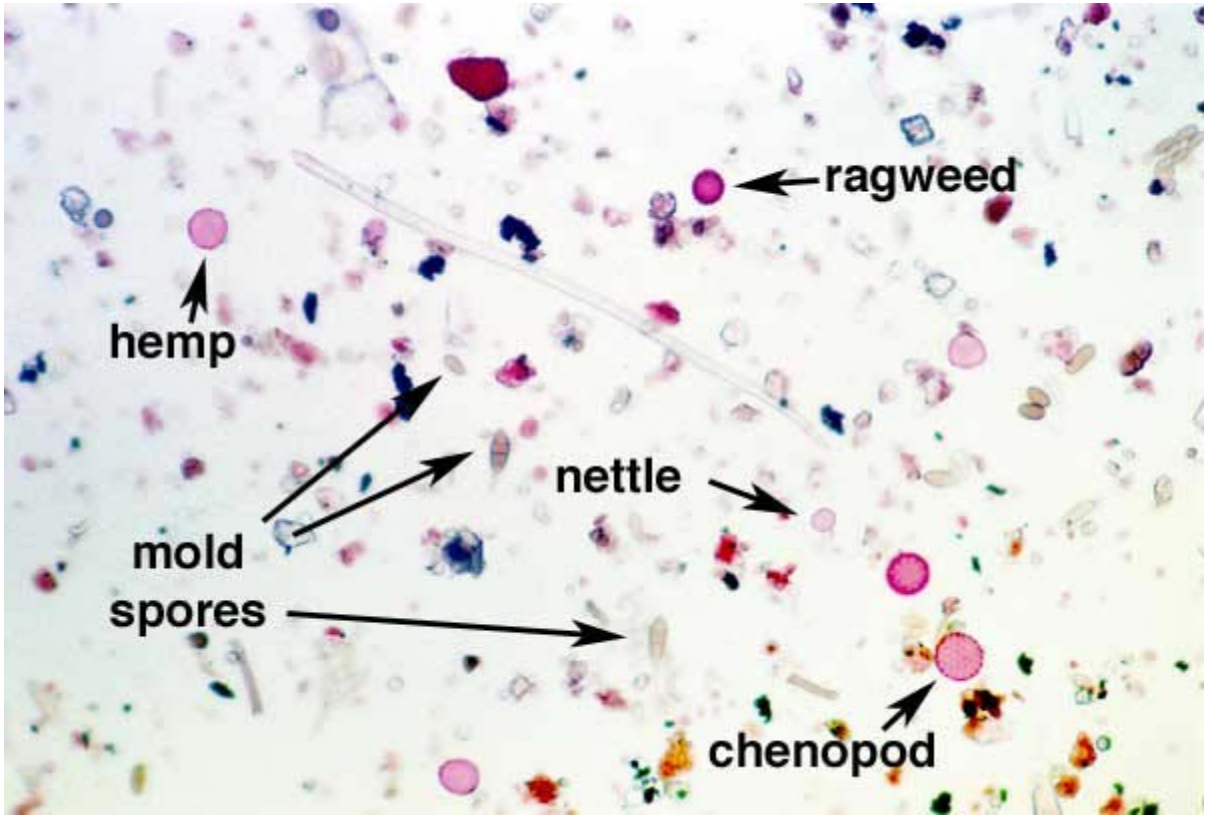


Image: InterNACHI

Where does it come from?

- Airborne particles
- Dusty surfaces
- Food and plants
- Inherent contamination of materials or solutions used during the manufacture of an object
- Contamination during use, for example outdoor exposure
- Moldy materials brought in from outside

Penicillium in petri dish. Image: mnhn.fr

Fungi – but not fun, guys.

The majority of mold found on heritage materials are *Eurotiales* conidial fungi, which include *Aspergillus*, *Penicillium*, and *Eurotium*.

Megan Biango-Daniels/CALS

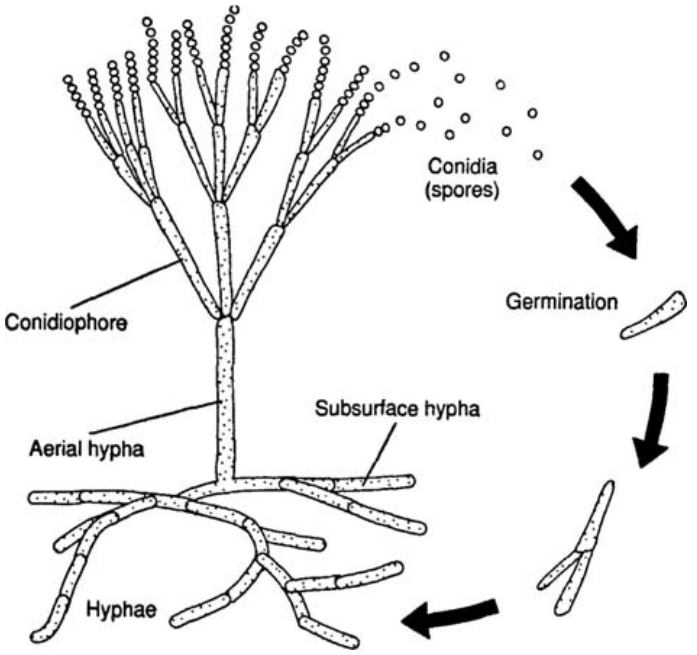


Image: cliffsnotes.com

Mold reproduction

Image: Libraries and Archives Canada

- Mold disseminates large numbers of conidia which travel through the air, land on new surfaces, and germinate (under the right conditions).
- Conidia sprout *hyphae* (the fuzzy, hair-like stuff), which in turn produce spore sacks that burst and release more spores. This begins the life cycle anew.

Mold is attracted to the materials that make up heritage collections

- Starches: adhesives, sizings, and cloth
- Proteins: leather, parchment, gelatin, animal glues, and photographic emulsions
- Cellulose and lignin: wood furniture, objects, and frames; paper and books
- Soiling deposits: skin cells, clothing fibers, external dirt, oily secretions, and industrial pollutants on collections and storage furniture

Mold damage to collections

- Compromises and weakens collections by digesting material components
- Weakened collections are more easily susceptible to further damage and can absorb water more easily
- Some molds contain colored substances that can cause permanent (or very difficult to remove) staining

Image: New York Society Library

Mold Prevention

Mold is a cheap date. It just needs organic material and moisture to be happy.

Environmental factors that affect mold growth

Image: hiveminder.com

- Moisture
- Temperature
- Air circulation
- pH
- Nutrients
- Light

Moisture and mold growth

- Relative humidity (RH) above 70% increases the likelihood of mold growth, but moisture content of the substrate it is growing on is also an important factor. The hygroscopic properties of heritage materials make them attractive to mold.

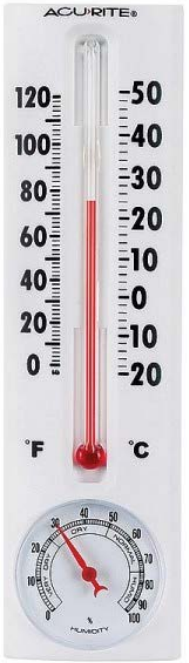
- Mold requires a moisture source to grow, to produce enzymes that break down material to obtain nutrients from the substrate, and to reproduce.

Moisture and mold growth

- Sources of moisture:
  - High relative humidity in the immediate environment; poor air circulation
  - Flood or water from an activated fire suppression system
  - Aqueous conservation treatments

Temperature and mold growth

- Most mold will grow at temperatures between 59-95°F, but can this range can to 40-100°F depending upon other factors.
- Optimum temperature for growth is around 86°F but varies depending on mold type.
- Mold spores can lie dormant at sub-zero temperatures.
- Temperature – RH relationship is important to understand.



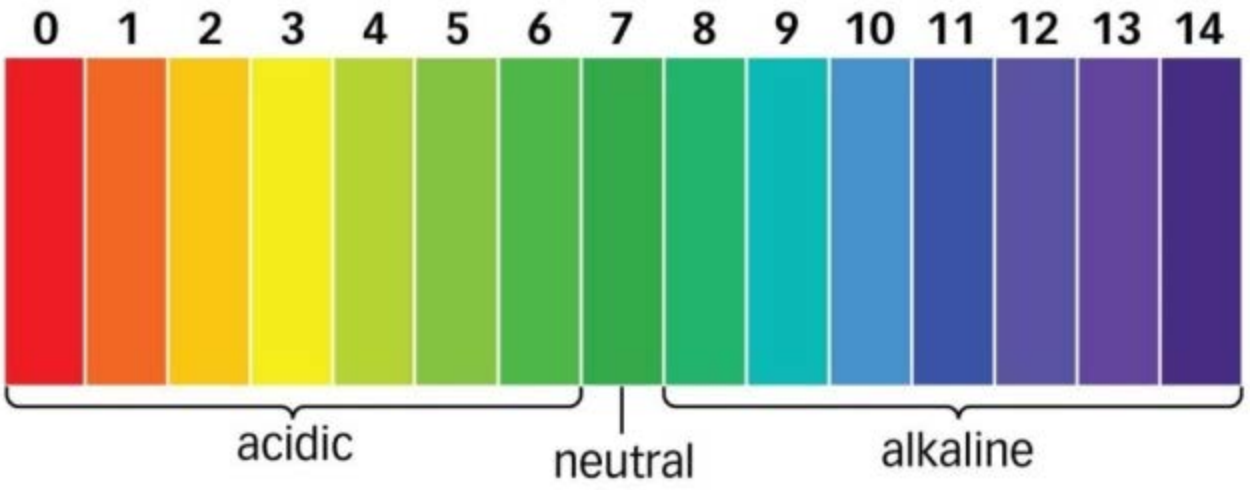
Air movement and mold growth

Image: nightmareonpreservationstreet.blogspot

- Air circulation increases evaporation and drying.
- All things being equal, air flow can mean the difference between mold bloom or no mold bloom.

pH and mold growth

- Slightly acidic substrates encourage mold growth.
- A pH of 6 is optimum for most species which grow on heritage collections.



Nutrients and mold growth

- An especially rich source of nutrients can compensate for other factors, like a harsher environment.
- Mold produces enzymes which break down the substrate to obtain nutrients – including carbon, hydrogen, oxygen, nitrogen, sulfur, potassium, magnesium, iron, zinc, copper, manganese, and in some cases, calcium.

(a different type of mold)

Light and mold growth

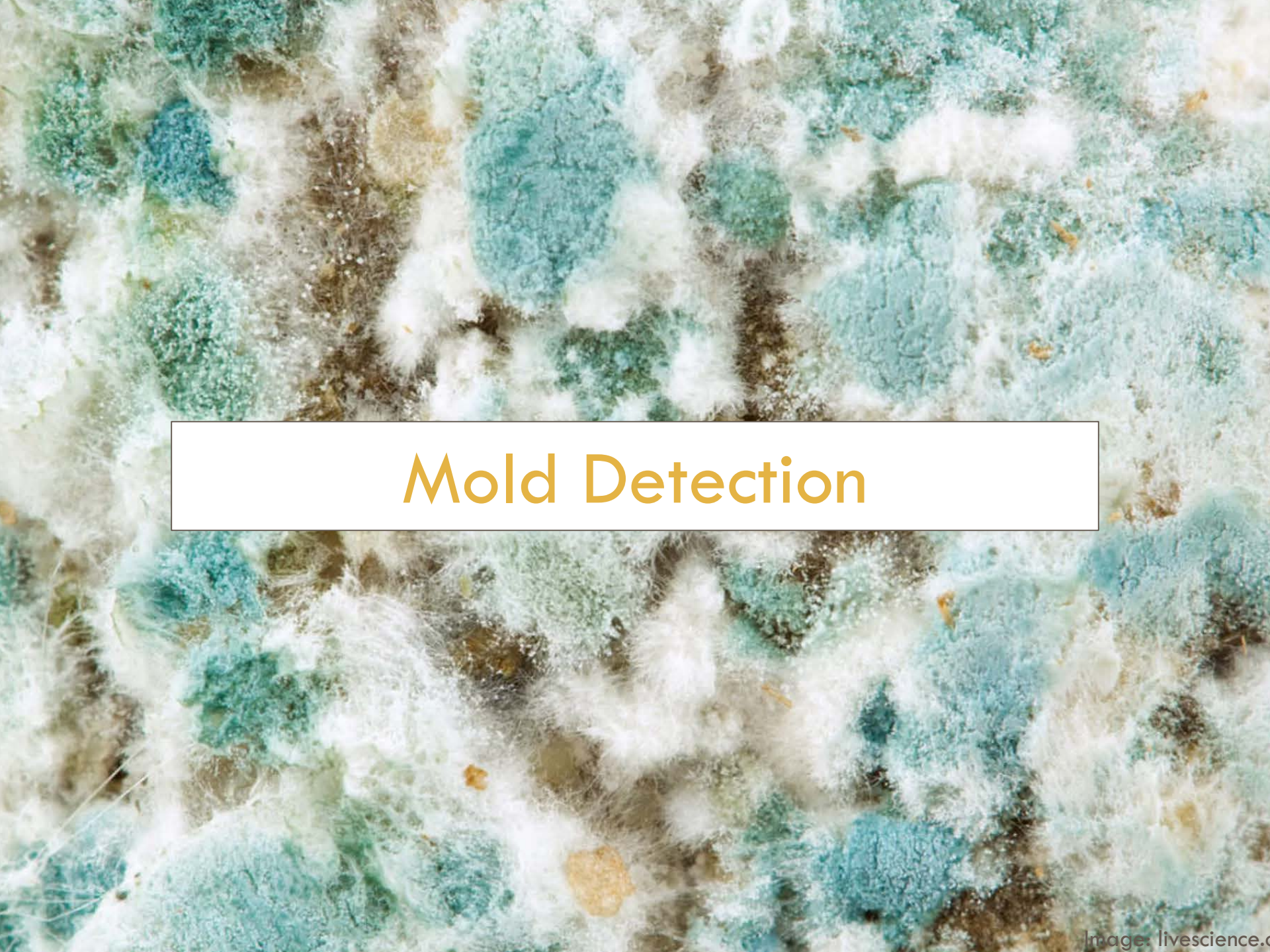
Image: The Atlantic

- Light necessary for spore production and the formation of conidiophores in some species.
- Some species are diurnal and growth is accelerated in the dark (concentric circles).

To sum up:

- In general, the higher the RH the more readily mold will grow.
- High temperatures, stagnant air, and uncontrolled storage spaces all contribute to mold growth.
- To keep mold spores dormant, temperature should be kept below 70F and 60% RH.

Mold Detection



Active mold vs. inactive mold

- Active mold: furry, fuzzy, smeary, spreads rapidly.
- Inactive mold: powdery, dry, easily brushed from the surface.
- If unsure, always assume it is active and be safe!

Image: miahalf.com

Mold will grow on a variety of surfaces and materials

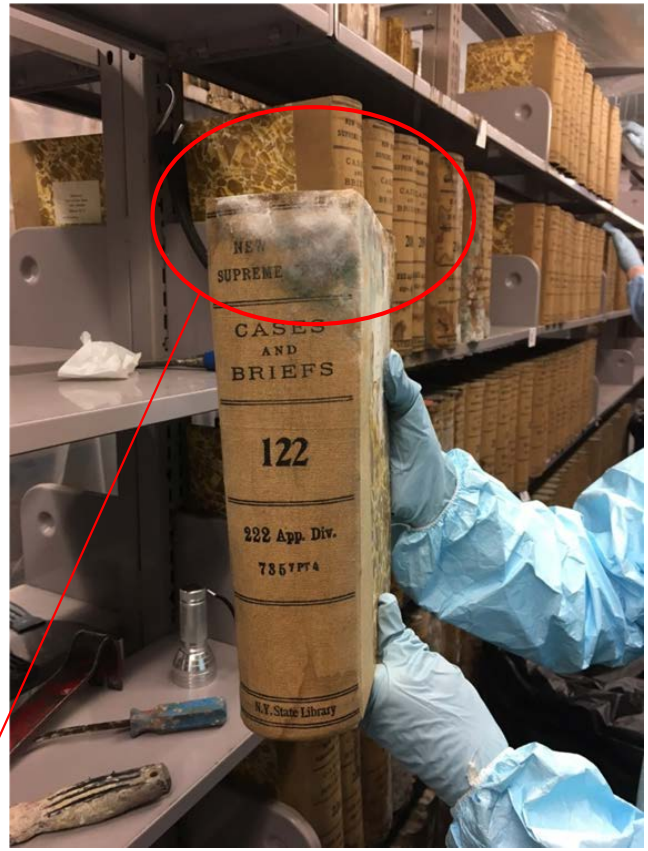


Image: NY State Archives

Fuzzy, active mold

Image: Filmcare.org

Look for circular, reticulated growth structures – networks of hyphae

Mold looks like:

Image: Document Restoration Services

Dark mold causes staining

Image: Filmcare.org

Distinct growth centered on individual germination sites

Mold also looks like:

Image: UCLA/Getty Conservation

Hyphae and spores

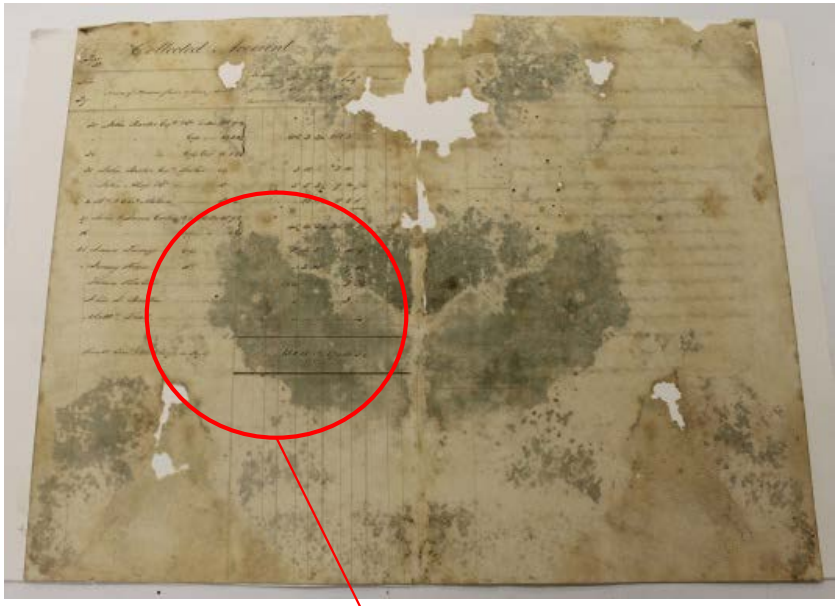


Image: Derbyshire Record Office

In folded papers and book gutters mold can look like a Rorschach test

Not mold but looks like it: foxing

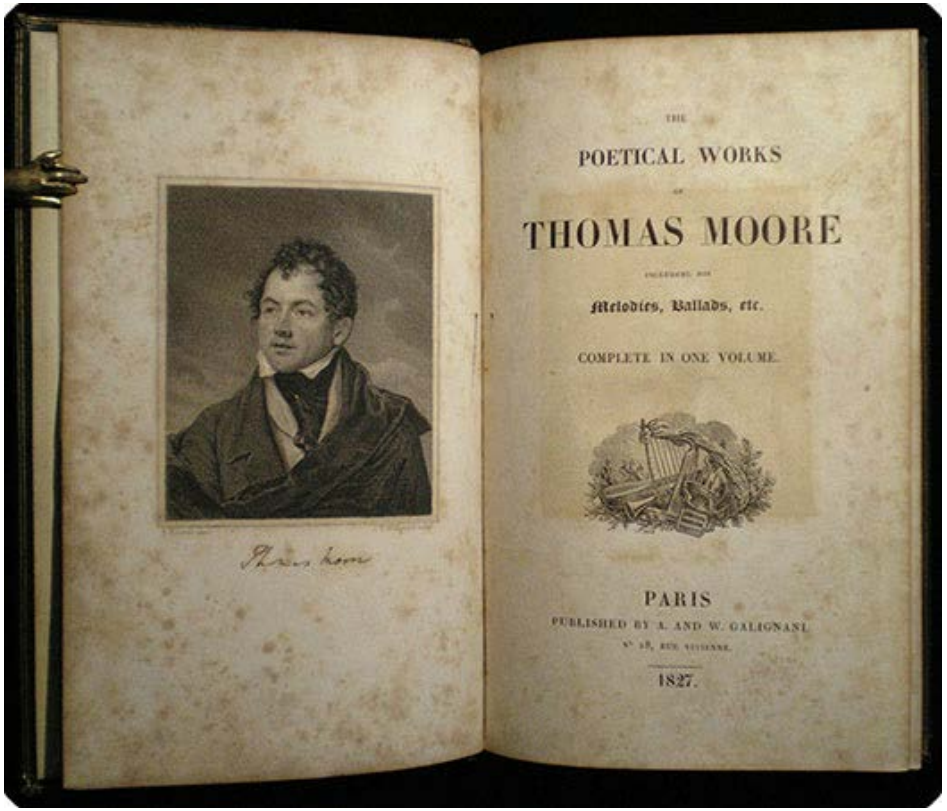


Image: theprivatelibrary.typepad.com

Not mold but looks like it: dust

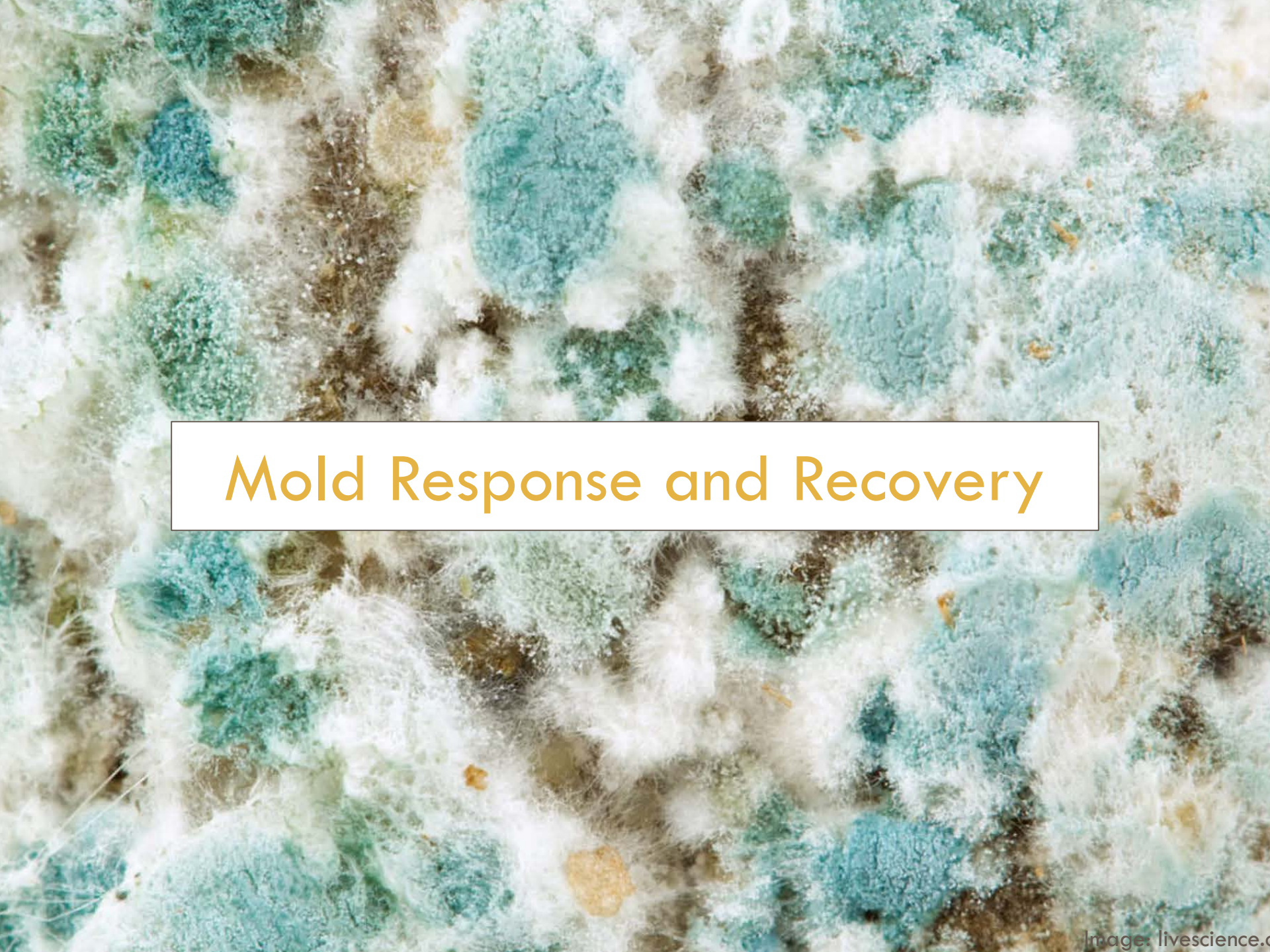
Dust tends to be uniform, with buildup along vertical edges; under magnification, dust will not show threadlike *hyphae* or growth centers.

Not mold but looks like it: tidelines

Image: Firefighters' Museum of Calgary

Exposure to moisture can cause tidelines; not mold BUT mold growth patterns do often follow areas of exposure to moisture.

Mold Response and Recovery



Mold health and safety

- Mold sensitivities can develop very suddenly and can be severe; can trigger allergies, asthma, inflammatory reactions in the short term.
- Long-term effects of mold exposure are still not fully understood.
- People with compromised immune systems, severe allergies, diabetes, asthma, people on steroid therapy, and pregnant women should NOT be involved in a mold recovery operation.

Personal Protective Equipment (PPE)

- Minimum Protection (10 square feet surface area or less): N95 respirator, gloves, goggles/eye protection.
- Limited Protection (10-100 square feet surface area): N95 respirator or half-face respirator with HEPA filter, gloves, disposable overalls, goggles/eye protection.
- Full Protection (100 square feet surface area or more): gloves, disposable full-body covering, head gear, shoe covers, full-face respirator with HEPA filter.

Personal Protective Equipment (PPE):

Respirators

Personal Protective Equipment (PPE):

Cover Up

First response for a mold bloom:

Step 1: Locate the source of moisture/humidity

- could be a leaky pipe, broken window, flooded basement, HVAC system issue.

- In a water emergency this should ideally be done within the first 24-48 hours.

The Great Flood of Florence, 1966

First response for a mold bloom:

Step 2: Lower humidity and increase air movement

- dehumidifiers, open windows, fans at low speed
- if HVAC system can dehumidify the air, turn on/adjust; if it is thermostatically controlled or is a fan coil system, turn it off
- Do not point fans directly at affected materials as this can spread mold spores

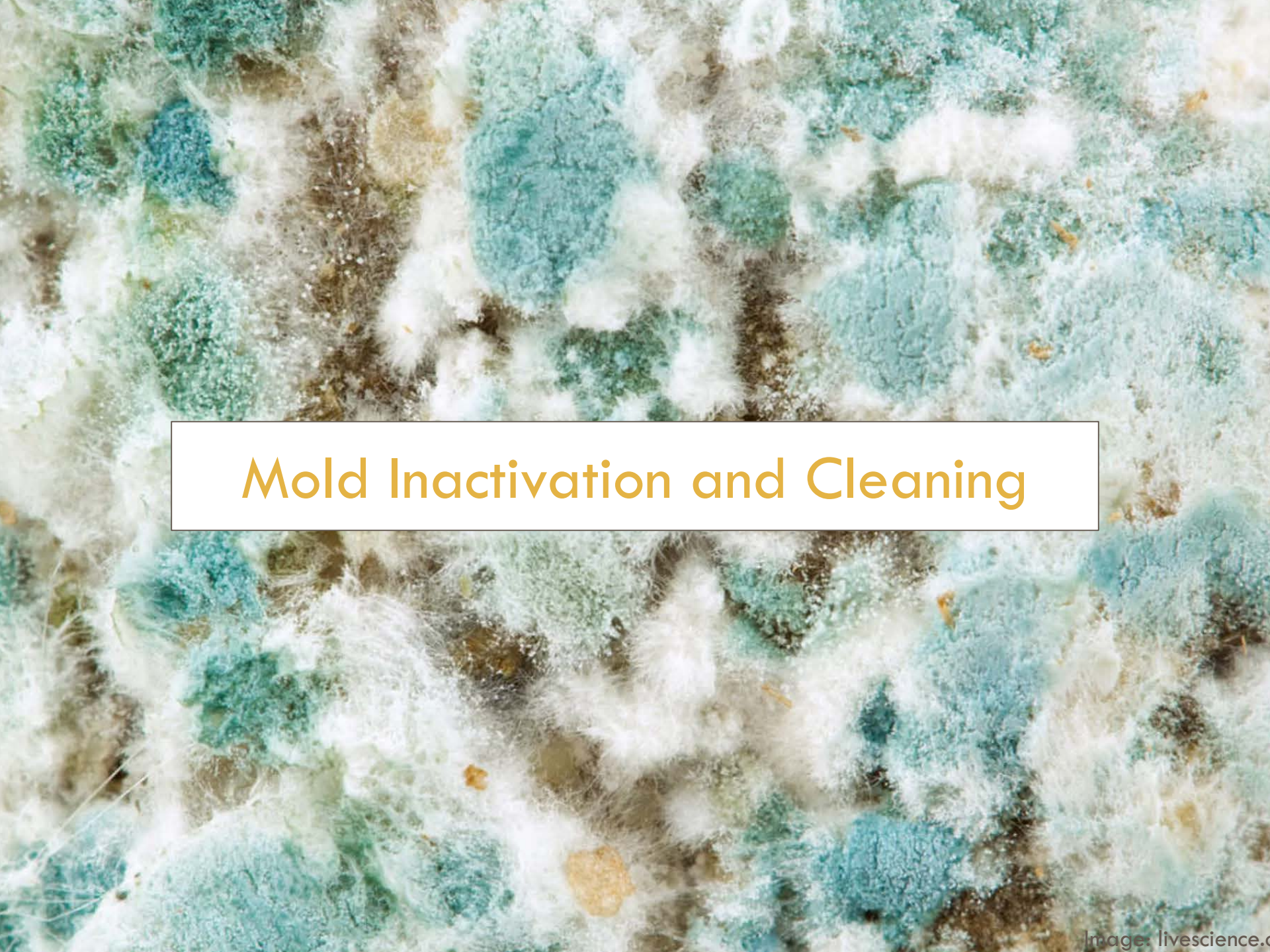
Image: Harvard University Library

First response for a mold bloom:

Step 3: Isolate affected materials

- In a large outbreak avoid moving affected materials out of the area; treatment in situ is best when possible. Temporarily cover wet items with Tyvek.
- In a smaller outbreak, items can be sealed in plastic bags for transfer to the mold treatment area.
- Unaffected items can be placed in plastic bags; disposable material should be packed in polyethylene bags, sealed, and disposed of.
- For large blooms quarantine the area and get professional help immediately. Close doors, hang plastic sheeting to isolate affected areas, and reduce air circulation from the affected area to other parts of the building.

Mold Inactivation and Cleaning



Times when you must get an outside contractor involved

- Medium to large-scale outbreak
- Toxic strain of mold
- Delicate, rare, or valuable materials
- When mold is also combined with the possibility of hazardous substances, i.e. from sewage, after a natural disaster, possibility of toxic chemicals
- If the HVAC system and building are also moldy
- When you just don't have the staff or resources to deal with it yourself

Steps for dealing with mold on collections

1. Inactivate active mold growth – do NOT try to clean active mold!
2. Clean the affected items.
3. Clean the site of the mold outbreak.
4. Address the origination of the mold growth.
5. Return the materials to the affected area.
6. Monitor conditions carefully!

Image: NY State Archives

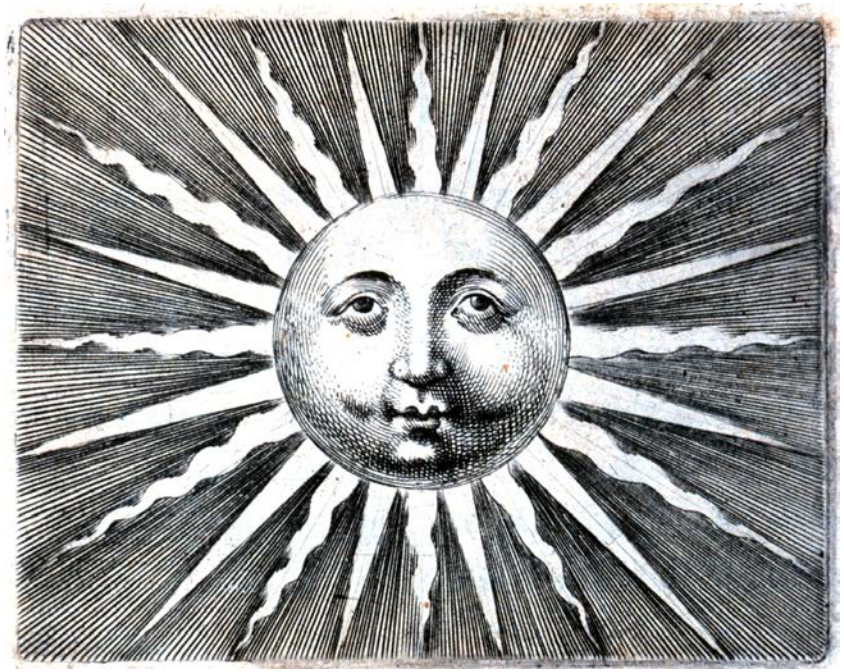
Inactivating mold: freezing

Image: Parks Library Preservation

- Below 20°F
- Pros: very low temperatures can stop active mold growth and prevent new mold growth from occurring; in the case of wet materials, buys you time while weighing drying options
- Cons: freezing not appropriate for all types of materials

Inactivating mold: UV light/sunlight

- Sunshine or UV lamp under 30 mins.
- Pros: good for small outbreaks, can inactivate mold and assist with drying.
- Cons: UV light is damaging to all archival and library materials, so exposure must be limited; dependent upon the weather.



Inactivating mold: desiccant drying

- Moist air pumped out of the outbreak area and circulated through desiccant drying system and reintroduced into the space – done by an outside vendor.
- Pros: good for medium or large-scale outbreaks.
- Cons: expensive, not always feasible.

Inactivating mold: air drying

Image: North Carolina Preservation

- This method is only for damp materials – not wet or soaked materials.
- Pros: good for small outbreaks, materials which may not be able to be frozen/desiccated.
- Cons: only for certain situations, takes quite a bit of space and manpower.

Cleaning mold off objects

- Do NOT try to clean active mold, or any friable materials (pastels, charcoal drawings, corroded iron gall ink, flaking paint)!!
- Do this outdoors or indoors using a fume hood with a mold-trapping filter.
- Use a variable-speed vacuum with a HEPA filter.
- Do not vacuum items directly.

HEPA vacuum

Image: Suzanne Sawyer, Emory University

Cleaning mold off objects

Images: Duke University Library

Cleaning mold-affected areas

- Thoroughly clean the affected area including floors, work surfaces, and shelves.
- Vacuum with a HEPA vacuum, then wipe nonporous surfaces with water or water with detergent.
- Cleaning surfaces:
  - 0.5% sodium hypochlorite by volume in water
  - 40% isopropyl alcohol (rubbing alcohol) by volume in water
  - 70% ethyl alcohol by volume in water
  - Ensure furniture, floors, and work surfaces are completely dry before returning objects.

Mitigating Future Risk

Mitigating Future Risk

- Planning and policy
- Segregated area for incoming items
- HVAC and building maintenance
- Proper storage
- Housekeeping
- Maintaining appropriate environmental parameters
- Environmental monitoring

Mitigating future risk: planning and policy

- Emergency preparedness and response plan
- Procedures for an incoming object suspected of a mold infestation
- Maintenance and housekeeping plans
- Environmental monitoring plan

Image: EPA

Mitigating future risk: HVAC and building maintenance

Image: Library of Congress Collections Recovery Room

- Regular inspection and cleaning of HVAC system, frequent change of filters
- Regular maintenance and checking of trouble areas
- Ensure good air circulation throughout the building

Mitigating future risk: housekeeping

- Regular dusting
- Keeping collections materials in boxes when possible
- Vacuuming floors instead of sweeping
- Keep collections areas free of food, drink, and plants

Mitigating future risk: environmental control and monitoring

- Keep humidity below 55% and temperature below 70°F to ensure that mold is not reactivated.
- Monitor the environment regularly with independent (non-HVAC) data loggers.
- Record data to observe trends.

Mitigating future risk: proper storage

- Avoid storing materials in damp basements.
- Store collections at least 4-6 inches off the floor.
- Avoid storage in areas with past leaks and/or poorly insulated exterior walls.
- Open compact shelving units to prevent formation of air pockets.

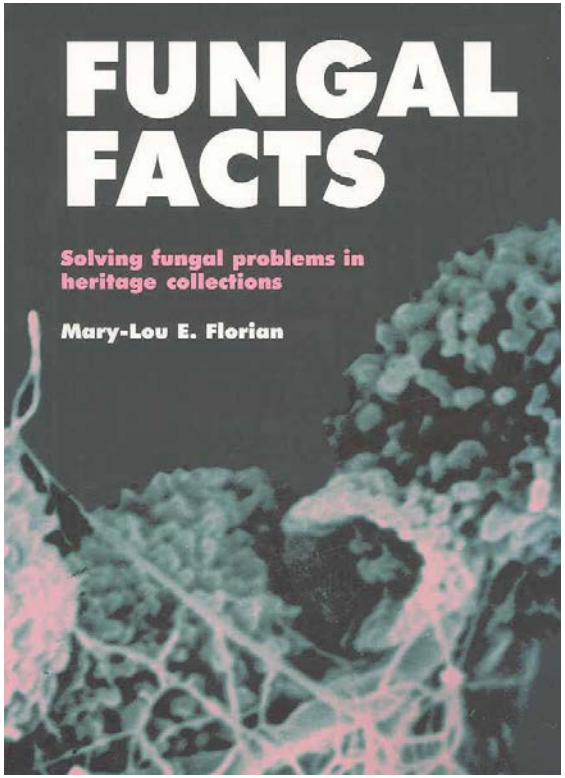
Image: Rudi Gernreich Archive, FIDM Museum

Resources

Additional resources

- Environmental Protection Agency guide to mold: https://www.epa.gov/mold

- American Conservation Institute (AIC) Find a Conservator tool: http://www.conservation-us.org/membership/find-a-conservator



Questions?

Fiber art by Elin Thomas (elinthomas.com)

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