NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

# Conserve O Gram

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## Causes, Detection, And Prevention Of Mold And Mildew On Textiles

*Mold* and *mildew* are the common terms used to identify a whole range of microorganisms that survive on organic materials and cause damage. Textiles are particularly susceptible to damage through microorganism growth, a problem familiar to collection managers. A large number of fungi, bacteria, yeast, and algae have been identified as surviving on fabrics. Associated with a characteristic musty odor, microorganism growth appears as an irregular stain which generally ranges in color from gray to black although yellow, orange, and red stains are possible. Permanent discoloration of the fabric results.

### *The Microorganisms*

Fungal spores are virtually omnipresent, in the air and in soil. Once exposed to the appropriate temperatures and levels of relative humidity (RH), they can germinate. These levels are different for each species of organism but in general, temperatures above 24°C (75°F) and a RH above 65% provide optimum conditions for growth. Under magnification, fungal spores look like tiny plants with roots, stems, and flowers. They grow in colonies as their roots spread. See NPS *Museum Handbook,* Part I (Rev 9/90), Chapter 5.

### *Factors Affecting Biological Deterioration*

1. *Fiber Content.* All fibers will support microorganism growth. However, natural fibers (cellulosic and proteinaceous) are more susceptible to damage than are synthetic fibers. The cellulosics, such as cotton, linen, rami, jute, and rayon, are most vulnerable and are attacked by cellulytic fungi an bacteria. These microorganisms produce enzymes that convert the cellulose to soluble sugar, which is metabolized as food. While protein fibers, such as wool and silk, are less susceptible to attack, keratinophilic fungi will feed on and damage these fibers as well.

2. *Environmental Conditions.* Microorganism growth on textiles is routinely associated with damp conditions. Requirements for spore germination vary with species. Growth is noted when the RH is above 50%, and rapid spread occurs above 80% RH. Temperature is another critical factor for germination. Generally, spore activity begins above 24°C (75°F), increasing with higher temperatures. Some microorganisms can grow in significantly lower temperatures and at lower RH levels. Poor air circulation or stagnant air exacerbates problems.

3. *Cleanliness of the textile surface.* Microorganisms often start growth on soilants and textile auxiliaries, such as starch, sizing, and brighteners. Textiles relatively free of dust and food stains are less susceptible to becoming a host.

4. *Acidity/alkalinity.* The acid and alkaline content, or pH, of a textile is measured on a scale from 0 (very acidic) to 14 (very alkaline) with 7 as neutral. The pH of a textile will affect the growth of bacteria and fungi on it. The microorganisms can survive in both acidic and alkaline conditions within the pH range of 4.0 to 9.0.

### *Detection*

Often, the initial indication of a microorganism problem is a characteristic musty odor. Examining the object will generally reveal stains with clearly visible pigmentations. Another means of detection is the examination of the piece under ultraviolet (UV) light. The growths will flouresce, appearing luminescent. However, some auxiliary agents added to textiles during processing and finishing and found in detergents contain chemicals (such as optical brighteners) which will also fluoresce, limiting the usefulness of this technique. Also, identification under a microscope is possible, a technique conservators routinely use.

### *Damage*

Microorganism growths will permanently stain a fabric. The resulting damage will remain as a darkened area and only radical treatment procedures inappropriate for a historic textile will visually diminish such stains.

Once a microorganism population is established, it alters the pH of the cloth. This alteration may result in a change of colors in the dyes. There can also be a decrease in the strength of the cloth. For these reasons, it is critical that an infestation be dealt with immediately.

### *Health Hazards*

Health risks must be considered whenever a microorganism infestation exists. Certain species of microorganisms are pathogenic in high concentrations. They attack the mucus membrane of the lungs and can cause chronic irritation.

If a very badly infested textile is discovered, caution should be exercised in its handling. Rarely are the resources available to identify the microorganism for its pathogenic nature. Therefore, as a precaution, a respirator with a high-efficiency particulate air (HEPA) filter and disposable gloves should be worn. The textile should be isolated by sealing it in polyethylene and the advice of a textile conservator sought immediately. The textile cannot be left in this condition as increased damage will occur.

### *Prevention*

Control of environmental conditions is by far the most effective method of preventing the biodeterioration of textile artifacts. It is effective not only for the control of micro-organisms but for control of other agents of damage such as insects. Cool, dry conditions, adequate ventilation, and general good housekeeping practices are critical to the long-term preservation of a textile collection.

### *Environmental Control*

Conditions recommended for textile storage include a temperature of 18°C to 20°C (64°F to 68°F). Temperatures may be lower than these levels but the upper limit should be 24°C (75°F). The relative humidity should be kept below 65% and a level of 50% to 55% is recommended if possible. These conditions should be maintained consistently as fluctuations may allow dormant spores to begin growth. Fluctuations are also deleterious to textile collections as fibers dry out and then absorb moisture, swelling and cracking with each swing in RH.

Numerous methods can be employed to eliminate dampness and maintain optimum conditions. Dehumidifiers will pull moisture out of the air. Desiccant bags can be placed in storage cabinets or exhibition cases for climatic stability. However, the bags must be monitored and maintained. They will absorb moisture and become fully humidified losing all effectiveness. They may need to be conditioned to a lower humidity level periodically. Stagnant air should be replaced with a gentle air circulation.

### *Treatment*

The growth of microorganisms should be controlled by prevention. However, when

growths are encountered on a textile, a combination of mechanical treatment methods should be attempted to eradicate the problem and prevent its spread. A textile conservator should be consulted in the early stages of the decision-making process for any treatments other than vacuuming.

Vacuuming the textile will remove most of the active growth. However, the procedures for vacuuming must be well thought out and the appropriate equipment must be used. A vacuum which will not exhaust the microorganisms out into the surrounding environment is critical. The Division of Conservation recommends using a vacuum with a HEPA filter. Such filters trap extremely fine particles. Alternatively, a vacuum which filters intake air through water, such as the Rainbow™ brand vacuum cleaner that many parks have been using, is acceptable for this purpose.

Suction of the vacuum should be gentle and regulated so that it is appropriate to the condition of the textile. Vacuuming guidelines are found in the NPS *Museum Handbook,* Part I (Rev 9/90), Appendix K.

After active growth has been mechanically removed, a decrease in moisture content will slow or inhibit new growth until appropriate environmental conditions can be achieved. Gentle air circulation in the form of a dry, cool air flow is effective to accomplish this.

Dry cleaning is another treatment option that will kill microorganism growth. However, the use of drycleaning solvents requires special procedures and temperature levels that must be adhered to when cleaning historic textiles. Therefore this option should be considered only in consultation with a textile conservator.

Freezing, which has recently become a widely used method of pest eradication in the United States and Canada, has not been thoroughly researched for its effects on bacteria and fungi. Growth and metabolic activities are reduced at 0°C (32°F) but not enough information is available regarding lethal temperatures.

Chemical biocides capable of destroying organisms are the treatment of last resort. It is recommended that the species of fungi be determined before selecting a biocide. Then its use may be considered only in consultation with the regional Integrated Pest Management (IPM) Coordinator and the Regional Curator. A proposal for pesticide use must be submitted and receive final approval from the Servicewide IPM Coordinator in Washington, D.C. Use must conform to all NPS and Environmental Protection Agency restrictions and guidelines. In addition, a textile conservator should be consulted to review the effects of any chemical proposed for use on the museum object.

### *Sources*

UV lamps may be ordered from a hardware store.

HEPA filter respirators and disposable gloves are available from laboratory supply companies, such as Lab Safety Supply, P.O. Box 1368, Janesville, WI 54547-1368, (800) 356-0783.

HEPA filter vacuum cleaners are available from laboratory supply companies, such as Lab Safety Supply, or from Nilfisk of America, 300 Technology Drive, Malvern, PA 19355, (213) 647-6420.

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