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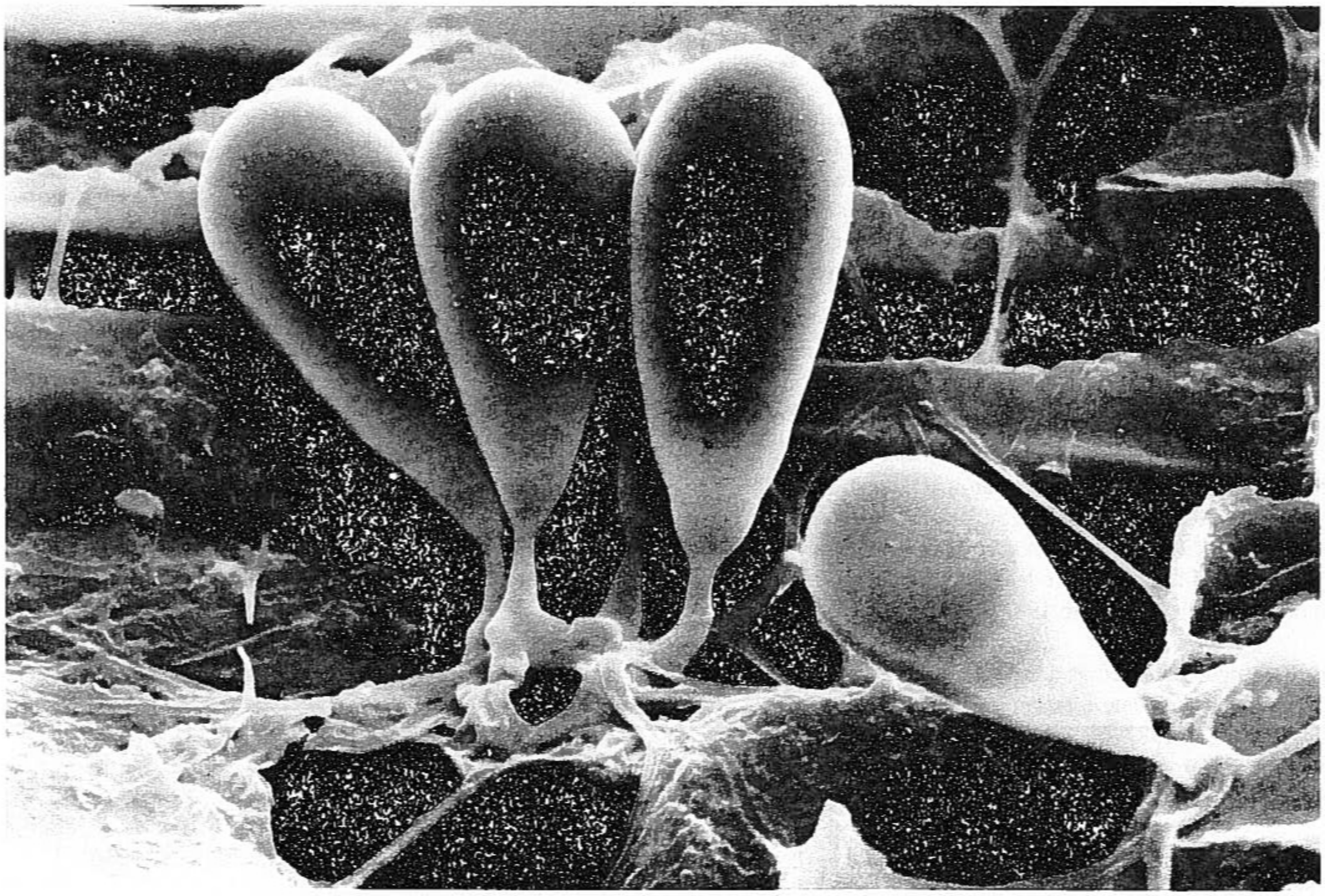
Controlling Museum Fungal Problems



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Controlling Museum Fungal Problems

by
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Abstract

Fungi can seriously damage artifacts in Canadian museums and archives. This damage can be avoided by controlling the museum environment. Nonchemical methods are most effective in eliminating fungal growth. Chemical methods (fungicides, fumigants) should be employed only as a last resort in coping with disaster.

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1. INTRODUCTION

Fungi are familiar organisms in forms such as bread mould, mushrooms, and toadstools. Unlike plants, fungi cannot photosynthesize, and they must feed solely by digesting the substrate on which they grow. Fungi are divided into two general groups: unicellular organisms called yeasts, and multicellular organisms popularly called moulds, mildews, and mushrooms.

The body of a mould is called a mycelium and consists of many fine filaments called hyphae. During their life cycles, many fungi form specialized structures that produce reproductive bodies called spores. Depending on the species, spores can range in size from 1 micron to 200 microns, yet even the largest are light enough to be carried long distances by air currents.

Museum collections include organic materials of plant or animal origin, such as paper, parchment, textile, leather, fur, and feathers. Under suitable conditions, fungi can attack all of these materials. Damage can range from stains to complete destruction.

Most fungi are ecologically beneficial organisms that consume dead organic matter. Museum collections have problems when poor environmental control allows the growth of fungi on artifacts.

Fungi will tolerate temperatures between -6° C and 83° C, but most grow between 4° C and 30° C. Some thermophilic fungi grow best at 40° C to 50° C. Fungi germinate, grow, and produce spores only when the relative humidity is higher than 65%.

2. IDENTIFYING A FUNGAL PROBLEM

Fungi often appear as a white or coloured velvety growth and are sometimes accompanied by a musty odour. Isolated disfiguring spots are a sign of early stages of mildew.

Powdered surfaces, dirt, dust, and fibre deposits are often mistaken for mould. The hyphae of surface mould will often appear to radiate from a central spot where the spore had germinated. Dust, on the other hand, will be randomly distributed. Examine with magnification to determine if the object is mouldy.

This Bulletin does not discuss the species of fungi that might attack museum artifacts. The extensive review by Kowalik (1980 a,b, 1984) and the handbook by Bravery *et al.* include many illustrations of the fungi that deteriorate textiles, wood, papyrus, paper, parchment, leather, and other organic materials.

It is not usually necessary to identify the species of mould before beginning treatment.

3. FUNGAL PROBLEMS IN WOOD OUTDOORS

Fungi will affect unmaintained wooden buildings and artifacts stored outdoors. Fungi only grow in wood when the moisture content is between 20% and 80%. Moisture content is the amount of water expressed as a percentage of the dry weight of wood. Wood with less than a 20% moisture content is too dry to support fungal growth. Wood with a greater than 80% moisture content is saturated with water and the oxygen concentration is too low for growth.

Wood-decaying fungi discolour wood and lower its mechanical strength. Fungal damage to buildings is indicated by odour, dampness, discolouration, and warping or sagging of the structure. Building deterioration can often be traced to water penetrating the roof and walls or rising from the foundation.

Any wood in direct contact with soil, or on stone or brick set in soil, can absorb enough water to be attacked by fungi.

As fungal decay begins, wood discolours around the active fungi: hardwoods turn cream or white; softwoods develop brown spots or streaks. A blue discolouration in newly milled coniferous wood results from sap-stain fungi, and does not affect strength.

As decay progresses, wood loses strength, takes on a mushroom odour, and becomes softer, less dense, and more hygroscopic.

Moisture meters can be used on wood to find dampness that may indicate active fungal growth. Detecting rot in wood can be difficult. Several non-destructive methods have been devised to find and measure loss of strength caused by rot in wood, but none are entirely successful (Grattan *et al.*, 1987; Grattan, 1989).

For general care of artifacts displayed or stored outdoors, consult CCI Note 15/2, *Care of Artifacts Displayed or Stored Outdoors*.

Wood-decaying fungi look like cotton batting, wool fibre, thin white sheets, or strands. There are three groups of wood-decaying fungi: brown, white, and soft rots.

3.1 Brown Rots

Brown rot fungi are most commonly found digesting the cellulose in softwoods. The wood turns brown and cracks across the grain into brick-shaped pieces that crumble easily. This process is called cross-checking.

3.2 White Rots

White rot fungi digest the lignin and polysaccharides in wood. The fungus appears first as small, lens-shaped holes filled with white material, and may eventually reduce the wood to a soft white mass. Cross-checking does not usually occur. White rots are most common on hardwoods.

3.3 Soft Rots

Soft rot fungi attack wood with very high moisture content that is exposed to air, such as marine pilings. The wood becomes dull, dark, and spongy. As it dries, the wood cracks into cubes.

In the advanced stages of any of these rots, fruiting bodies may eventually appear as mushrooms, brackets, or round or elongated structures with pores or gills.

4. CONTROLLING FUNGI

The nonchemical methods that follow are the simplest, safest, and most effective ways to prevent and control fungi found on organic materials in museum collections. This Bulletin does not discuss preventing and controlling fungi on artifacts preserved in liquids.

4.1 Prevention

Keeping the relative humidity below 65% will prevent mould growth on artifacts.

Monitor the relative humidity throughout the museum to detect damp areas where fungi could grow. Exterior walls, floors, and cold surfaces should receive special attention. A temperature difference of a few degrees can create a large variation in local relative humidity.

Do not store or exhibit artifacts directly against outside walls. Use exterior walls as one side of aisles in the storage area. Outside walls are often sites of high relative humidity and condensation, especially if the walls are poorly insulated. Walls will also convey water from leaks above the storage area.

Condensation can form very quickly and takes much longer to evaporate when conditions improve. Even when relative humidity is high, mould germination will often happen only where condensation has formed.

Storage rooms built with floors on grade (level with the outside ground) or below grade are particularly vulnerable to flood water. The lowest shelves and cabinets should be raised at least 10 cm above the floor. Use waxed or painted wooden blocks to insulate shelving and cabinets from cold floors.

Examine collections for fungal growth often, especially in damp seasons.

Maintain adequate air circulation in storage and display areas to prevent zones of high relative humidity from forming. Fans and dehumidifiers are recommended to assist an existing system. Purchase as large a portable refrigeration-type dehumidifier as is possible. Frost-free operation and a port for routing collected water through a hose to a drain are desirable features. To dehumidify a room, the equipment should be capable of exchanging the air in the room once per hour. For example, a medium domestic dehumidifier (capacity: 200 cubic feet per minute or 5664 litres per minute) will handle a 12,000 cubic-foot room (340 cubic metres). Portable dehumidifiers will not operate efficiently below 35% relative humidity and 18° C.

Instruct the cleaning staff to avoid splashing cleaning agents on artifacts.

Keep collections clean and free of dust with sealed cases, cabinets, or dust covers. Dust and dirt contain fungal spores and nutrients for fungi that permit fungal growth on normally inert materials, such as plastics and glass. Effective storage also reduces the possibility that water will contact objects during a disaster.

Storing textile, wood, and paper objects that are equilibrated with a relative humidity below 65% in heat-sealed polyethylene bags will preserve them from fungal and moisture damage during humid conditions, provided there is no difference in temperature across the bagged object. Store bagged artifacts in properly located storage furniture. Bagging will also confer protection from insects.

Do not drape plastic over artifacts resting on sources of moisture, such as slab-on-grade concrete or earth floors, without first isolating the artifacts from the source with a polyethylene undersheet.

Make prompt repairs to all leaks in roofing, guttering, windows, and pipes. Eliminate condensation from cold water pipes by using insulation.

Monitor refrigerated storage units and equip them with alarm systems that will signal a power failure or a rise in temperature. When refrigeration systems fail, very high internal humidities can develop rapidly and promote fungal growth. Refrigerated storage should always be combined with prior packaging of the objects in heat-sealed polyethylene to eliminate the possibility of humidity and fungal damage should the institution not be able to respond to the alarm. Bags or equivalent packaging also prevent condensation damage when objects are retrieved from refrigeration and allowed to warm to room temperature in the package (Michalski, 1987).

Crawl spaces are often a cause of chronic humidity and fungal problems in buildings. Natural ventilation of a crawl space or basement can prevent excessive moisture accumulation. For earth-floored crawl spaces, the total vent area required is

$$TVA = (P / 50) + (A / 300)$$

where TVA is the total vent area in square metres, P is the crawl space perimeter in metres, and A is the crawl space floor area in square metres.

The total vent area can be reduced when an earth floor is covered with a vapour barrier such as 150 micron (6 mil) polyethelyne plastic sheeting. If a vapour barrier is used, divide the TVA by 10 (equation derived from *ASHRAE Fundamentals*, 1985, [21.12]).

Screen crawl space vents to prevent insects, rodents, and debris from entering. Fine screens will decrease the ventilation rate, so the vent area should be increased by one-quarter of the calculated area (multiply TVA by 1.25).

A minimum of four vents, with a total area equal to the calculated vent area, should be placed on opposite sides of the building, near the corners and as high as possible on the walls of the crawl space. Crawl spaces below ground level can be ventilated through ducts.

Cover vents when outside temperatures go below freezing to reduce heat loss and to prevent damage to plumbing and the accumulation of blowing snow in the crawl space. Remember to remove the covers in early Spring.

4.2 Nonchemical Control

If mould develops on artifacts, several nonchemical methods can be used to eliminate or control it.

Locate all objects affected by fungi.

Find the source of moisture and eliminate it.

Do not disturb the mould, even if it is inactive, without first taking precautions that will prevent the spores from spreading. Spores can cause allergic reactions and, in rare cases, can cause disease.

Isolate the infected pieces by sealing them in plastic bags. This will prevent the spread of spores and mould. If artifacts cannot be treated immediately, carefully place the bagged artifacts in a freezer to prevent further mould growth. Freezing will usually kill the hyphae but not the spores.

Mould is not active on a dried artifact, but the remaining spores potentially are. Careful vacuuming will remove dried mould from most materials. Ensure that the artifact surface is intact and that it does not have any poorly adhered material, such as flaking paint, that could also be removed by vacuuming. Avoid direct contact between the vacuum nozzle and the artifact. Mould that proves to be difficult to remove can be lifted off with a scalpel or with a soft brush.

Industrial vacuum cleaners may filter out fungal spores. However, the exhaust of vacuums should be directed away from the work area. This can be achieved by a hose on the exhaust opening leading to a fumehood or directed outside.

Cleaning artifacts is often a delicate procedure. Consult with a conservator before proceeding. Information on cleaning techniques is available in CCI Note 8/1, *Removing Mould from Leather*, and CCI Technical Bulletin 11, *Dry Methods for Surface Cleaning of Paper*.

Carefully dry wet or damp objects to prevent and stop mould growth. Freeze-drying is the preferred method. The alternative is air-drying in a cool, well-ventilated room. These methods are safer than any form of rapid drying, especially those using heat, because warmth increases the rate of mould growth. Consult a conservator before setting up a drying program. See CCI Note 10/5, *Emergency Treatment for Water-Damaged Paintings on Canvas*, and CCI Note 16/5, *Care of Colour Photographic Materials*.

Before drying wet or damp textile and paper artifacts that have active mould, consult a conservator about the possibility of washing the artifact. Wet cleaning can lessen permanent mould staining. See CCI Note 13/7, *Washing of Non-Coloured Textiles*.

Dry wooden artifacts to a moisture content below 20% and store them below 65% relative humidity. This will kill the mycelium and stop fungal damage.

4.3 Working with Mouldy Materials

Safety precautions are necessary when working with mouldy materials. Fumehoods are the best places to work. If a fumehood is not available, use gloves, goggles, approved dust respirators, and coveralls or labcoats. Very dirty working conditions may require more protection, such as hoods or surgical caps to cover the head, and polyethylene bags or plastic overboots to cover footwear. If possible, use disposable safety clothing to eliminate the need for cleaning. Shower when the work is complete, or at least wash face and hands, and launder non-disposable safety clothing.

Consult local health authorities or provincial occupational health ministries if there are safety concerns over the quantity of mould or the possibility of being exposed to pathogenic fungi when removing bat or bird guano.

4.4 Chemical Methods of Control — Fungicides

Chemical methods should be used to control fungi only after every effort has been made to solve a fungal problem by removing the source of water and controlling the relative humidity.

The effectiveness of a fungicide depends on its toxic effect and on the time it remains active after application. Removing loose mould increases the effectiveness of fungicide solutions. Most fungicides are effective against many species of fungi, so identification is not essential for control.

Before using a fungicide, consider whether the artifact will soon undergo conservation. Some conservation treatments, such as washing, bleaching, and solvent cleaning, are fungicidal. Also, some fungicides may interfere with conservation treatments or analysis.

Avoid using residual fungicides on artifacts if a volatile fungicide is available since there is more likelihood of adverse reactions over time with a residual chemical.

If a serious fungal problem requires extensive spraying, contact local health authorities and CCI for detailed advice, and employ a professional company for the work.

Avoid inhaling or making skin contact with fungicides since they are toxic even in low concentrations. Wear disposable rubber or plastic gloves, protective clothing, and goggles. If not spraying in a fumehood, wear an appropriate cartridge-type respirator. Spraying may also require a full face mask and protective clothing. Choose protective clothing rated for use with the solvents and other ingredients in the fungicide.

The active ingredients in commercial fungicides can vary, even under the same brand name. Carefully read the fungicide label for ingredients, precautions, and instructions to help prevent damage to artifacts.

Make a complete record of fungicide ingredients when documenting the treatment of artifacts.

The short- and long-term effects on a material are not known for many fungicides. Testing prior to application is recommended. Spot tests on an inconspicuous area of the material will indicate only the fungicide's short-term effects. If the fungicide is not recommended for the material, seek advice from a conservator, the manufacturer, or CCI. Materials can be damaged by the active ingredient or by the liquids in which the fungicides are dissolved. For example, if fabric dyes are not colourfast in the solution, fading or bleeding of colours will result. Oil-based or coloured solutions can stain porous materials.

At present, the safest and best fungicides for use on museum artifacts are 70% ethanol (ethyl alcohol), solutions containing orthophenylphenol, and solutions containing sodium orthophenylphenate.

Ethanol (Ethyl Alcohol)

A 70% solution of ethyl alcohol in water can be an effective fungicide. Alcohol kills fungi by dehydration and protein denaturation, and is most effective when in prolonged contact with the hyphae and spores. The artifact should be tested in an inconspicuous spot to ensure it will not be damaged by an alcohol solution. Alcohol can disfigure certain wood finishes and can cause some textile dyes to run.

Ethanol is available through chemical supply houses and provincial liquor control boards in 96% and 100% concentrations, and should be diluted to 70%. Special permits may be required to buy and possess these high concentrations; consult your local liquor control board.

Ethanol denatured with methanol or isopropanol is less expensive than pure ethanol, and is an effective fungicide. Denatured ethanol is available from chemical supply houses. Methanol (methyl alcohol or wood alcohol) is not recommended because it is an ineffective fungicide and is toxic to humans. Isopropanol (rubbing alcohol) is an effective fungicide but is more toxic than ethanol if the vapours are inhaled.

Orthophenylphenol (Dowicide 1, Topane S)

Orthophenylphenol is almost insoluble in water, but is soluble in most organic solvents. The preferred solvent for orthophenylphenol is 70% ethanol with 30% water because it has low toxicity and good fungicidal action. Mix a solution with 0.05% to 0.1% orthophenylphenol in ethanol and water or, alternatively, use commercial aerosol containers of 0.1% orthophenylphenol in a 68% aqueous solution of ethanol. Choose commercial preparations with the fewest unnecessary additives, such as scents. Occasionally, commercial solutions of this type have been reported to discolour white paper and cotton, so test each can before using it on artifacts.

Orthophenylphenol is slowly volatile. This reduces its effectiveness as a residual fungicide. Orthophenylphenol is registered and used as a preservative for liquids in containers.

Sodium Orthophenylphenate (Dowicide A, Topane WS)

The sodium salt of orthophenylphenol is soluble in water, acetone, and ethanol, but is almost insoluble in petroleum solvents. Aqueous solutions of sodium orthophenylphenate can be used where organic solvents are undesirable. Because the sodium salt is less volatile than orthophenylphenol, it provides longer residual protection. However, it must be present in higher concentrations to be effective. The drawbacks of sodium orthophenylphenate include discolouration of silk (Nugari *et al.*, 1987) and, when applied in aqueous solution, discolouration of basic lead carbonate (lead white) and ultramarine blue pigments (Baynes-Cope, 1971).

A solution of 0.1% sodium orthophenylphenate in denatured ethanol has been effective in removing lichen from stone (Wainwright, 1986).

The less-toxic orthophenylphenol is preferred to its sodium salt unless the residual effect of sodium orthophenylphenate is desired (Oral Rat LD50: OPP 2700 mg/kg, NaOPP 656 mg/kg) (Sax, 1984).

There is limited evidence that sodium orthophenylphenate may be an animal carcinogen (Sax, 1984).

4.5 Chemical Methods of Control — Application

Use a soft cloth or cotton swab dampened in a 70% ethanol solution, with or without 0.1% orthophenylphenol, to remove mould from the surface of wood, books, or skins and to provide a fungicidal action on remaining hyphae. Ensure that the fungicidal solution will not damage the object. Fungicide can be applied to furs as a light spray.

Interleaving fungicide-treated tissue with pages of air-drying books has been recommended (Strassberg, 1978, p. 31). Interleaving tissues are prepared by dipping or spraying with solutions of fungicide and drying before interleaving. However, the fungicide will protect only the tissue and the adjacent pages in the book. Interleaving dry tissues without fungicide will speed up the drying of books if the tissues are changed frequently. Too many interleaving tissues at one time can spread a book and damage its binding.

4.6 Problems with Other Fungicides

Although fungicides are widely used in commercial applications, caution must be observed when deciding whether or not to use them on museum artifacts. This section describes specific fungicides, citing why they may not be appropriate for use on museum artifacts.

Wood Preservatives

Wood preservatives are necessary only for wood kept outdoors. For exterior use, pressure treating wood with fungicides is the best method available. Fungicides will not penetrate as much when the wood is only brushed or dipped, nor will brushing or dipping ensure protection against fungal activity already in the wood (Ruddick, 1983).

Most effective wood preservatives will colour the wood green. The aesthetic changes to unfinished wooden objects could be unacceptable. Ensure that the preservative chosen does not damage existing finishes on the object.

Use care when handling wood preservatives since they are very toxic. Chromated copper arsenates, pentachlorophenol, and naphthenates are used as wood preservatives.

Chromated Copper Arsenate

Chromated copper arsenates are the most effective and most widely used commercial preservatives for wood outdoors. Pressure treating is the only effective method of applying these preservatives. The treated wood retains a green colour.

Pentachlorophenol (Penta, Santobrite, Dowicide 7)

In the past, this compound was widely applied to wood, textiles, paper, leather, and other materials. Because of the presence of dioxins in technical-grade chlorophenols, their registration for use under the pesticide regulations of Agriculture Canada was suspended in 1984 for situations involving contact with people or for coating materials used inside domestic buildings. Pentachlorophenol itself is highly toxic through inhalation or skin contact.

Pentachlorophenol induces corrosion of iron, degradation of cellulose, and discolouration of pigments, paper, and wood finishes (Jedrzejewska, 1968).

Similarly, sodium pentachlorophenate (a water-soluble sodium salt), pentachlorophenol laurate, and other chlorophenols are no longer considered suitable for museum use.

For surface disinfection of shelving and walls, a commercial solution of 0.1% orthophenylphenol in 70% ethanol is an effective substitute for pentachlorophenol.

Copper and Zinc Naphthenates

Copper naphthenate and zinc naphthenate are registered as wood preservatives for indoor and outdoor use. Commercial naphthenates come dissolved in petroleum distillates.

Naphthenate compounds can provide good fungicidal protection on wood outdoors and above ground if they are thoroughly applied and adequately maintained. Pressure treating is the most effective way to apply them. Copper naphthenate is more effective than zinc naphthenate in protecting artifacts kept outdoors. Copper naphthenate is green and permanently colours wood. Copper-naphthenate-treated wood can be painted over if appropriate. Zinc naphthenate does not discolour wood.

Naphthenate-treated wood may have a temporary musty odour from the volatile naphthenic acid.

Copper naphthenates are also reported to accelerate the degradation of cotton by light.

Because these compounds are moderately toxic, avoid skin contact with the treated wood until it is thoroughly dry.

Arsenic-containing residual fungicides are health hazards. For the most part, they are no longer used.

Formaldehyde (Formalin) has been used to control fungus in soil and on infected surfaces. Formaldehyde is a known carcinogen. Formaldehyde reacts with proteinaceous material and should never be used as a fungicide on museum artifacts.

Hypochlorite bleaches, most **quaternary ammonium compounds**, and many **household cleaners** contain reactive chlorine, so they should not be used to disinfect shelves, storage rooms, etc., or to treat artifacts.

Mercury-containing residual fungicides are health hazards. They have largely been discontinued.

Parachlorometacresol is not registered for use in Canada, and has been found to discolour some pigments and cause yellowing of paper.

Paranitrophenol is not registered for use in Canada. Paranitrophenol turns a strong yellow colour when the pH is above 7.5, and can cause staining of alkaline paper and leather (Calnan, 1985).

Salicylanilide (Shirlan) is not registered for use in Canada. Salicylanilide and its derivatives have been used to protect textiles in storage.

Zinc Dimethyldithiocarbamate (Ziram) has been used in low concentrations (0.5-1.0%) on textiles, and can discolour when copper or iron are present. While this fungicide is registered for use in Canada, it is not recommended for museum use. Zinc Dimethyldithiocarbamate and other carbamate pesticides are suspected carcinogens (World Health Organization, 1986).

4.7 Water-Repellent Surface Coatings

Surface coatings, usually paints and varnishes, protect wood from rotting by preventing the absorption of water. Wax-varnish water-repellent coatings alone can provide good long-term protection against decay, but only when applied to new millwork exposed above ground outdoors (Feist and Mraz, 1978). While the water repellent tested did protect against rot, it did not protect against mildew beyond the first year of service (Feist, 1984). Weathered wood is not well protected by surface coatings. Consult a conservator or contact CCI before applying water-repellent coatings to artifacts.

4.8 Fumigants

Fumigation is the release of a toxic gas in an enclosed space. Properly performed, fumigation can provide the most thorough coverage of artifacts by a fungicide with the minimum amount of physical handling. Since fumigants are very volatile chemicals, they do not provide residual protection.

Some of the common fumigants, such as ethylene oxide and methyl bromide, are known to be effective against both fungi and insects. However, they have drawbacks, such as high toxicity, chronic exposure hazards, and deleterious effects on museum materials. These fumigants are discussed in CCI's Technical Bulletin 15, *The Insect Problem in Museums: Chemical Control.*

Thymol (5-Methyl-2-(1-methylethyl)phenol)

Thymol is frequently cited in conservation literature as a fumigant for fungi on paper, and has been commonly used in museums and archives in heated fumigation chambers.

Thymol is not registered for use as a fumigant in Canada, but only as a material preservative and disinfectant.

A number of problems have been reported with the use of thymol, including questionable fungicidal effectiveness, softening of natural gums and resins, softening of paints and varnishes, yellowing in displayed works on paper, softening and discolouring of polymethyl methacrylate sheeting, recrystallization on surfaces, lingering odour, and health problems following prolonged exposure (thymol can induce nausea, vomiting, dizziness, and drowsiness).

CONCLUSION

Prevent or stop fungal growth by controlling the relative humidity in the museum so that it remains below 65%.

By controlling sources of moisture, fungal problems will be eliminated without recourse to chemical methods.

Many fungicides listed in the conservation literature are not registered for use in Canada. Most available fungicides are not suitable for use on museum artifacts.

Used with caution, 70% ethanol appears to be the least damaging readily available fungicide for use on museum objects. Alternatively, commercial preparations containing 0.1% orthophenylphenol with a minimum number of additives in 70% alcohol can be used.

MATERIALS AND SUPPLIERS

Pure and 96% ethanol:
provincial liquor control boards.

Denatured ethanol, orthophenylphenol (Dowicide 1, Topane S), sodium orthophenylphenate (Dowicide A, Topane WS):
chemical supply houses.

Soft brushes:
artist supply stores.

Vacuum cleaners, dehumidifiers, polyethylene sheeting, Lysol Spray®:
hardware and domestic retail stores.

3M 8710 and 8715 Dust Masks:
chemical supply houses and safety equipment suppliers.

SOURCES OF INFORMATION AND SERVICES

Pesticide Call Line
Pesticides Directorate
Agriculture Canada
SBI Building, 2nd Floor
2323 Riverside Drive
Ottawa, Ontario
K1A 0C6
Tel.: 1-800-267-6315

National Identification Service — Fungi
Biosystematics Research Institute
William Saunders Bldg.
Central Experimental Farm
Ottawa, Ontario
K1A 0C6
Tel.: (613) 996-1665

For site inspection and evaluation of health risk, contact industrial hygienists in your provincial or federal ministries of labour.

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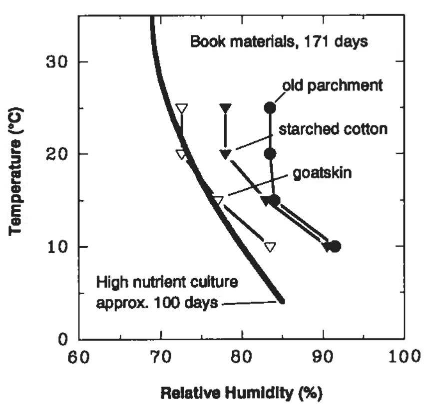

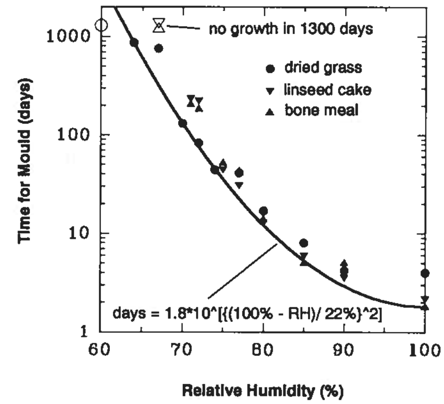

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