Recognize, Remove, and Remediate Mold and Mildew

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Abstract

Mold and mildew cause no structural damage to wood other than unsightly discoloration. Nevertheless, mold fungi are still cause for concern to the homeowner. Mold on the exterior of a home is indicative of inadequate surface drying of condensation. This condition is typically observed on north-facing walls or caused by overhanging tree branches or shrubbery planted too close to the structure. Mold on interior walls, joists, or ceiling of the basement, attic, or bathroom is typically due to high humidity and poorventilation. Leaks in pipes and foundations supply the constant source of moisture necessary for mold growth and may eventually encourage more destructive decay fungi to colonize wood. Mold fungi produce copious spore clusters that can have an adverse effect on individuals with allergies. Minimizing moisture and using paints containing mildewcide are effective methods for controlling mold fungi on wood. Efforts to recognize, remove, and remediate mold and mildew are preventative measures that will discourage colonization of decay fungi and lower the homeowner's exposure to spores.

Introduction

Molds are fungi than grow readily on finished and unfinished wood surfaces in conditions of high humidity (9). They are ubiquitous and resistant to desiccation and UV radiation. The huge numbers of colored spores produced by mold fungi are responsible for the moldy odor and unsightly mildew patches that develop rapidly on damp surfaces. Perhaps the most common mold fungus associated with wood *Aureobasidium pullulans* also displays resistance to some biocidal paint additives, known as mildewcides. Mold spores are ubiquitous, and the best way to limit their germination is to eliminate sources of moisture.

Recognize the problem

"How do I know if it's mold or decay?" is a common question asked by homeowners. There are several features that differentiate mold growth from decay (Fig. 1). Mold often appears as black, green, or brown fuzzy or powdery patches on surfaces in humid environments, though spores can also be gray, purple, or red in color. Mildew is the common term used to describe mold and its discoloration to unfinished wood. The terms mold and mildew can be used interchangeably. Discoloring mold growth can easily be brushed, planed, or washed off and the wood beneath the discoloration will most often be sound, unless decay fungi have colonized the wood.

Decay fungi also thrive under conditions of excess or repeated moisture, however, wood can actually be too wet to support growth of decay fungi. Wood that is constantly saturated or water-logged will not be in danger of decay, but alternating repeatedly between wet and dry conditions certainly increases the likelihood that decay fungi are also present.

The two recognized types of decay fungi, brown rot and white rot, actually damage weaken the wood structure. Early stages of decay often include discoloration of the wood. Unnatural brown or bleached areas may indicate early fungal infection, which is more difficult to recognize than later stages of decay (5,9). Brown-rot,

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the most destructive type of deterioration caused by decay fungi, is typified by darkening and shrinking of the wood, with eventual crumbling in the advanced stage. With white-rot, wood may lose its color or appear bleached. It will not shrink or crack, but will feel spongy in the advanced stage.

Preventative Measures

There is no sure way to eliminate mold spores from an environment. They are ubiquitous and abundant. Spores are resistant to desiccation, high temperatures, and UV radiation, but if they are not given adequate growth conditions, i.e., nutrients, moisture, and proper temperature, they cannot germinate.

Architectural and building site design plays a role in preventing mildew formation. Good air movement around the exterior of a home can be accomplished by removing overhanging tree branches or ensuring that shrubbery is not planted too close to the structure. Even then, north-facing walls and areas shaded by the roof overhang are likely candidates for mildew. Buildings under construction that are exposed to heavy rain should not be closed in before adequate drying takes place.

Since the presence of mold fungi is often associated with the presence of decay fungi, recommendations for preventing decay in buildings are also wise recommendations for the prevention of mold formation. They include such design features as adequate roof overhangs, gutters, moisture impermeable ground cover in soil-floored crawl spaces, ventilation of crawl spaces and attics, proper flashing and moisture barrier installation, periodically inspection for moisture, recaulking joints, painting or staining when needed, and using exterior finishes that shed water (9). A well drained building site and planning so that shrubbery and trees are not too close to a structure are essential.

Good air flow inside the home and eliminating sources of moisture are equally important considerations for reducing the mold spore load for building occupants. Run a dehumidifier to lower humidity and condensation. Increase attic and crawl space ventilation with vents and fans when humidity levels are low outdoors. In regions of high humidity or when the dew point is high, reverse air flow on fans or block vents to prevent humid air from entering the structure. Ventilate bathrooms to the outdoors. Installing insulation in ceilings and walls can reduce moisture levels in walls. Painting with a paint containing mildewcide is recommended for surfaces exposed to high humidity.

Look for leaks in roofs, pipes, and foundation walls and correct them. Leaks are not always obvious and may need to be traced from the area of visible dampness to the actual source of moisture. Continuously exposing wood to moisture encourages more destructive decay fungi to colonize the wood (3,5).

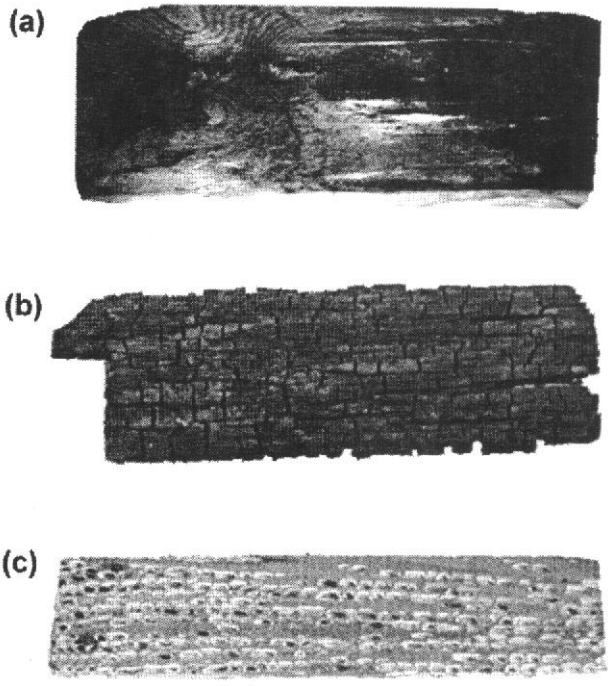

Figure 1.—*Usual differences in wood colonized by representative mold (a), brown-rot (b), and white-rot (c) fungi.*

Reduce the Spore Exposure

Other than on damp unfinished wood, mildew formation is most often found on painted wood surfaces, presumably because of nutrients provided by the woody substrate that diffuse into the paint film (6,8,9). Discoloring surface growth can often easily be brushed off or the surface can be cleaned with household bleach mixed 1:4 with water. However, once a mold fungus is established on unfinished wood or painted wood, the numerous spores produced by these organisms readily lodge in porous surfaces and can survive cleaning solutions only to reappear when optimal moisture and temperature conditions resume.

Other Sources of Mold

Mold and mildew formation in buildings is not limited to wood and painted surfaces, though for the purposes of this discussion, those two media have been emphasized. The huge number of spores produced by mold fungi can accumulate in other moisture-laden areas of the home and can cause allergies and other health concerns for its occupants. Other areas of concern include HVAC systems, fiberglass insulation, gypsum board, ductwork, and condensation on windowpanes

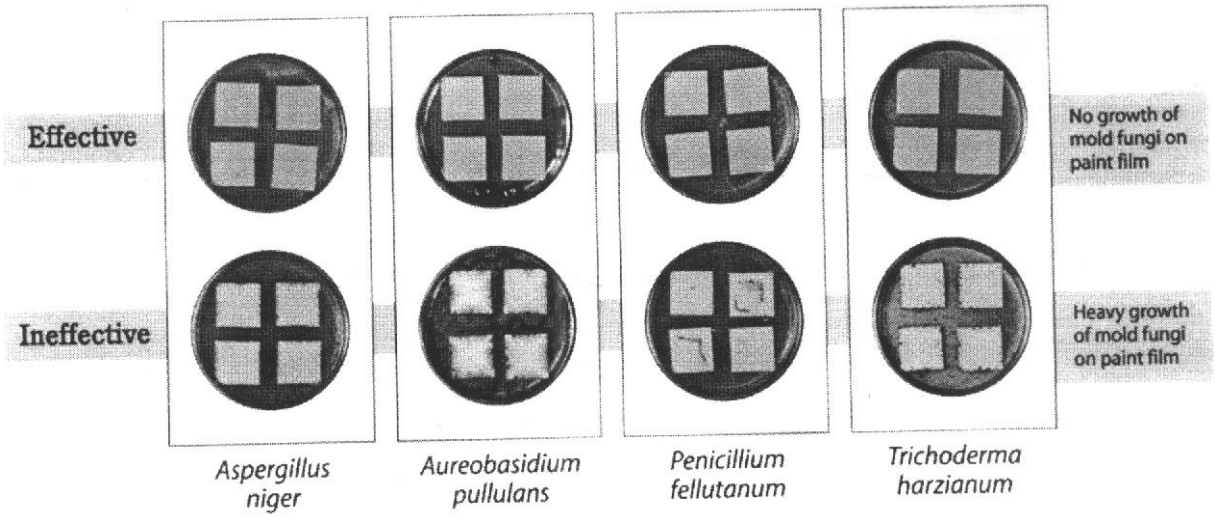

Figure 2.—*The agar plate toxicity test evaluates the efficacy of paint biocides for resistance of four common mold fungi. Note the zone of inhibition that the effective biocide shows for Aureobasidium pullulans.*

and pipes (7). Ventilations systems with an air intake on north facing exterior walls may aspirate huge numbers of mold spores into a home. The nominal retention size of furnace filters is not intended for entrapment of mold spores and can actually support microbial growth that, with time, can contribute to the spore load of a residence.

Resistance of Paints to Fungal Attack

Biocides, such as barium metaborate and zinc oxide, added to paint formulations are very effective at preventing mildew when used at the proper concentration (9). Depending on the concentration of mildewcide added to a paint formulation, mildew resistant paint will display varying degrees of resistance to mold fungi. Some paint formulations, which add minimal amounts of mildewcide, have low resistance to common mold fungi. Independent laboratories test and rate the resistance of paints to mold fungi (4). The homeowner can compare ratings to select the paint with the greatest resistance to common mold fungi, among them *Aureobasidium pullulans, Trichoderma* spp., *Penicillium* spp., and *Aspergillus* spp. Among the common mold fungi, *Aureobasidium pullulans* is by far the most ubiquitous and important mildew agent. *A. pullulans* is resistant to hostile conditions such as desiccation, UV and it can adhere firmly to paint and unfinished wood surfaces, so it dominates by outcompeting other mold fungi for nutrients. *A. pullulans,* unfortunately, also displays resistance to some biocides.

Homeowners can select paints that exhibit resistant to mold fungi based on agar-plate toxicity testing (1). In agar-plate toxicity tests, paint films are placed on malt agar in Petri plates and challenged with spore suspensions of common mold fungi. Sealed plates are incubated for 4 weeks at 28°C and 85 to 90 percent relative humidity. Each plate is evaluated for extent of fungal growth using a rating system:

1 = clean (less than 5% of the surface covered with fungal growth)
2 = light (5% to 20% of surface covered with fungal growth)
3 = moderate (20% to 40% of surface covered with fungal growth)
4 = heavy (greater than 40% of surface covered with fungal growth)

An ineffective biocide will allow heavy growth of common mold fungi on the paint film surface after 4 weeks (Fig. 2). An effective biocide will not allow common mold fungi to grow on the surface of a paint film after 4 weeks of incubation. In some instances, mildewcides may also leach into the agar and create a zone of inhibition, i.e., inhibit the ability of the fungus to grow on the surface of the agar. The effective biocide in Figure 2 has significantly inhibited *Aureobasidium pullulans* from growing on the agar surface. As new mildewcide formulations are developed, those that show fungal resistance in agar-plate toxicity tests are further evaluated by ASTM standards (2) and field tests before commercialization.

Summary

Damp conditions and inadequate ventilation typically results in mold and mildew on both painted and unfinished wood surfaces. Although mold fungi do not structurally damage wood, differentiating between

mold fungi and decay fungi is important because decay fungi damage and weaken the wood structure. The conditions necessary for mold growth, i.e., moisture, temperature, and food source, are also often ideal for decay fungi. Preventative methods for lowering humidity to discourage mold growth include increasing ventilation, dehumidifying, repairing leaks in pipes or roofs, and preventing condensation on cool surfaces. These are important steps for homeowners because continually exposing wood to moisture encourages more destructive decay fungi to colonize the wood. Reducing the humidity source is half the battle. Removing mold spores from wood surfaces with a bleach solution, rinsing the surface with fresh water, and thoroughly drying the area after cleaning will lower spore numbers, a potential health concern of individuals with allergies.

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