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BIODETERIORATION OF WOOD IN HOUSES

In an effort to reduce household heating costs, some homeowners have inadvertently caused household moisture problems that create conditions suitable for attack by mildew, molds and wood destroying fungi. Most homeowners in South Carolina are acquainted with mildew both inside and outside. Mildew tends to start growing at about 600 F in 60 percent relative humidity. Surface molds are frequently found on the sapwood of floor joists under houses with a poorly ventilated and damp crawl space. Wood destroying fungi attack floor joists and subfloor when the wood surface is frequently wetted due to. surface condensation, or when the moisture content of the wood member is for various reasons 20 percent or more. This publication is intended to help homeowners have a better understanding of these organisms and the range of conditions they require for growth.

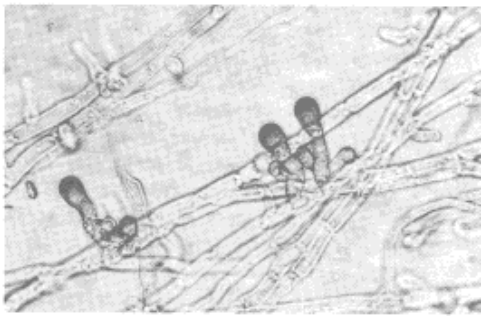

Figure 1. Microscopic view of fungus hyphae and spores

Description of Some Organisms

Most deterioration problems are caused by fungi and are a direct result of excessive moisture. Fungi are small, often microscopic, plants which do not have chlorophyll and which reproduce by spores (Figure 1). Most fungi are beneficial and decay organic matter which would soon accumulate to unmanageable proportions (Figure 2).When wood in service is wetted, a succession of fungi attack the wood. If the wetting continues, decay eventually will develop and ultimately lead to the total destruction of the wood. In this regard, decay fungi are harmful and cause great economic losses each year.

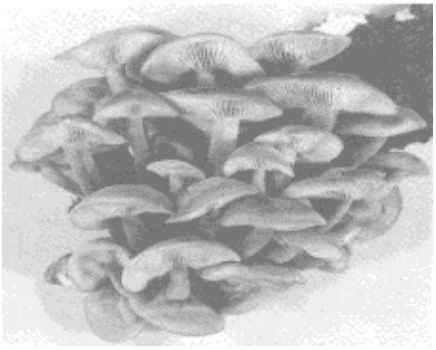

Figure 2. Fruiting bodies of wood decaying fungus

Surface Molds

Experience in South Carolina indicates that surface molds and mildew will often be evident growing over the sapwood (young, outer growth of the tree) portion of the wood in the crawl space of a house. These do little or no harm to the wood but their striking appearance (Figure 3) is usually a good first clue to thehomeowner that there is a moisture problem. Presence of surface molds in the crawl space may decrease the resale value of the residence. Surface molds typically produce tremendous quantities of spores which appear as a dusty coating on the wood. Excessive moisture inside the house may also promote fungus growth (Figure 4).

The homeowner need not remove the mold growth from the wood in the crawl space unless they have an allergy to fungus spores, but should eliminate the origin of the moisture problem, such as by excluding surface water, installing a ground cover, and opening foundation vents.

If severe moisture conditions continue or frequently recur, surface molds can penetrate deeply in the wood and discolor it. Growth is first evident in the sapwood where parenchyma and ray cells contain a rich source of sugars and starches. If the wood remains wet, true staining fungi may soon colonize and deeply penetrate the wood. They usually do not greatly reduce the strength of wood but their presence is strong evidence of a continued undesirable moisture problem. Furthermore, they are extremely unsightly and the prodigious quantity of spores that some produce may aggravate allergy problems in some people. Stain fungi are not restricted to wood but may be found on almost any organic substance, from paint to shingles (Figure 5). The blue staining fungi caused *by Ceratocystis,* although common in sapwood of freshly sawn lumber, are usually not a problem in wood after it is placed in service. The presence of blue stain usually means that the lumber was improperly stored or dried after sawing. Blue stain can develop, however, where a water leak from a water supply line continually wets the wood.

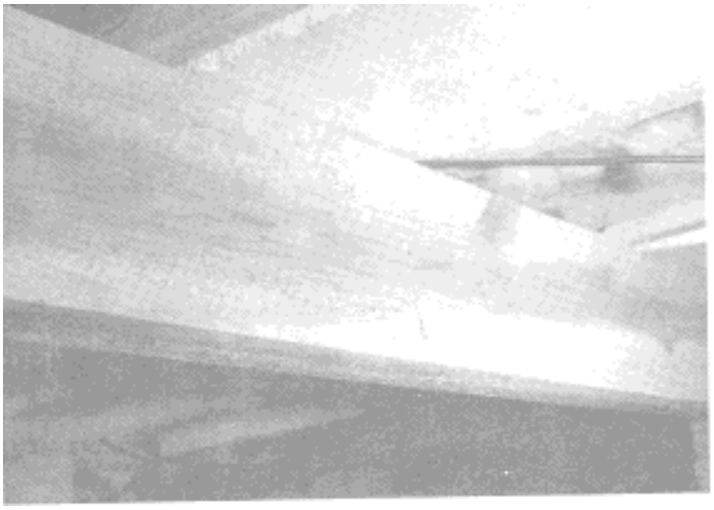

Figure 3. Surface mold on sapwood portion of floor joists

Figure 4. Surface mold on insulating ceiling tile.

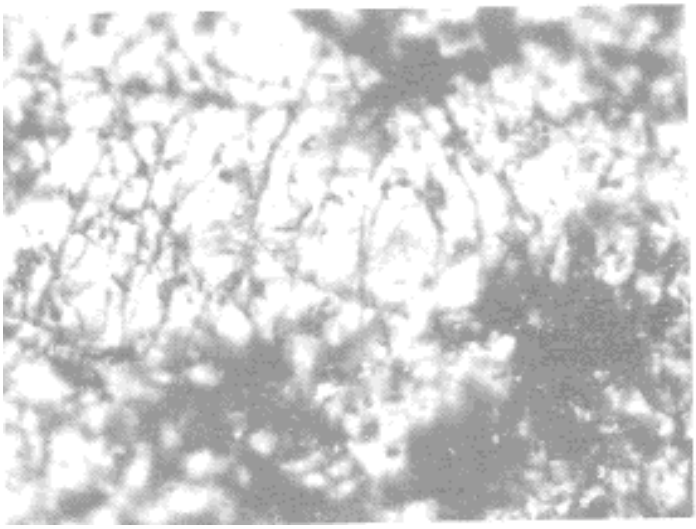

Figure 5. Closeup view of fungus growth on paint.

Decay

Decay is the final stage of deterioration and occurs when wood is colonized by true decay fungi in the class known as the Basidiomycetes. Most fungi in this class are beneficial in the forest because they decay wood and bark of fallen trees and other organic matter, but a few do attack wood in service.

Many fungi are quite specialized and can thrive only in the heartwood (older, inner growth) of living trees; others are only able to attack wood of a single tree species. Few of these fungi can cause decay of wood in service, but those that do, do so very effectively. The genera Poria, Coriolus (Polyporus), *Geophyflum (Lenzites),* and *Coniophora* probably account for more than 70 percent of fungal species that decay wood in service. Coniferous wood used for structural members in residences is usually attacked by a group of fungi known as brown rotters. After the

Figure 6. Piece of lumber with brown cubical rot. Fruiting body is of *Lenzftes trabea.*

wood is decayed by brown rotters, it dries, shrinks, and cracks excessively producing what is known as brown cubical rot (Figure 6). Wood in this stage of decay has lost virtually all its original strength. A very detrimental feature of brown rot attack is that significant strength loss occurs rather early during colonization. So, wood can be greatly weakened but decay may not be very evident to casual inspection.

A handy method that inspectors or home owners can use to check for early stages of brown rot is to thrust an ice pick into the wood perpendicular to the grain and at approximately a 45° angle. Pushing down on the handle will raise a splinter of wood. If a long splinter is raised, the wood in that area is probably sound. If, however, the splinter breaks cross-wise above the pick, the wood is likely decayed

What Are Fungi?

The wood decay fungi, as do all fungi, consist of microscopic hyphae, or collectively known as mycelium, which colonize the wood. The hyphae secrete enzymes which hydrolyze (digest) the complex polymer components of wood, cellulose, or lignin, and convert them to monomers (simple sugars) which are then metabolized by the fungi to produce energy for growth and reproduction. Initial colonization of the wood results when spores produced by the fruiting body of the fungus land on the wood surface and germinate. The spores are blown about by the wind and are found in the air in great numbers. Homeowners who have an allergic reaction to spores are often aware of a decay or moisture problem before it might be evident to an inspector.

Conditions Necessary for Decay

Fungi cannot decay dry wood. If wood were kept dry, it would theoretically last forever. The chances of decay developing increase greatly as the moisture content increases above 20 percent. As dry wood absorbs water, the entering water is first adsorbed and held by the microfibrils of cellulose that compose the cell wall. This water is bound, in varying degrees, within the microfibrils and is not available for use by most decay fungi. At approximately 28 percent moisture content, all these spaces are filled. As moisture content increases beyond this point, free water collects and fills the spaces or lumens in the center of each wood cell. It is this water that is needed by decay fungi and serves to transport fungal enzymes to the wood and diffusion of sugars back to the

Figure 7. Rhizomorphs (arrows) of Poria *incrassata, the* water conducting fungus.

hyphae. Since fluctuating temperatures can cause moisture to condense on wood even if it is below fiber saturation, the somewhat lower moisture content of 20 percent is more practical and has a built-in safety factor. Surface molds, however, can colonize wood as low as 20 percent so this is a very realistic figure.

Dry Rot

Dry rot, a term commonly used to describe a special type of decay, is a misnomer because no decay can develop if the wood is kept dry. The fungus causing dry rot, *Poria incrassata*, has root-like structures called rhizomorphs which convey water from the soil and into the dry wood, wetting it in advance of its growth and thus assuring adequate moisture for decay (Figure 7). This type of decay is present in South Carolina. Damage can be minimized by periodically inspecting the crawl space under the house for dampness, surface mold or staining of joists. The next several figures show several houses extensively decayed by *P. incrassata*. Figure 8 shows a baseboard in advanced decay and the interior of the kitchen cabinet indicates that fungus attack has progressed up the wall studs (Figure 9). It will seldom grow higher than 8 feet above ground, however. Figure 10 shows deteriorated wall studs after the sheetrock has been removed. Note that the paper covering of the sheetrock has also been decayed. Figure 11 illustrates the loss of strength in the floor of another house. In carrying out the television set, the mover broke through the floor with each step. If a home owner suspects a case of Poria, they should seek help from a specialist.

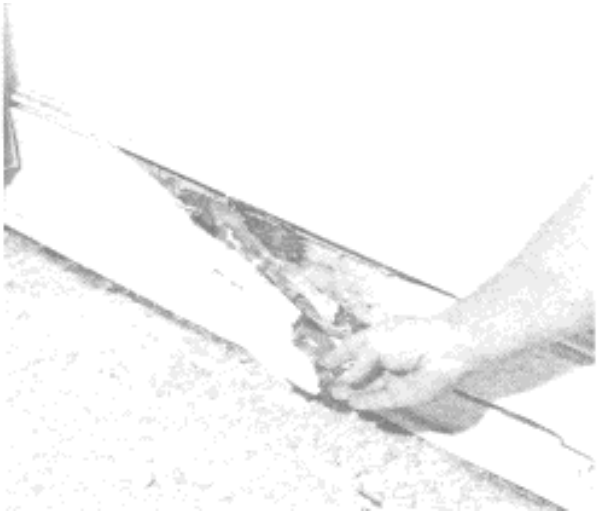

Figure 8. Decay in baseboard, often the first sign of Poria attack.

Figure 9. Decay Inside kitchen cabinet, caused bv Poria.

Prevention and Control of Wood Decay

The development and growth of wood-destroying fungi along with surface molds and mildews are limited by minimum levels of moisture. Air-dried wood with a moisture content of 20 percent or less is considered dry and will not decay. Wood with a moisture content of 28 percent and more is subject to attack by wood-decaying fungi.

In new construction, wood structural members expected to be exposed to prolonged moist conditions should be pressure treated with a wood preservative (Figure 12). The toxic preservative material inhibits fungi growth and wood decay for many years. Other effective measures have been developed to prevent or control moisture accumulations in various locations in a residence and do not have the environmental hazard of chemical preservatives. These measures employ vapor barriers to prevent moisture migration through the walls, floors, and ceilings; ventilation to keep moisture in bathrooms and kitchens at reduced levels; and diversion or exclusion of both surface and subsurface water around the residence. Special circumstances may require use of mechanical equipment, such as a sump pump, to dispose of accumulated water under the house or refrigeration/dehumidification equipment to reduce household humidity levels. This is especially crucial in modern houses which are being increasingly tightly sealed to reduce energy costs.

Figure 10. Decay caused by Poria.

Techniques Used to Control Household Dampness and Moisture

Surface runoff may be controlled by providing drainage to meet the requirements of the CABO building code section R301.3. It requires "the grade away from the foundation walls shall fall a **minimum of 6 inches within the first 10 feet**, except as restricted by lot lines where the fall will be a minimum of 6 inches regardless of the horizontal distance available." (Note: This equals a **5 percent** slope.) The proper slope directs rain water away from the house. Gutter water may be controlled by providing an approved splash block at each downspout or by intercepting gutter water at each downspout with a 4-inch pipe. The latter is the preferred method. Subsurface drainage may be controlled by waterproofing the foundation wall and installing a footing drain.

Moisture migration from the soil into the crawl space under an older house may be reduced by installing a 4-mil or 6-mil plastic ground cover sheet over about three-fourths of the crawl space area. If the house has hardwood floors, some ground moisture is needed to prevent excess shrinkage. The total crawl space of a house may be covered where carpet and vinyl products are used on floors throughout the house. In new construction, the entire crawl space should be covered regardless of the floor covering.

Foundation vents can dissipate accumulated moisture vapor in the crawl space. The foundation vents should have an unobstructed area equal to 1 square foot of clear ventilation space for each 150 square foot in the crawl space.

Figure 11. Decay caused by Poria.

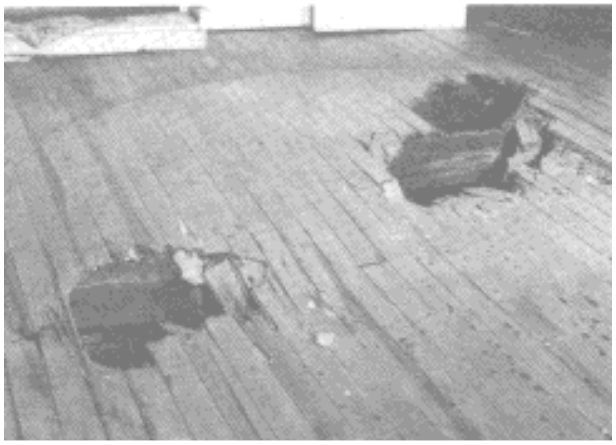

Figure 12. Decay which could have been prevented by proper design and construction.

Never close all foundation vents in South Carolina. Moisture vapor tends to migrate from the living area into the attic during cold weather. This is particularly true for those houses with blown-in or loose-fill insulation in the, attic without a vapor barrier. The function of attic ventilators is to dissipate both heat and moisture. One square foot of clear ventilator space is needed for each 150 square feet of attic space. Soffit vents used in combination with gable or ridge vents are most effective.

This publication was prepared by Linda L. Gardner, Ph.D., Extension Residential Housing Specialist Major contributions to this publication were made by Frank H. Tainter, Ph.D., Professor of Forest Resources, Clemson University