Fungal Damage in Buildings with Emphasis on *Meruliporia* ‘poria’ *incrassata*

prepared by

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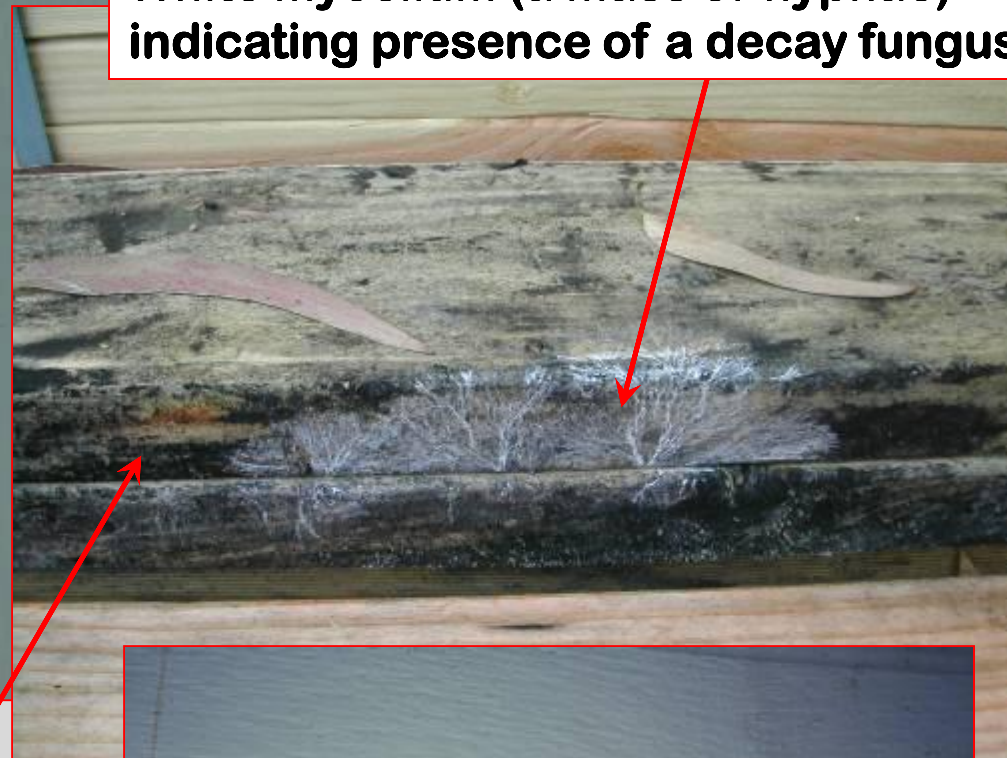
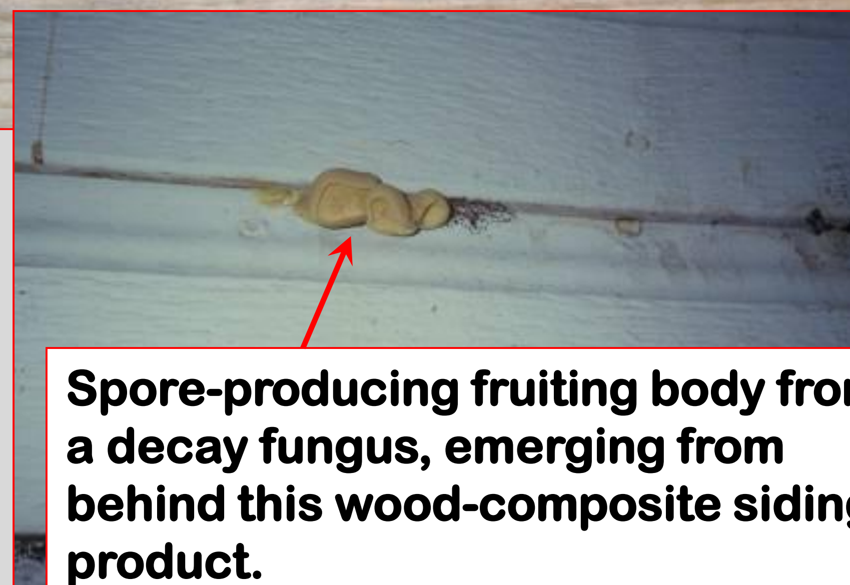
Many species of fungi can utilize one or more components of wood and wood-based products for food. Some fungi can structurally degrade wood, and some cannot, depending on the chemical constituents of wood that they can utilize for food.

Damage from a decay fungi (one that can structurally degrade wood)

White mycelium (a mass of hyphae) indicating presence of a decay fungus.





Dark growth, spore producing portion of a sapstain (bluestain) fungus. This fungus doesn’t structurally degrade wood – it uses sugars found in storage cells found in the sapwood (the wood located near the bark).

Spore-producing fruiting body from a decay fungus, emerging from behind this wood-composite siding product.

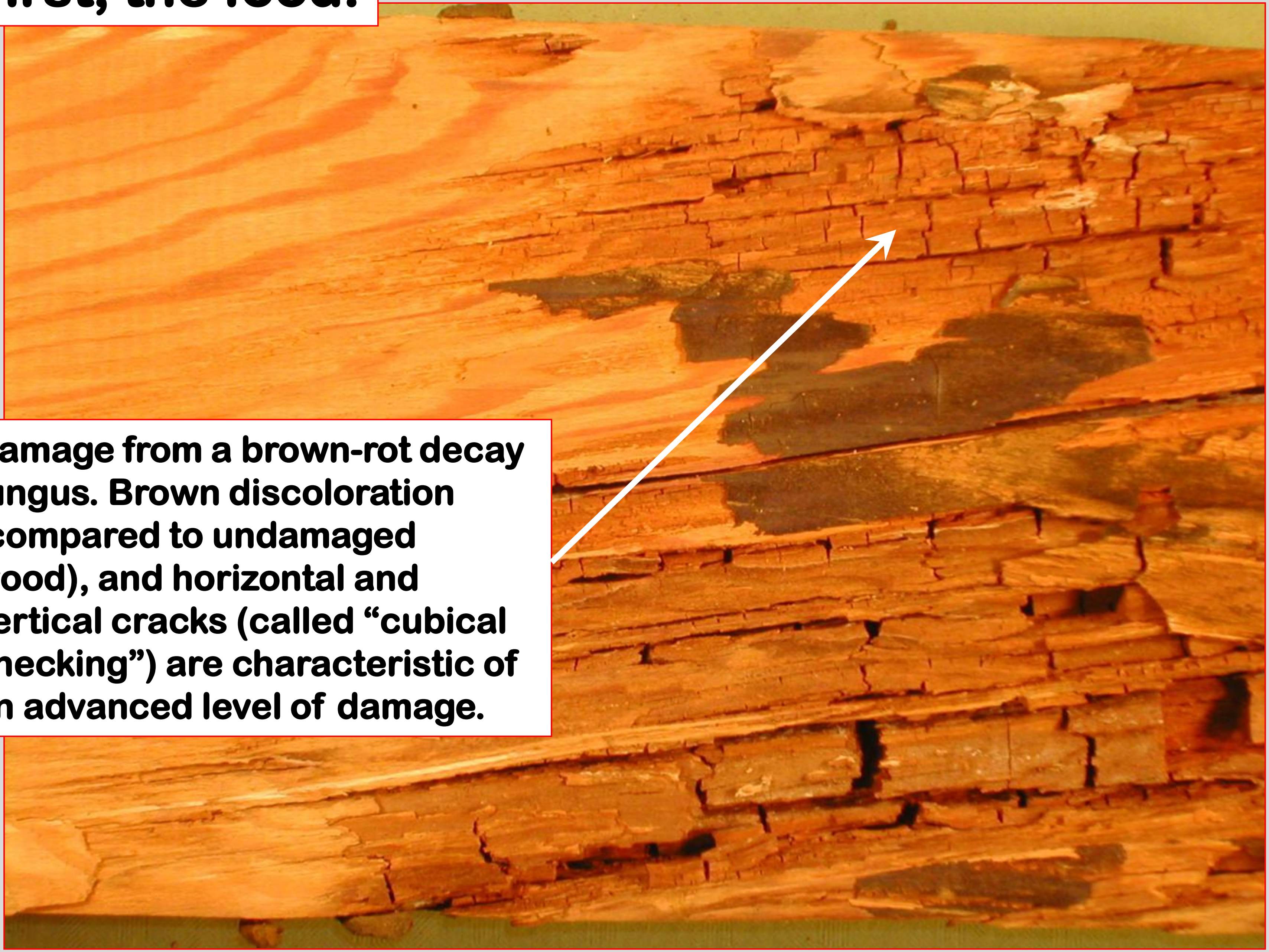
Requirements for fungal growth include the following:

- **Favorable temperature (~32 to ~105 °F)**
- **Atmospheric oxygen**
- **Supply of free (unbound) water**
- **Digestible carbon compounds (the food)**

from: *Wood Microbiology*, 1992, Zabel & Morrell

All four requirements must be met. Eliminating any one of the four will stop growth. Since temperature and oxygen are difficult to change, the most effective way to control fungi is to <u>alter the food</u> (e.g., through the use of preservative treated wood), or <u>lower the moisture content</u>.

First, the food.



Damage from a brown-rot decay fungus. Brown discoloration (compared to undamaged wood), and horizontal and vertical cracks (called “cubical checking”) are characteristic of an advanced level of damage.

The three principal constituents of wood are polymers, and are classified into three major types: cellulose, hemicellulose, and lignin. The proportion of the three polymers varies between species. Relative amounts are given below.

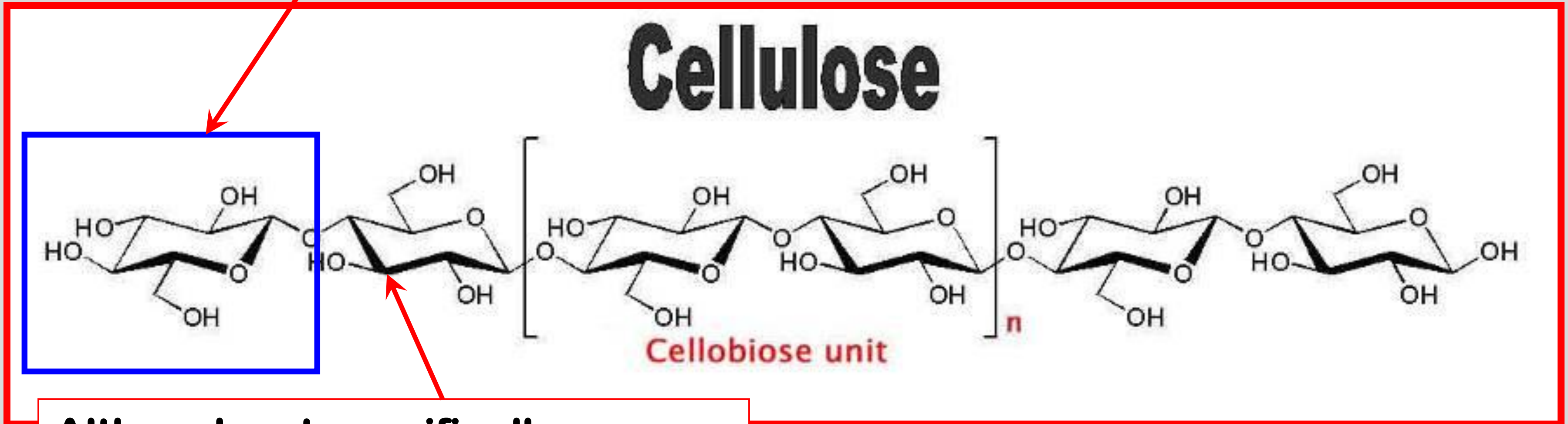
COMPOSITION OF WOOD BY TYPES OF POLYMERS

POLYMER	PERCENT OF DRY WEIGHT
Cellulose	40-50
Hemicellulose	20-35
Lignin	15-35

Table from the SWST Teaching Unit
www.swst.org

Cellulose is the most important single compound in wood. Cellulose is made up of a large number of glucose (sugar) molecules linked together by chemical bonds.

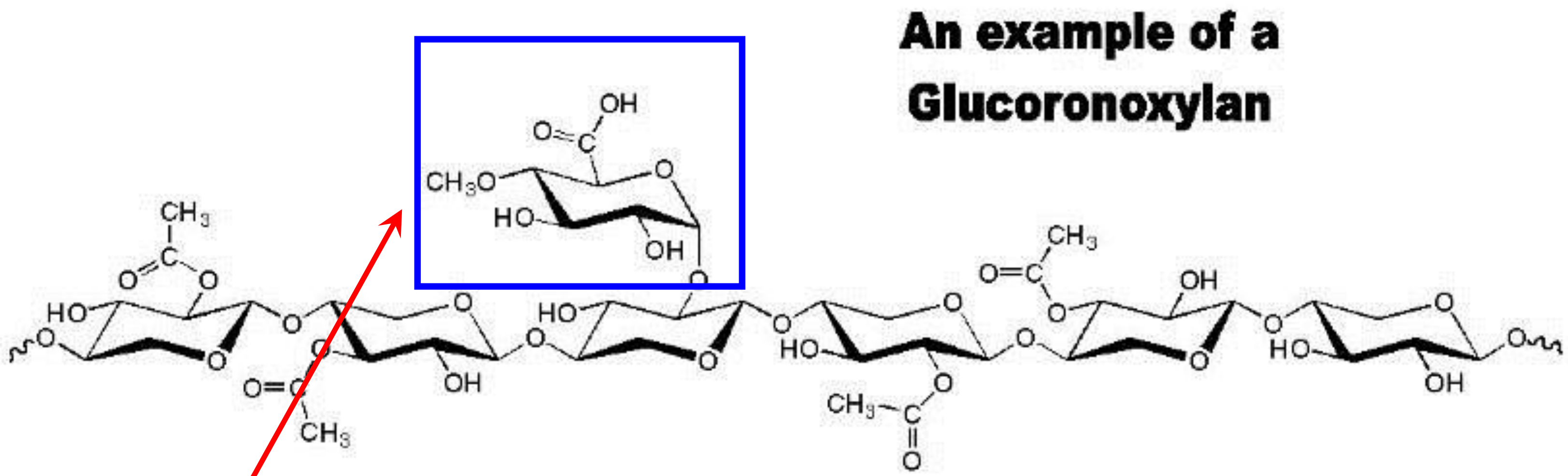
One glucose sugar molecule. If a particular fungus can break the chemical bonds between the sugar molecules that together make up the cellulose polymer, the fungus can then utilize the sugar molecule for food. Not all fungi have the capability to break these bonds.



Although not specifically indicated, carbon is located at each point where two lines meet.

Figure from the SWST Teaching Unit
www.swst.org

Hemicelluloses are a group of compounds similar to cellulose. The number of sugar molecules is much lower than that in cellulose, and the hemicellulose polymer is branched (i.e., it has side chains).

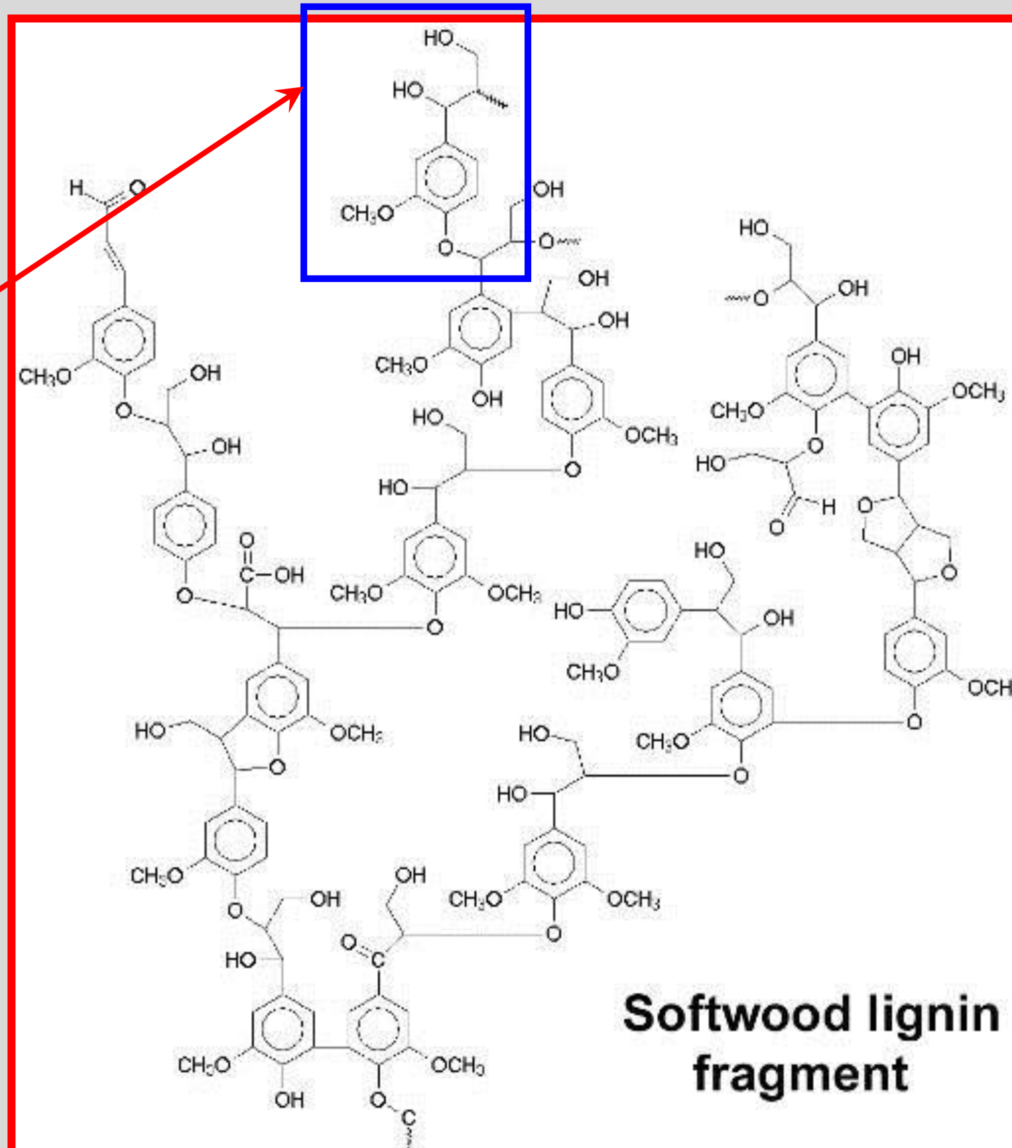


One sugar molecule. Hemicellulose is made up of a number of different types of sugars. Just as was the case with cellulose, if a particular fungus can break the chemical bonds between the sugar molecules that together make up the hemicellulose polymer, the fungus can then utilize the sugar molecule for food. Not all fungi have the capability to break these bonds.

Figure from the SWST Teaching Unit
www.swst.org

Lignin is an amorphous polymer that acts as a binding agent to hold cells together.

A phenyl-propane unit. Many of these make up the lignin polymer. These molecules look different than the sugar molecules that make up the cellulose and hemicellulose polymers. Brown rot fungi cannot metabolize lignin. The ring structures in lignin have some level of toxicity, and their presence makes it more difficult for fungi to metabolize.



Softwood lignin fragment

Figure from the SWST Teaching Unit
www.swst.org

Descriptive names are used to classify the two basic decay fungi groups:

- white rot - stringy, white (bleached) color

- brown rot - cubical checking, brown color

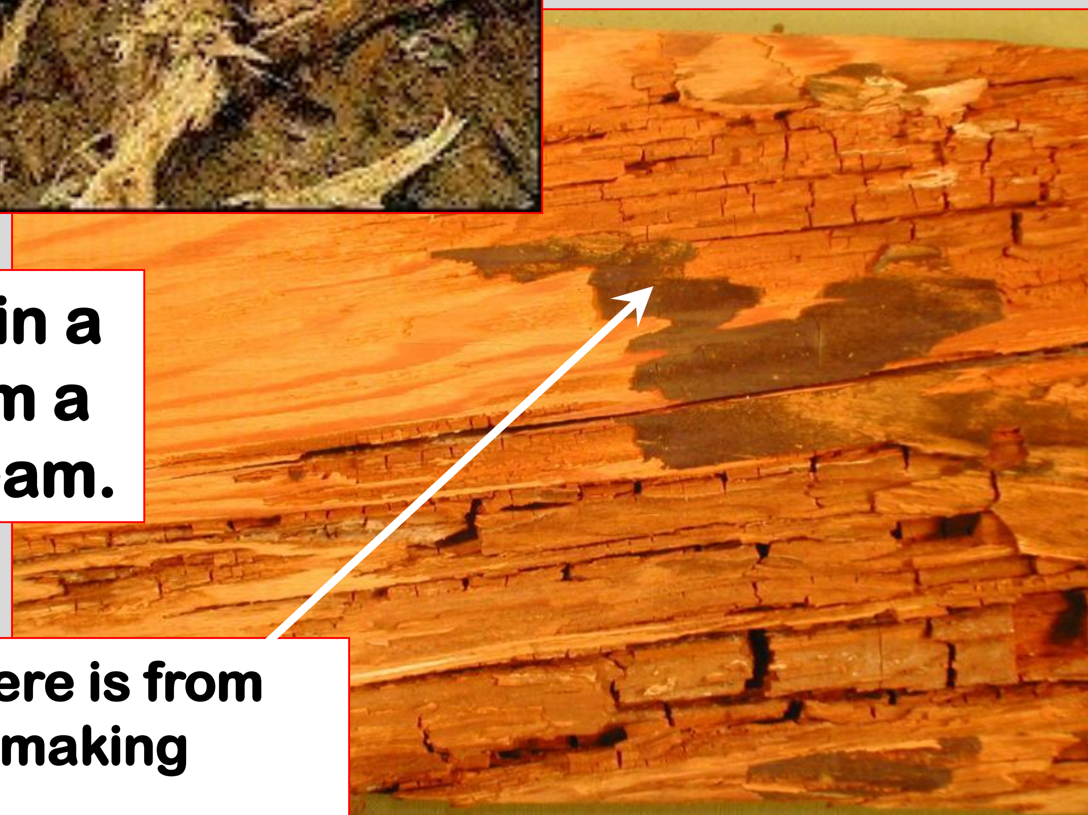
Due to the predominant use of softwoods (Douglas-fir, white fir, southern yellow pine) in construction, and the fact the brown rot fungi preferentially attack softwoods, we more commonly find brown rot fungi in buildings.

The natural color of lignin is brown. Because brown rot decay fungi cannot fully utilize lignin, the wood attacked by brown rot fungi is brown in color because of the remaining lignin residue. White rot decay fungi can fully utilize lignin (and the cellulose and hemicellulose polymers), and therefore wood attacked by these fungi is white in color.

White paper bag: the wood pulp used to make white paper is bleached to remove additional lignin.

Brown paper bag: the paper used to make the familiar brown grocery sacks is unbleached, and therefore has a higher lignin content, and hence a brown color.

White rot damage in a tree.

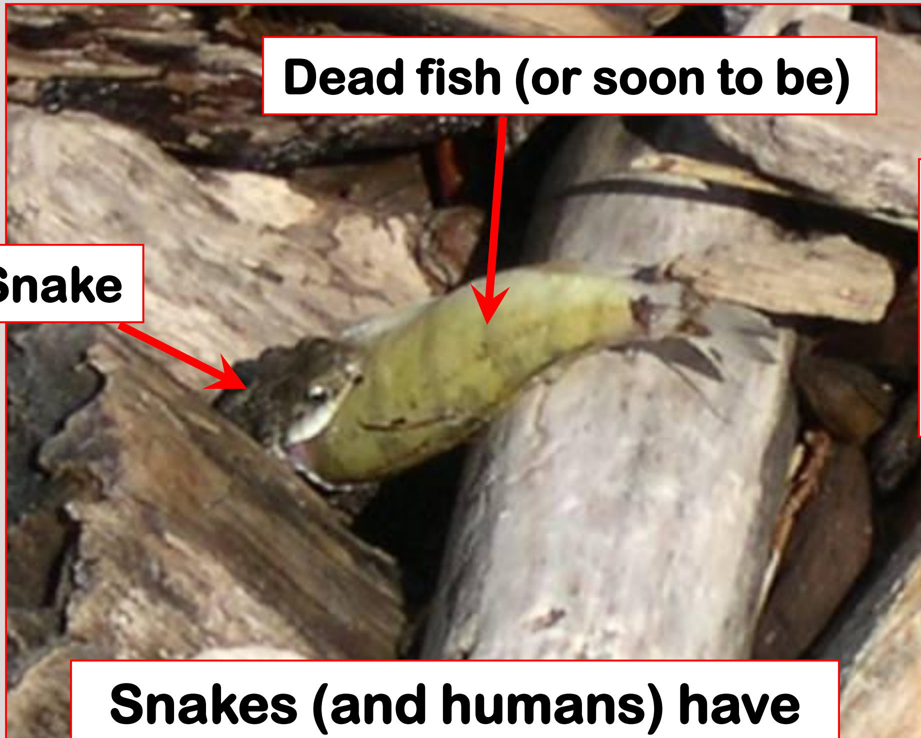


Brown rot damage in a board removed from a glued-laminated beam.

This reddish color shown here is from the adhesive (glue) used in making glued-laminated beams.

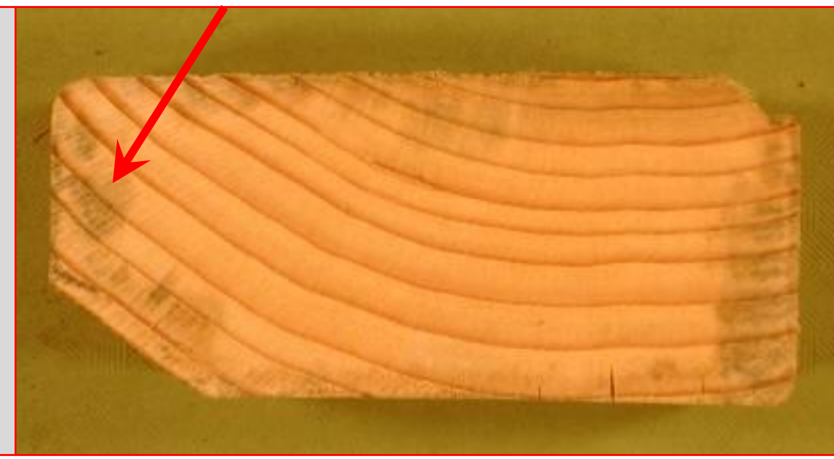
Next, the water.

The process of eating



Snakes (and humans) have an internal digestion system to process food.

Hyphae (pigmented) from a stain fungus penetrating ray cells in the sapwood to locate sugars that can be used as food.



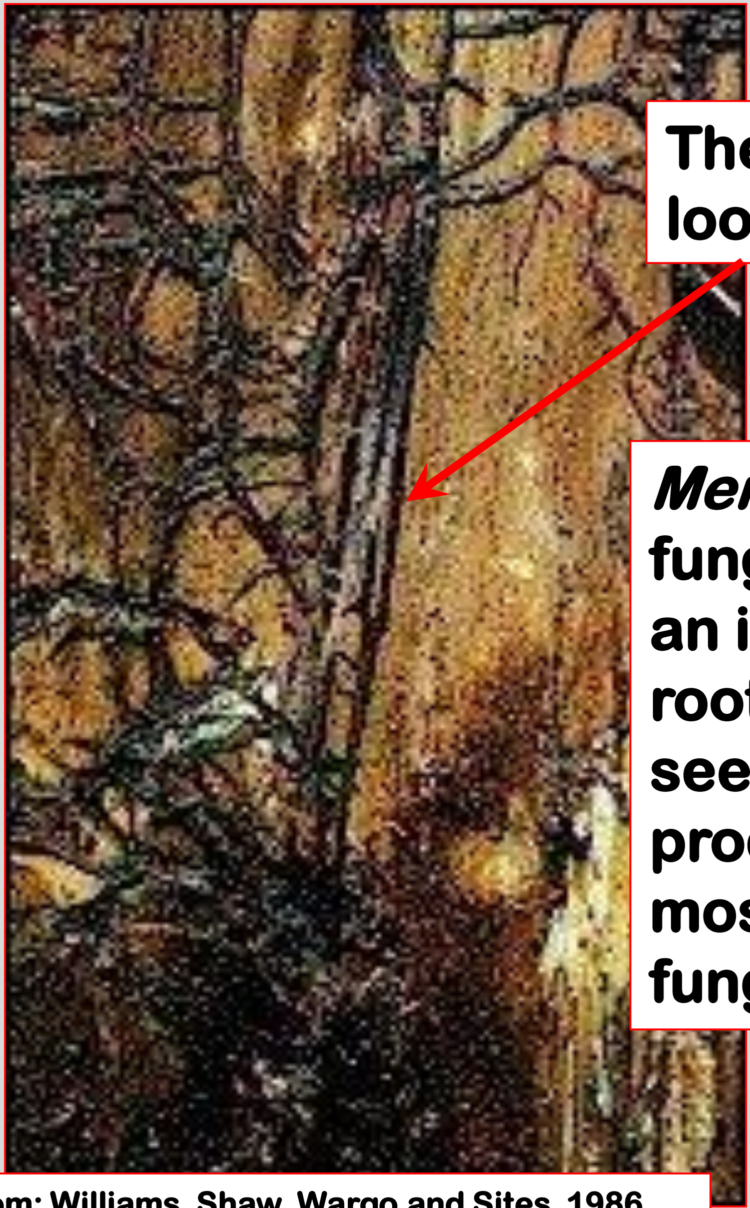
Fungi have an external digestion system. The fungi break down the food products externally (by secreting enzymes and other chemicals), and absorb the food products. This external digestion process means that liquid water (moisture content of wood > ~28%) must be present so that the secreted enzymes, and food products can diffuse from and back to the hyphal tip. Without this moisture, the fungus cannot be active (it may become dormant, or it may die).

Most decay fungi rely on a leak for the required moisture

Leak at a window, with advanced decay in Oriented Strand Board (OSB) sheathing.

Leak at a window, with advanced decay in plywood sheathing.

Some brown rot fungi have developed a specialized water-conducting hyphal mass called a "rhizomorph." A leak is no longer necessary. Water (usually from soil) can be conducted through the rhizomorph to the wood in your home. *Meruliporia incrassata* ("poria") is the most common "water conducting" fungus in North America, and the one most commonly found in buildings.

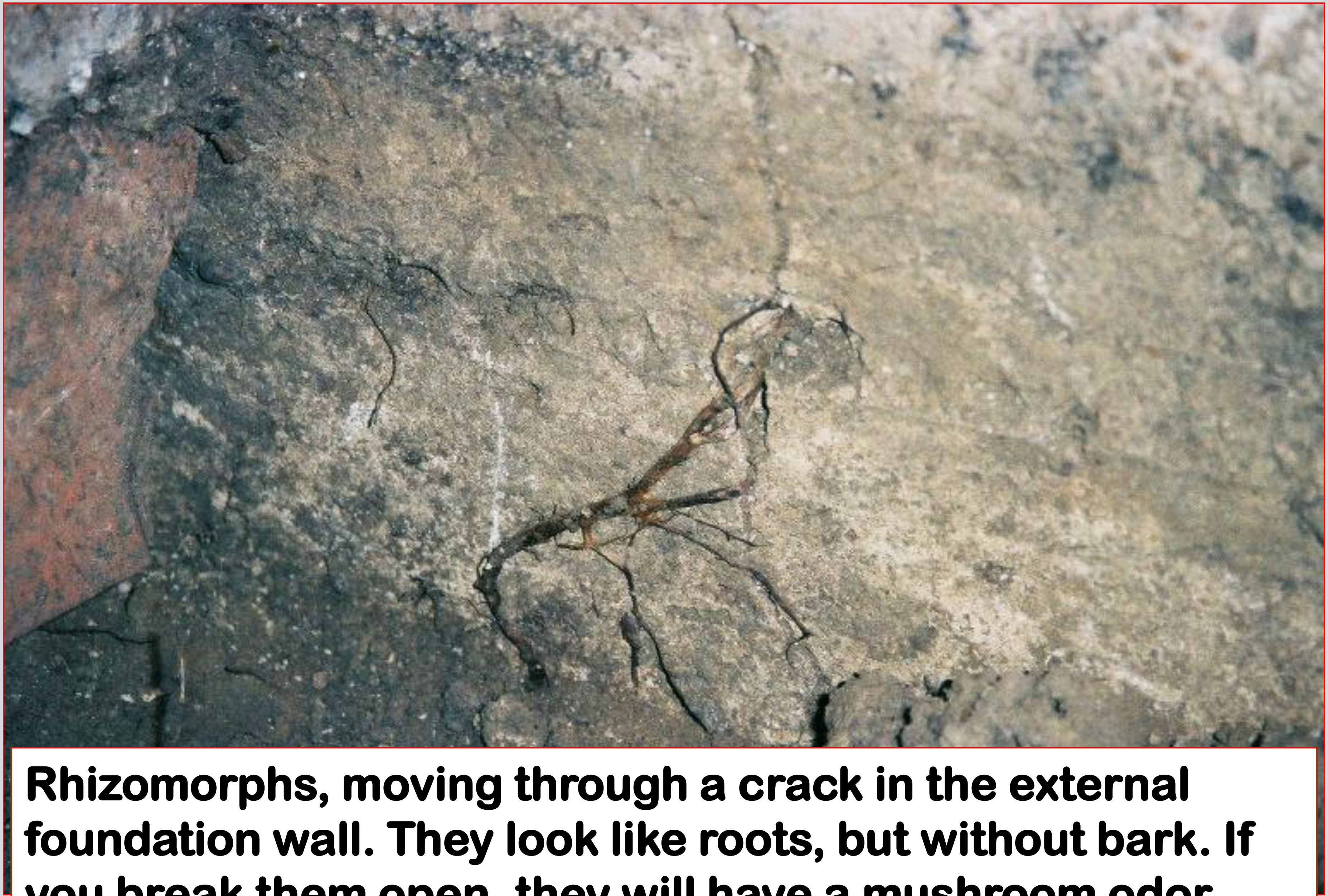


The rhizomorph of decay fungi can look like this.

Meruliporia is a common decay fungus found in forest soils and plays an important role in decomposing roots and other woody debris. As seen here, it isn't the only fungus that produces a rhizomorph, but is the most common "water-conducting" fungus found in buildings.

from: Williams, Shaw, Wargo,and Sites. 1986. Armillaria Root Disease. Forest Insect & Disease Leaflet # 78, USDA Forest Service.

Meruliporia is a brown rot fungus, and as such, the decayed wood will look just like the decayed wood from any other brown rot fungus (e.g., ones that rely on a leak for its required moisture). There are two distinctive characteristics that can be used to identify *Meruliporia* in the field (i.e., in your home), that won't require sending samples to a laboratory. The first of these is the water conducting rhizomorph. Don't confuse these with tree or plant roots (a rhizomorph won't have bark).



Rhizomorphs, moving through a crack in the external foundation wall. They look like roots, but without bark. If you break them open, they will have a mushroom odor.

The second is the spore producing "fruiting body". If you see either of these, you can be sure the fungal infestation is from *Meruliporia.*

Mature fruiting (spore producing) body of *Meruliporia*. The mature fruiting body produces a lot of brown colored spores. When touched, it feels a little like cream cheese.

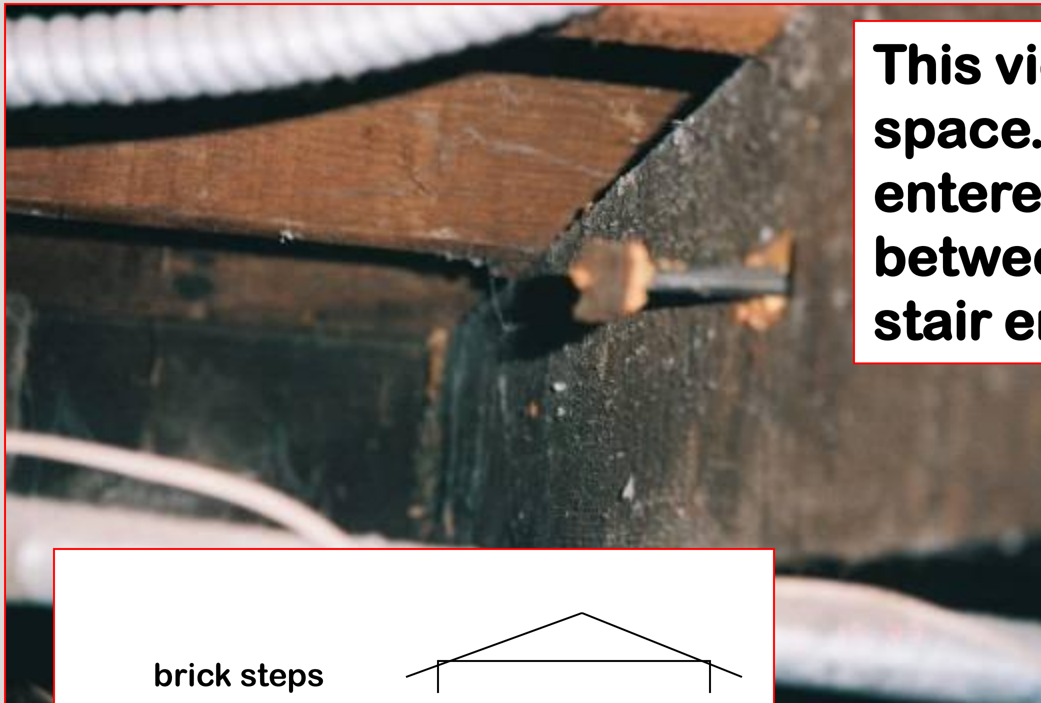
Another view of a rhizomorph in a stud cavity.

An immature fruiting body, and therefore not yet producing spores. Although it looks yellow here, it more often looks orange. This is a good id feature, but you aren’t as likely to see the fruiting body in the immature state.

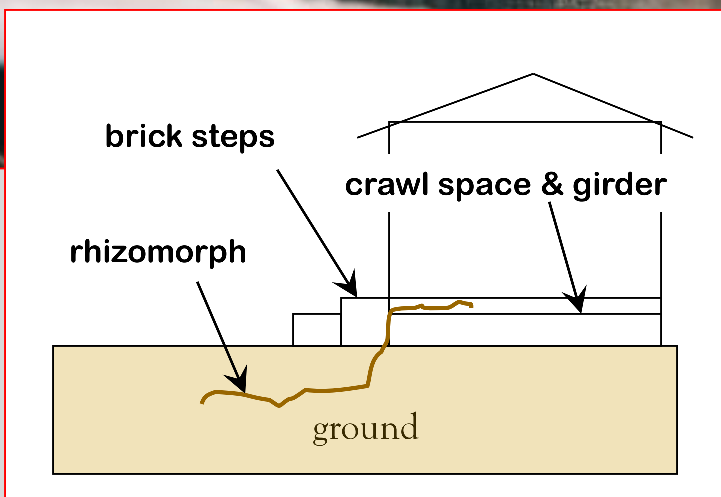
What can you do about *Meruliporia*? *Meruliporia* is very sensitive to dehydration (drying out), so the key is to avoid construction details that allow the rhizomorph to reach the building without drying out. Some of these details include the following:

- **siding extending below grade**
- **very humid crawlspace (resulting from inadequate ventilation or inadequate earth-wood clearance)**
- **cracks in perimeter foundation or slab**
- **planter up against exterior wall, with crack in planter wall**
- **sprinklers or other water source creating 'ponding' near the home (related to poor grading)**

All of these allow *Meruliporia* to enter a building without experiencing a drying environment. Therefore the key to avoiding damage from *Meruliporia* is to avoid (or repair) the details that allowed entry in the first place. Although a simple solution in principle, it can be expensive to implement in an existing building.

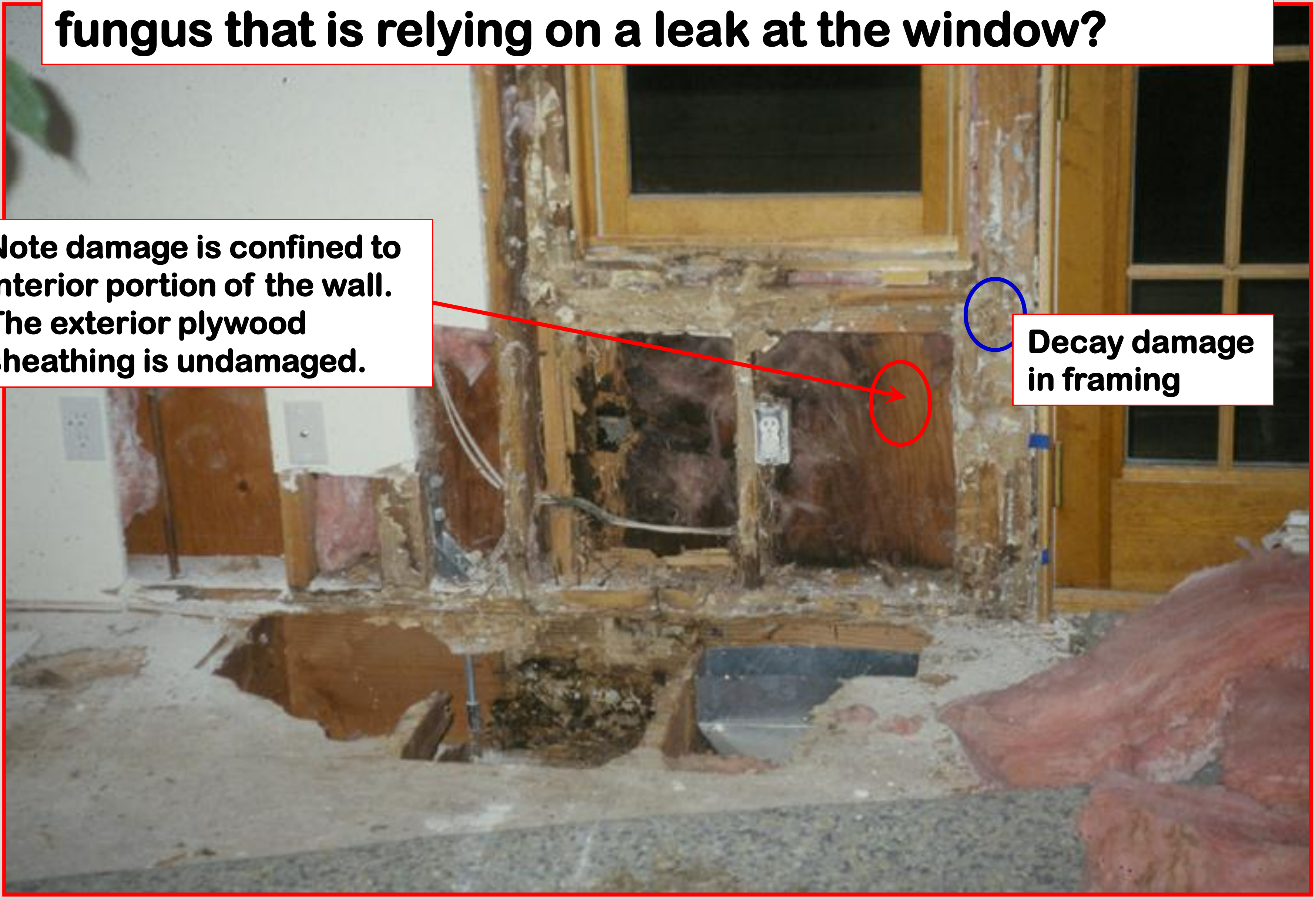


This view is of a girder in a crawl space. The rhizomorph of *Meruliporia* entered the girder by growing between the exterior wall and an brick stair entry into the home.



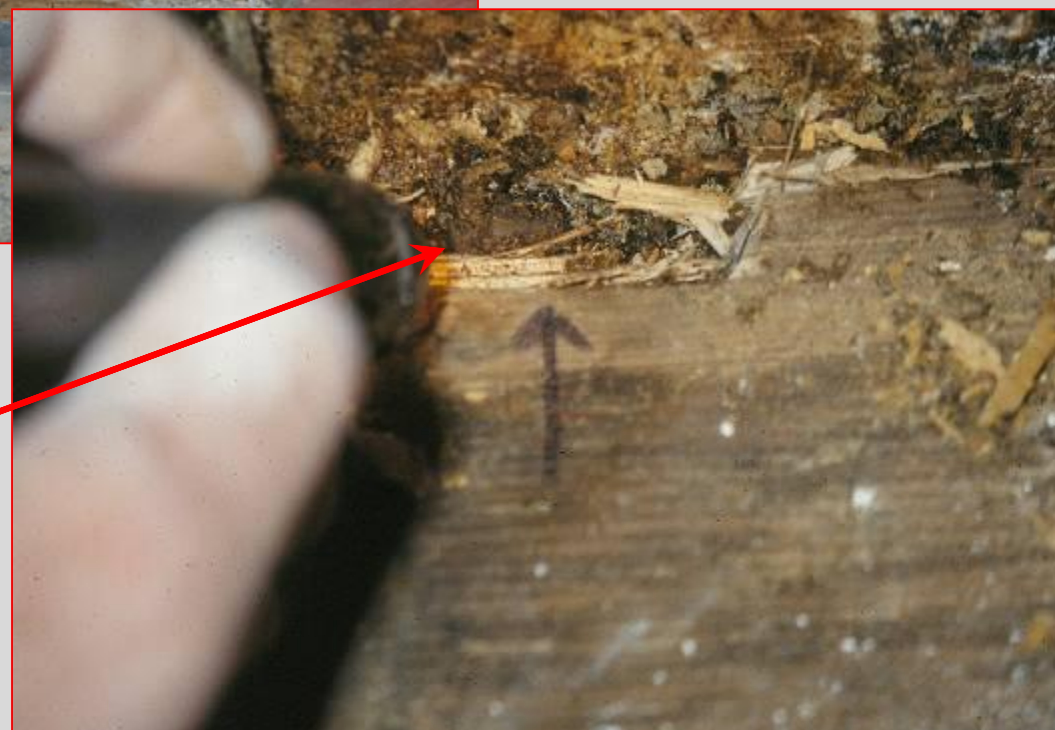
A fresh rhizomorph, taken from inside the girder shown in the top left photo. The girder was opened up on the face not visible in the above photo.

Is this damage from *Meruliporia*, or a ‘normal’ decay fungus that is relying on a leak at the window?



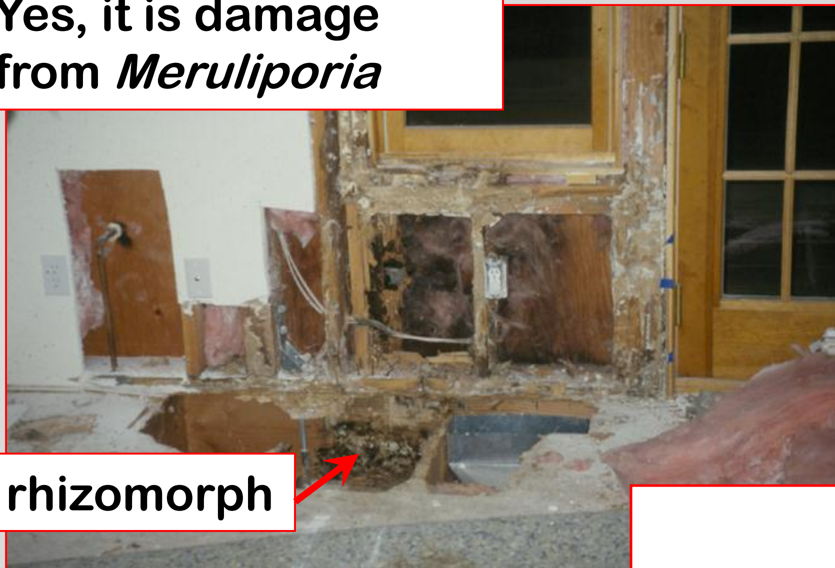
Yes, the damage is from *Meruliporia*

If you assumed the source of water was from a window leak, and either replaced the window, or tried to repair the window flashing, your efforts would not solve the problem.



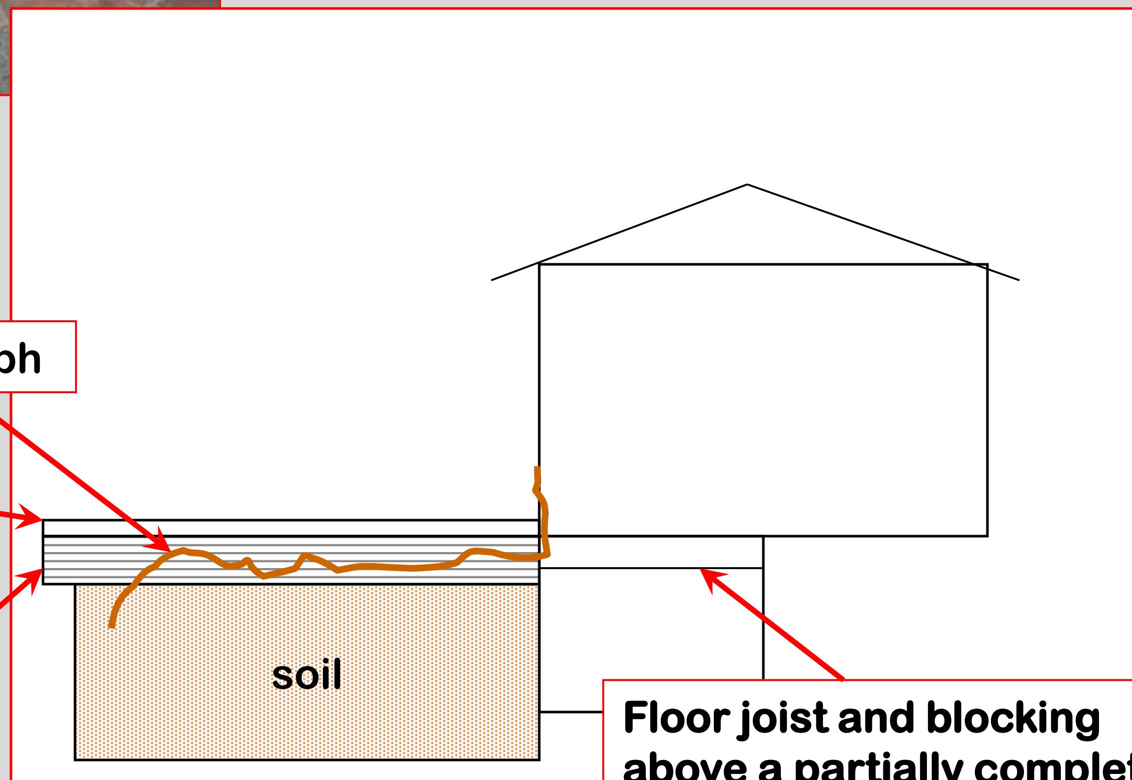
rhizomorph

Yes, it is damage from *Meruliporia*



rhizomorph

At this house the outside grade was the same level as the inside floor framing. The rhizomorph grew through the gravel bed that was underneath the exterior concrete slab patio, and was able to enter and infest the 'between joist' blocking .



Floor joist and blocking above a partially complete full-height crawl space.

Is identification of a decay fungus to genus or species necessary?

Many would argue that is doesn't matter, except for distinguishing between *Meruliporia incrassata* ('poria') and all other decay fungi. The repair for "all others" is the same.

What would be an appropriate repair for the decay damage observed in the roof support system on this leaking roof?

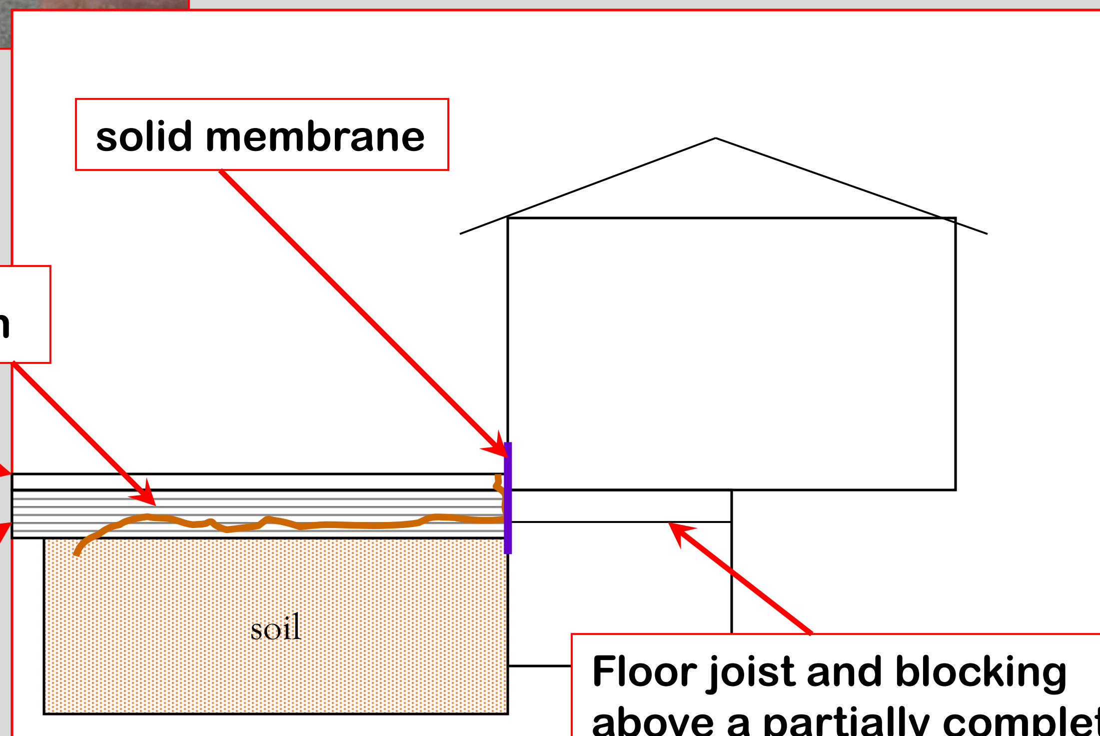
Answer: Fix the roof leak and replace damaged wood.

For both “*Meruliporia*” and “non-*Meruliporia*” damage you are eliminating the source of water, and replacing damaged wood. With *Meruliporia*, in order to eliminate the source of water you have to sever all rhizomorphs entering the building, and modify the construction detail to prevent entry of other rhizomorphs in the future.

Yes, it is damage from *Meruliporia*

Repair options for this *Meruliporia* infestation could include:

- Lowering the exterior grade, all around the structure. This would force a rhizomorph to move over an the exposed concrete on the exterior of the foundation. This is an expensive repair.
- Excavate around the perimeter foundation and apply a solid membrane (torch applied), and then back fill. Reasonable expense.



Thanks for your attention …

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