

Of all the life that can be seen without a microscope, fungi may be the most misunderstood. Perhaps it is the strange dual world they inhabit—macroscopic bodies that form from microscopic parts, or perhaps it is their perceived similarity to other microorganisms like bacteria and archaea. Regardless, the fact is that fungi are an integral part of our existence. Some are helpful, some are harmful, and most don't affect us one way or the other. I'd like to invite you to take a short journey with me through Kingdom Fungi. We will take a peek at life cycles, wander through paranoia, delve into some science, and emerge with an understanding of fungus toxicity, and (I hope) a renewed interest in utilizing spalted wood.

# Spalted Wood

## Health and Safety

Sara Robinson

### Spalting

Spalted wood is wood colonized by very specific types of fungi. These fungi make black lines, beautiful colors, and lightened bleached areas on deciduous wood. Calling wood spalted instead of rotten or punky indicates that the decay has been halted before significant mass loss has occurred. Spalting implies that a certain usefulness remains in the wood.

The three types of spalting are created by two distinct groups of fungi. Bleaching (*white rot*) and black lines (*zone lines*) are formed by basidiomycete fungi—specifically, white rot fungi. Basidiomycete fungi are wood-decay fungi whose role in the ecosystem is to break down dead trees so the nutrients can return to the soil to nurture future generations. Such fungi are helpful and necessary for forest growth. Basidiomycetes are not going to sneak into your house at night, invade your cupboards, or grow miniature mushrooms in your lungs. That's just not how things work, but more on that later.

Pigments, the third type of spalting, are formed on wood primarily by ascomycetes, some of which are often unaffectionately referred to as molds. To be fair, not all ascomycetes are molds. Some are pseudo white rots (*Xylaria polymorpha* or dead man's

finger) and some are soft rots and stains (*Scytalidium cuboideum* or pink stain). Fungi are not as clear-cut as one might suspect. Ascomycetes serve a variety of roles in decomposition, and unlike the basidiomycete white rots, very few are suitable for use in spalting. In fact, outside of the *Ophiostoma* and *Ceratocystis* genera, only three species of ascomycetes are actively utilized for spalting: *Xylaria polymorpha*, *Scytalidium cuboideum*, and *Chlorociboria aeruginascens* (elf cup).

### What is a fungus?

A fungus is a filamentous organism with a chitinous cell wall, which I realize means very little to most people. Basically, fungi sprout from spores and grow in strands (*hyphae*) and those strands are thinner than a human hair. When enough of the strands are in the same place, the fungus becomes visible to the naked eye. Fungi can grow indefinitely from these strands; however, as with many organisms, a second mode of growth and dispersal is handy. When it is time to reproduce, the fungus creates and sends out spores, which will be carried by the air to some new location and, if conditions are right, will sprout and form new strands. Generally, fungi need moisture,

warmth, dark, and a sugar source to grow.

Some fungi have special mechanisms for dispersing spores, called *mushrooms*. Not all fungi make mushrooms, but many basidiomycetes do, which is handy for do-it-yourself spalting. Some mushrooms are edible, some are poisonous; most are tough and not very palatable. Some spores are tasty (contained in a delicious morel, for instance), some are toxic, but most simply exist.

### **Molds: Terror from the air?**

Many of the molds that people (often incorrectly) associate with lung problems are airborne household molds that have absolutely nothing to do with spalting. Spalting fungi primarily grow *in* wood. Mold fungi grow *on* wood and *on* other things, like your walls. You are probably not going to find *Trametes versicolor* (turkey tail) growing on the bread in your cupboard, just as you are not likely to find *Penicillium spp.* (common air mold) on the inside of a log. Fungi have niches, just like plants and animals. Molds are in your home because they like high humidity and can grow on nutrient-poor surfaces, like bathroom tile. Molds grow on the top of wet wood to eat the available sugars, then are pretty much done. Decay fungi (and some soft rot and stain fungi), capable of penetrating into cell walls, are the fungi that really get into the wood and cause internal spalting. The erroneous assumption that all fungi behave the same is like saying that a dandelion and a cedar tree are the same because they are both plants.

Air movement of their spores transmits many fungi. The spores are so small that you need a microscope to see them, and are so light the faintest air movement sends them across a room. With humidity situations

often beyond our control (bathroom humidity, flooded basement) certain mold fungi are concentrated in domestic enclosures (your house). A sample of air from inside an apartment building would yield very different results than one from the forest, although both would contain ample amounts of fungal spores. Fungus spores are in the air no matter where you go, although the types vary by location. Even the best air filter available for home use is not capable of removing all of the spores from the air.

### **Spalted wood: Moisture and finishing**

Enough biology for a moment, let's talk about spalted wood. All wood has fungus on its surface, because spores are always in the air. Spalted wood has fungi *on* it; it also has fungi *in* it—and most of what is in it is not producing spores. The fungi get into the wood either by digesting wood components for food or

by boring little holes (and sometimes both). The fungi grow in the wood happily while moisture remains. Once the wood moisture content drops below about 15 percent (higher or lower depending on different fungi) the fungi stop growing. After a week or two without adequate water, the fungi die. Any spores on the outside or inside now sit in stasis, awaiting the return of water.

Before you reach for your air filter helmet, remember that fungus spores are always on wood, because they are always in the air. If you let your wooden cutting board remain wet for several days in a warm place, it will grow mold, even if it not made from spalted wood. Any wooden bowl put in contact with moisture for extended periods of time will grow fungus, spalted or not. This ►

(Below) **Mike Mahoney**, untitled canister, 2008, Spalted madrone, African blackwood, 9" × 6" (23 cm × 15 cm)



(Above) **Dennis Paullus**, *Rope Handles*, 2011, Spalted maple, 14" × 8½" (36 cm × 22 cm)

Photo: Mike Maffitt



is one of the reasons we woodturners use protective finishes on our pieces. Although it may seem like the purpose of a finish is to make the wood shiny, finishes serve an important role in minimizing moisture gain and loss in wood during changes in relative humidity (or when you dunk your bowl in water). They don't *prevent* moisture from leaving and entering, but they do slow it down, which helps protect wood from decay caused by fungi.

## Busting the myth(s)

Let's proceed to discussing urban legends.



**Fred Klap**, 2005, Untitled, Spalted maple (white rot, zone lines), African blackwood, abalone, 7" x 3" (18 cm x 8 cm)

### **Myth: Bringing spalted wood into my shop will introduce fungal spores that were not there before.**

Reality: Unless you've lined your entire shop with the very expensive air filters that mycologists use in laminar flow hoods (to create a sterile work environment), there are already spores in your shop. Because it is a wood shop, most of the spores are probably already a good mix of basidiomycete and ascomycete. Remember, if there is air, there are fungal spores. It's really that simple.

It is true that mold can grow on the surface of wood. It is also true that bringing moldy wood into your shop will bring a large batch of spores in with it. What *isn't* true is that these spores are just now being introduced into your shop. The mold got on the wood in the same way it got into your shop: the air. And it's not just wood that brings in spores. Other sources include pets, cheese (*Penicillium roqueforti* makes blue cheese blue), and you, on your clothes, in your hair, pretty much anywhere.

And of course, because spores are everywhere, that means they're also

on nonspalted wood. All wood has fungus on it. The main difference is that with spalted wood the fungus has been given ample time and moisture to colonize, whereas clear wood contains only small amounts of fungus. Either way, if you get the wood wet, the fungus will grow.

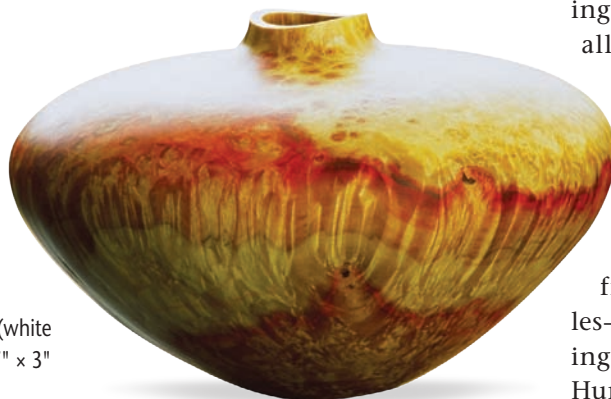
### **Myth: Spalted wood in my home, even finished pieces, produces spores.**

Reality: Fungi cannot grow and reproduce if the wood is dry. If the wood is dry, the fungus is inactive. If the wood is dry for an extended period of time, the fungus is dead. Spores can lay dormant for millions of years, but they're not going to *do* anything without moisture. So, unless you display your spalted bowls in a shower stall, do not worry about fungi growing.

Applying finish on spalted wood effectively seals the wood pores. Even if the spores were magically activated, they would not be able to go anywhere. Finishing wood has the added benefit of limiting the amount of moisture change from humid summers to dry winters. A finish not only keeps spores in, it keeps out a lot of the moisture that could activate the spores.

(Below) **Mike Mahoney**, untitled, 2007, Boxelder, 7" x 10" (18 cm x 25 cm)

The pink stain in boxelder is not spalting; it is produced by the tree and is not color stable.



### **Myth: Molds will get into my lungs and grow mushrooms.**

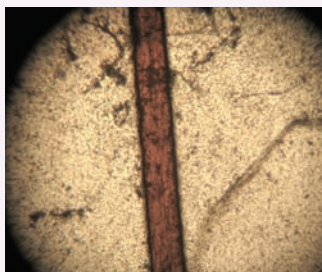
Reality: This is probably my favorite urban legend. Consider the following: If fungus spores are in the air all the time, no matter where you are, how is it that every single human being does not have little mushrooms growing in their lungs? The primary answer is the immune system.

This fantastic system keeps us from dying if we scrape our knuckles—it is responsible for destroying foreign material in our bodies. Human immune systems appear to

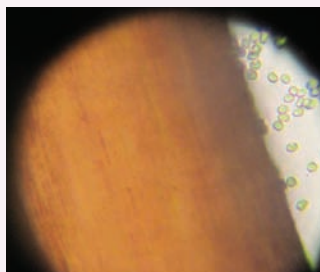
## Mold comparison

The shots of the molds were done to take a comparative look at ambient mold fungi in a variety of settings. Petri plates contained a 2% malt agar solution (think of it as unflavored jello) and were left uncovered in their location for 30 minutes. Growth was visible after 5 days. Photos are from one week of growth. For the rabbit plate, I briefly rubbed my rabbit's coat, then lightly touched my fingers to the petri plate.

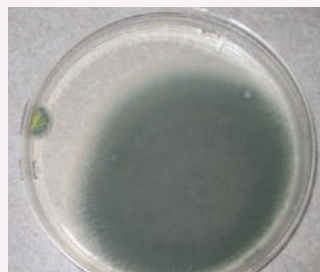
Most university microbiology courses now incorporate this type of experiment on their first lab day – encouraging students to take several plates home, touch things around the house (or even their face!), then let the plates incubate to see what is alive in our supposedly 'clean, civilized environment.' It offers a stunning reminder that we are never free of fungi or bacteria, and in fact live in harmony with many, many species of both groups.



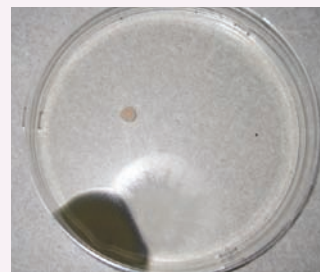
A human hair with several hyphae and millions of fungal spores.



A closer look at the same hair, and the comparative size of the spores.



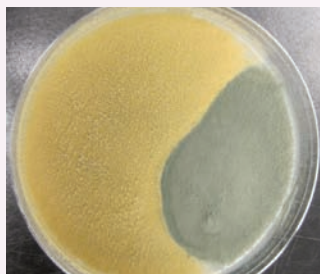
Petri plate from the ambient air in my kitchen.



Petri plate from the ambient air in my bathroom.



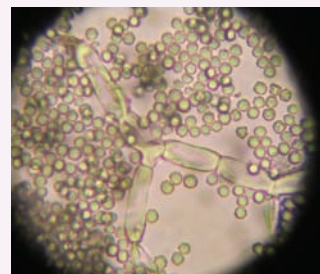
A close-up (1000x magnification) of a fungus producing spores.



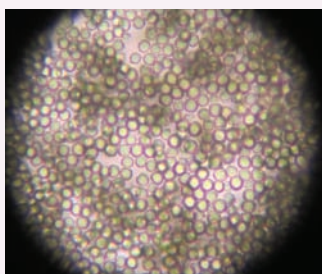
Mold growth on a petri plate after petting my rabbit, then touching the agar.



Petri plate from the ambient air of downtown Toronto. Note that there are many more types of fungi on this plate than any of the others.



A close-up (1000x magnification) of fungal spores and their size relative to fungal hyphae.



Previous shots were taken for clarity. This shot shows the typical spore load from a colonized area of the petri plate.



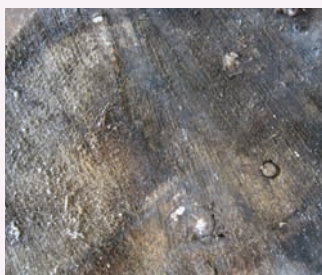
Spalted aspen (*Populus* spp.) – what it looks like on the inside, free of surface molds.



Mushrooms on the outside often directly correlate to where the spaltering is occurring on the inside.



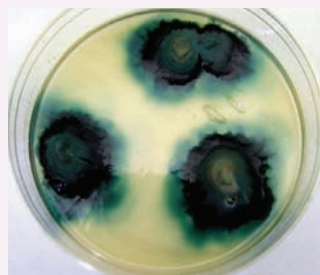
Spalted aspen – what it looks like on the outside, covered in all sorts of fungi and bacteria.



Close-up of the external surface of spalted aspen. Note the heavy concentration of mold.



Fruiting bodies of elf cup (*Chlorociboria aeruginascens*) on a downed conifer.



What elf cup looks like in its growing stage.



*"...all it takes is ten minutes on the Internet to develop fungus paranoia. Unfortunately it takes far less time to find fiction, conjecture, and hearsay than to fact check and find, well, the facts."*

be working well, considering that we can routinely live into our eighties, even with all the fungus in the air.

This is not to say that our immune system cannot be overwhelmed, especially when it is not functioning properly. The likelihood of a healthy immune system having any problems with airborne molds is low, but if you are concerned, protect yourself by wearing a proper respirator when working with any wood, including spalted wood. I recommend a NIOSH 95 or higher, such as NIOSH 97 or NIOSH 100. I hope that all woodworkers are aware of the dangers of wood dust and take steps to avoid inhaling it.

Can fungi grow in the lungs of humans? Certainly. Are they *likely* to grow in your lungs? No. Fungus growth in lungs occurs primarily when someone possesses compromised lungs or a compromised immune system from conditions such as AIDS or leukemia or while undergoing chemotherapy. Since the body is unable to fight off infection, pretty much anything can grow anywhere. Three examples of fungi that tend to grow in lungs are *Aspergillus*, *Fusarium*, and *Penicillium spp.* These are common airborne house molds and are completely unrelated to spalted wood, although they can readily grow on the surface of wet wood.

If you are still unsure about molds and your health, check out this circular from the Florida Department of Agriculture and Consumer

Services: [freshfromflorida.com/pi/enpp/pathology/pathcirc/pp339.pdf](http://freshfromflorida.com/pi/enpp/pathology/pathcirc/pp339.pdf).

**Myth: Woodworkers die from fungus inhalation.**

Reality: Woodworkers who die from occupational lung diseases die from wood dust inhalation, and the involvement of fungi is unlikely. For further explanation, read the Center for Disease Control (CDC) report on wood dust ([cdc.gov/niosh/pel88/wooddust.html](http://cdc.gov/niosh/pel88/wooddust.html)) and

the wood dust carcinogen report ([ntp.niehs.nih.gov/ntp/newhomeroc/roc10/WD.pdf](http://ntp.niehs.nih.gov/ntp/newhomeroc/roc10/WD.pdf)) by the U.S. Department of Health and Human Services. Healthy individuals generally do not die from inhaling fungus spores (because we inhale them every day). People *do* get sick and die from wood dust inhalation. Most stories we hear about some guy dying from turning spalted wood have much more to do with the fact that woodworkers have only recently started wearing dust masks and respirators. Breathing spalted wood dust did not cause those deaths; they died from inhaling *wood dust*, plain and simple.

**Myth: Burning spalted firewood is not safe.**

Reality: Where to begin with this urban myth? Fungus is in the air. Fungus is on all wood, regardless of whether it appears to be spalted. Firewood is routinely left outside, covered, during the year, and thus has plenty of fungus on it already. There is no difference between burning firewood and burning spalted wood.

It is worth mentioning that spalted wood should not be confused with pressure-treated wood, which often has a greenish cast to it. Burning treated wood releases toxic chemicals, which can be harmful. It's not a good idea to burn old decking in a bonfire if you are not positive the lumber is untreated. It is, however, safe to burn that old tree in your backyard, the one with the mushrooms growing on it.

**Myth: Using a spalted wood cutting board is not safe.**

Reality: It is safe, although the differences in density between sound and punky areas might not make for the



**Fred Klap**, *Untitled*, 2005, Spalted maple (white rot and zone lines), holly, 7" x 3" (18 cm x 8 cm)

**Dennis Paullus**, untitled, 2011,  
Spalted maple, 6½" × 8" (16 cm × 20 cm)

best cutting surface. All wood will rot if it gets wet. Cutting boards get wet. Spalted or not, if you keep a cutting board perpetually wet, fungus will grow on it.

Could spalting fungi be reactivated on a spalted-wood cutting board by keeping it wet for several weeks? Sure. But if a cutting board remains wet for long enough for a fungus to develop, I would avoid using wood cutting boards. Plastic would be a better choice.

Despite the tendency for wood to rot when wet, human beings have been using wood for eating and cooking since well before we could even write, and it seems to still be serving us well. So what if you eat a few fungus spores from the vegetables you just chopped on your spalted-wood cutting board? The veggies themselves come complete with fungi of their own.

### **The Internet says spalted wood is a health hazard!**

That information on the Internet is wrong. Before you quote from that



Forest Products Laboratory bulletin ([fpl.fs.fed.us/documnts/techline/producing-spalted-wood.pdf](http://fpl.fs.fed.us/documnts/techline/producing-spalted-wood.pdf)), let's take a look at what it *actually* says:

*Although the white rot fungi responsible for the decorative appearance are not pathogenic (a health problem), there might be some molds associated with the spalting process that could cause allergies in people. It is also possible that some pathogenic molds, such as fumigatus (responsible for "farmers lung"), might be present, so it is always a good idea to work in well-ventilated areas. (2004, 2)*

## Safe practices for working with spalted wood

- **YES**, healthy people can get sick from fungi, specifically people with a background of immune system problems or with compromised lungs.
- **NO**, becoming ill from working with spalted wood is not likely to happen.
- **YES**, some of the mold fungi that grow on the surface of wet wood are harmful.
- **NO**, the fungi utilized in controlled spalting, and those that cause white rot and zone lines, are generally not harmful.
- **YES**, spalting your own wood with unknown fungi can be dangerous.
- **NO**, spalting your own wood with known, pure-culture fungi is not a serious health risk. (For information on DYI spalting, read the author's article in *AW*, vol 25, no 6.)

**Dick Wilson**,  
*Nazca is Waiting*, 2011,  
Spalted sycamore, dye,  
black lacquer,  
10" × 7"  
(25 cm × 18 cm)



So to clarify, the Forest Products Lab (an extension of the U.S. Forest Service) says:

1. White rot fungi are not pathogenic (they're not going to hurt you).
2. There *might* be some molds that cause *allergies* in people.
3. Pathogenic molds may exist *on* spalted wood.
4. Ventilation is necessary (no mention of avoidance).

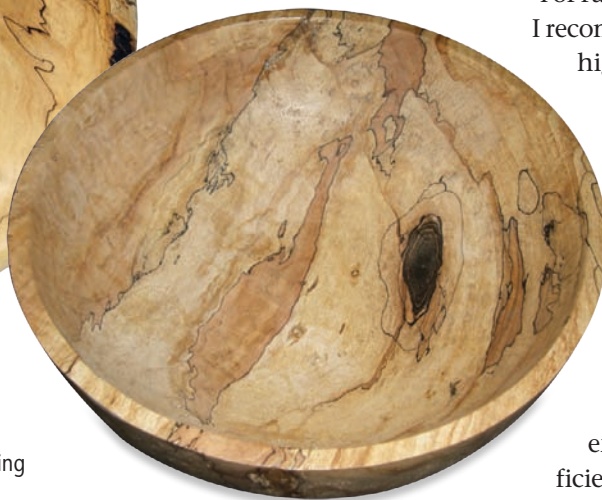
Some people are allergic to molds, just as some people are allergic to dogs or cats. Some people are also allergic to white rot fungi (just ask some of the students in my lab). Because something is an allergen does not mean it is inherently *dangerous*, but it certainly does make it irritating. Many woodturners have found wood species they are allergic to, often an exotic species or a native species with a high extractive ▶





(Above) **Joe Houtp**, Untitled, 2002, Maple, (white rot, zone lines) 19" x 3" (48 cm x 8 cm)

allergens affect some people more strongly than others. Being around a cat for several hours will leave me wheezing for days, but I don't insist that everyone stay away from cats because of potential allergies. I



(Right) **Bill Wiard**, Maple, zone lines and bleaching (dimension and year unavailable)

content (like cedar). If you find a wood species you are allergic to, do you stop turning *all* wood? No, you just stay away from that species or wear a respirator. If spalted wood bothers your allergies, turn a different type of spalted wood or wear a proper respirator.

It's also true that some individuals develop a hypersensitivity to fungi. Again, this is nothing new. Some

simply avoid cats. If you're allergic to mold, don't work with spalted wood.

So what about pathogenic molds? They can grow on the surface of wood, just as they can grow on hay, on walls, and in food. Spores are airborne; you're going to inhale them sooner or later, regardless of how careful you are. For those who are seriously concerned: those fungi are on the *surface* of the wood, not inside, which means that you can kill them with a surface application of bleach and isopropyl alcohol.

Obtain two spray bottles. In one, pour household bleach to a level of 10%, then fill to 100% capacity with water to achieve a

10% bleach, 90% water solution. In the other bottle, simply pour in 91% (or 99%) isopropyl alcohol (available from a pharmacy). Spray the liquids from the two bottles onto the surface of the wood, either at the same time or one right after the other and have at it with a gouge.

For further filtering in your shop, I recommend a HEPA E12 filter (or higher) if you are concerned about fungal spores, otherwise an E11 is sufficient. (An E10 filter is insufficient for filtering workshops.) Inexpensive, plug-in household filters are often just carbon filters. Higher-priced shop filters can filter to 1 micron (80% removed) and 90% of 5 microns or larger. One micron is excellent for filtering; 80% is sufficient when paired with a NIOSH 95 or higher mask.

A good-quality, effective dust collector and air-filtration system should be part of any shop. Again, this isn't because of the fungus, but because of wood dust. But since you should already have one in place, you can rest a little easier knowing that a good air cleaner will catch those fungus spores too, along with the tiny dust particles.

## What does it all mean?

All wood has fungi on it. The air has fungi in it. Everywhere you go you are constantly bombarded with fungi. Turning spalted wood may produce a high spore count in your shop, but at least in the shop you are wearing a respirator that filters out all the nasty particulate matter, of which fungi are a very, very small part. Think about how many fungus spores you pick up when you walk through the woods in autumn, and you're not even wearing a mask.



**Sara Robinson**, Untitled, 2010, Aspen with pink, blue, yellow stain, yellow zone lines, 4" x 8" (10 cm x 20 cm)

Understanding that fungi have different roles, different requirements, and different behaviors is the first essential step in working with spalted wood. This isn't because a deep understanding of fungi is required to turn a spalted bowl, but because every group has at least one person who has an irrational fear of microbes. When one person starts with, *there was this guy in Texas who had mold on his wall or did you hear about the woman who turned spalted wood for 20 years and then died when mushrooms grew in her lung?*, all it takes is ten minutes on the Internet to develop fungus paranoia. Unfortunately it takes far less time to find fiction, conjecture, and hearsay than to fact check and find, well, the facts. These facts are backed up with relevant, peer-reviewed scientific literature, which you can read for yourself in scientific journals.

So, take a deep, fungus-filled breath and enjoy your woodturning experience. Wood dust, wood finishes, and even the very act of machining with power tools is far more dangerous than breathing fungus spores. Don't miss the opportunity to work one of nature's most fabulous artistic achievements: spalted wood. Snap on a respirator, pull down your faceshield, and mount that spalted-wood blank onto your lathe with full confidence that you are protecting yourself from the real dangers of turning wood: wood dust and flying objects. ■

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*Sara Robinson has a PhD in forestry (within the field of wood science) from Michigan Technological University and currently works as a postdoctoral research fellow at the University of Toronto's Faculty of Forestry. She invites everyone interested in spalting to come visit the Faculty of Forestry's Applied Mycology Lab where the public, graduate students, and undergraduates from all backgrounds and disciplines can explore the interactions of fungus on wood. You can visit her website ([northernspalting.com](http://northernspalting.com)) to learn more about spalting and stay up-to-date with the latest developments in spalting research.*

## Spalting in the news

Recently, the Mayo Clinic in Florida presented a poster at a conference which indicated, via the abstract, that spalted wood may be linked to a case of hypersensitivity pneumonitis (HSP) in a 61-year-old former smoker (and current woodworker/home spalter). Based on the information presented in the abstract (there is no paper available; this information came from a poster session), no actual link has been made between a fungus that came specifically from the wood the man was spalting and his lungs. Despite the claims made in the abstract that HSP was associated with spalted wood, no actual evidence of this linkage was presented. Confused? Allow me to elaborate.

Just because two events happen at the same time does not mean they are causal. If I enter a store and it starts to rain, then it stops raining when I leave the store that does not mean my going into the store caused the rain. In that same vein, getting a chest infection and working with spalted wood does not mean that the spalting caused the chest infection. I'm not refusing to admit the possibility, especially as the gentleman had a history of respiratory infections for the past two years (indicating a poor immune system, which makes a person susceptible to all kinds of nasty things). However, it is important to remember two things:

1. Wood dust is harmful to the lungs and can cause serious damage.
2. Wood that is not purposefully spalted (i.e., wood left outside for long periods of time and not intentionally inoculated) can grow all sorts of bacteria and nonspalting fungi on the surface. Many people are sensitive to these surface molds (which are not the kind that cause spalting and can in fact be completely avoided if care is taken when intentionally spalting wood).

When reading articles like this abstract, piece together the facts presented. In this case, an older gentleman with a probable compromised immune system was an avid woodworker, who worked with spalted wood. After not working with spalted wood for thirty days, the man showed remarkable improvement. No information is given about the fungi/bacteria responsible. Was it only bacteria? Was it surface mold? Or was it an actual spalting fungus? We don't know. There was also no control: What if the gentleman was told he could work with normal wood, but not spalted wood? Was it the removal from all wood that cured him, or was it specific to the spalted wood? Did the man wear a respirator when working with his wood?

With so many unanswered questions, it is important not to jump to conclusions. People with poor immune systems probably should not be working with wood, and everyone, regardless of health level, should be wearing a respirator. Wear a respirator of sufficient quality, and there is no need to worry about fungi or bacteria (even the harmful ones), because they cannot pass through the respirator's filtering system.

Fungi cannot be avoided forever, but a smart woodturner will be careful about the ones invited into his or her shop by exercising some control over spalting experiments. Keep the wood contained and out of air circulation. Sterilize the surface before turning with a mixture of bleach and isopropyl alcohol. (It is important to use 91% [or 99%] isopropyl alcohol, not simply inexpensive rubbing alcohol.) Obtain two spray bottles. In one, pour household bleach to a level of 10%, then fill to 100% capacity with water to achieve a 10% bleach, 90% water solution. In the other bottle, simply pour in isopropyl alcohol. Spray the liquids from the two bottles onto the surface of the wood, either at the same time or one right after the other.