Evaluating, Remediating, and Preventing Mold in Residential Dwellings

Famous Litigation:
Ballard v Farmers Insurance of Texas
“Ballard case has had a profound impact on mold litigation.”

“As the result of cases such as Ballard, mold (viewed earlier as the most ordinary of household nuisances) became a potential cash cow for plaintiffs’ lawyers.”

Summary

Once just a common nuisance, “mold” is now a source of income for businesses and attorneys, and a source of fear for home owners.
Terms

“Mold” vs “Fungi”

“Mold” is a common term applied to a variety of fungi which grow as semi-microscopic organisms, and whose mycelium tends to form a loose meshwork rather than a dense tissue. Molds are distinguished from the larger, fleshy fungi, like mushrooms.
“Fungi” can be pronounced with either a hard or soft “g”:

- **fuhng-gahy** (hard “g”)
- **fuhn-jahy** (soft “g”)

Defined as any one of a group of related organisms that lack photosynthesis and obtain food through breaking down dead organic matter.

“Hyphae” (singular: hypha)

Very finely branched, threadlike structures that are the vegetative body of a fungus.
“Mycelium” (plural: mycelia)

The entire mass of hyphae making up a fungus. Mycelium typically occur on the food source where the individual hyphae obtain the water and nutrients that fungus needs to grow.

“Mycology”

The formal study of fungi. Scientists who consider some aspect of the biology or ecology of fungal organisms are known as “mycologists.”
"Fruiting Body" and "Spores"

The fruiting body is the reproductive structure of fungi. For our purposes, the mycelium is the reproductive structure or fruiting body.

Spores are, in simple terms, similar to plant seeds. They are the beginning of new fungal growth.

"Mycotoxin"

A chemical produced by a fungus that evokes a toxic response when ingested by humans or other animals.

For most humans, mycotoxins are derived from fungi that have contaminated improperly stored food.
“Aspergillus”

A genus of fungi consisting of over 200 species. Aspergillus is VERY common, and will almost certainly be identified in any mold sampling that is done.

“Penicillium”

A genus of fungi consisting of over 250 species. Like Aspergillus, it is very common, and will almost certainly be identified in any mold sampling that is done.
The Good. . .

Both *Penicillium* and *Aspergillus* include species that are important to humans. For example, *Penicillium chrysogenum* is the source of the antibiotic penicillin. Other species of *Penicillium* are used to make cheese.

The Bad. . .

Both *Penicillium* and *Aspergillus* can create mycotoxins if they contaminate some foods, and *Aspergillus fumigatus* is responsible for aspergillosis, a pulmonary disorder.

“*Stachybotrys*”

*Stachybotrys chartarum* is the species usually called “black mold,” (though there are many other species of mold that are also black.) It is frequently detected in damp or water-damaged buildings, as it requires a high moisture content to grow and grows well on gypsum board (drywall).
How Fungus Grows

Fungi require five essential elements to grow:
1. substrate (food)
2. air (oxygen or in some cases carbon dioxide)
3. a surface to grow on
4. appropriate temperature range (varies by species)
5. moisture.

In addition, there are two favorable conditions for fungal growth:

- low light
- low air movement
How Fungus Grows

Fungi differ from plants in that they cannot produce food from photosynthesis.

Most fungi literally grow to reach a food source by extending the reach of the individual hypha strands.

When the food source is reached, the fungus releases digestive enzymes which break down the large molecules of the organic food into small molecules that pass through the hyphal wall.

How Fungus Grows

Breaking down the large molecules of the organic food, such as wood, destroys the integrity of the wood. This is commonly known as wood rot.

That’s right. Wood rot is really fungal deterioration or destruction of the wood structure.
How Long Does it Take for Fungus to Grow?

It is widely reported that fungal growth become visible within **24 to 48 hours**.

However. . .

Informal and formal testing indicates that fungal growth that is visible to the unaided eye shows up after **two to five weeks** of sustained conditions conducive to growth.

References:

Common Food Sources and Substrates

Gypsum Board
a.k.a. drywall and sheetrock

Common Food Sources and Substrates

Medium Density Fiberboard (MDF)
Common Food Sources And Substrates

Wood

Common Food Sources And Substrates

Fabric
Common Food Sources And Substrates

Carpets

Common Sources of Moisture

- Roof Leaks
- Leaking pipes
- Broken pipes
- Sweating pipes
- Leaking fire-protection sprinkler systems
- Landscaping
- Ground slopes
- Gutters and downspouts
- Sewer and drain backups
- Flooding
- Humidifiers
- Ice Dams
- Damp basement or crawlspaces
- Houseplants
- Cooking
- Bathing
Not-So-Obvious Sources of Moisture

- Bathroom ventilation fan vented to attic
- Combustion appliances – clothes dryer, water heater, vented into a garage, crawlspace, or attic
- Gas-burning space heaters
- Unvented and vented gas fireplaces
- Oversized air conditioning system
- High-humidity outside air
- Each of these can cause high indoor relative humidity (greater than 60 percent)

Moisture Transport

In addition to knowing where moisture comes from, it is helpful to analyze how it gets into the house. There are four primary means of this transport:

1. Liquid flow
2. Capillary suction
3. Air movement
4. Vapor diffusion
Examples Of Fungal Growth

Fungal growth on a pillows.
Finished basement with water intrusion in one room.
Fungal growth on unfinished medium density fiberboard (MDF)

Fungal growth on pine wood floor joist in a crawlspace.
Fungal growth and wood rot in a crawlspace beneath a tile shower.

Fungal growth on kitchen cabinets. High indoor relative humidity in an unoccupied house.
Fungal growth and wood rot from paint failure on a window frame.

Fungal growth and gypsum board and MDF base trim in a basement. Water in the wall from leaking window head flashing.
Fungal growth on just about everything in this basement. Moisture from water intrusion of the front basement wall.

Mold Studies

If fungal growth is clearly visible, a mold study should focus on identifying the source of moisture and the transport mechanism.

If fungal growth is not visible, but fungal contamination is suspected, a mold study should focus on determining whether mold spore levels within the house are excessive and identifying the possible source(s) of moisture and the transport mechanism(s).
Mold Studies - Instrumentation

In cases where fungal growth is clearly visible, a mold study will usually use the following instruments:

- Hygrometer
- Contact moisture meter
- Pin moisture meter
- Infrared camera

Hygrometer
Pin Moisture Meter

Contact Moisture Meter
In the case where fungal growth is not visible, but fungal contamination is suspected, a mold study should focus on determining:

- are mold spore levels within the house excessive?
- identifying the possible source(s) of moisture and the transport mechanism(s).

Measuring spore levels is done using an Anderson Air Sampler.

The samples must include one outdoor location for comparison.
Measuring spore levels is done using an Anderson Air Sampler.

Air Sampler Lab Results

- The absolute number of mold spores is not important.
- The number of mold spores of indoor samples compared to the outdoor sample is of primary importance.
- A significant difference indicates mold spores are being created inside.
- The definition of “significant difference” is vague, and there are no government regulations or guidelines.
Remediation

Remediation Protocols are available from:

• OSHA
• EPA
• IICRCS-500
• State of New York
The United States Environmental Protection Agency publication “A Brief Guide to Mold, Moisture, and Your Home” states:

- If the moldy area is less than about 10 square feet (less than roughly a 3 ft. by 3 ft. patch), in most cases, you can handle the job yourself, following the guidelines below.
- If mold growth covers more than 10 square feet, consult the U.S. Environmental Protection Agency (EPA) guide: Mold Remediation in Schools and Commercial Buildings.

continued

- Fix plumbing leaks and other water problems as soon as possible. Dry all items completely.
- Scrub mold off hard surfaces with detergent and water, and dry completely.
- Discard absorbent or porous materials such as carpet.
- Consider wearing an N-95 respirator to limit exposure to airborne spores.
For areas greater than 10 square feet, the EPA recommends four methods of cleanup:

1. Wet vacuum
2. Damp wipe
3. HEPA vacuum
4. Discard

Table 2: Guidelines for Remediation Building Materials with Mold Growth Caused by Clean Water*

<table>
<thead>
<tr>
<th>Material or Furnishing Affected</th>
<th>Cleanup Methods</th>
<th>Personal Protective Equipment</th>
<th>Containment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEDIUM – Total Surface Area Affected Between 1.0 and 100 (sq ft)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Books and papers</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpet and backing</td>
<td>1, 2, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete or masonry</td>
<td>1, 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard surface, porous flooring (brick, ceramic tile, vinyl)</td>
<td>1, 2, 3</td>
<td>Limited or Full</td>
<td></td>
</tr>
<tr>
<td>Non-porous, hard surfaces (plastics, metals)</td>
<td>1, 2, 3</td>
<td>Use professional judgment; consider potential for remediation exposure and size of contaminated area</td>
<td></td>
</tr>
<tr>
<td>Upholstered furniture &amp; drapes</td>
<td>1, 2, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinyl board (drywall and gypsum board)</td>
<td>3, 4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Wood surfaces</td>
<td>1, 2, 3</td>
<td></td>
<td></td>
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DONAN: CE Seminar Birmingham, AL

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<tr>
<td>LARGE – Total Surface Area Affected Greater Than 100 ft² or Potential for Increased Occupant or Remediator Exposure During Remediation Estimated to be Significant</td>
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</tr>
<tr>
<td>Books and papers</td>
<td>3</td>
<td>Full</td>
<td>Full</td>
</tr>
<tr>
<td>Carpet and backing</td>
<td>1, 2, 3, 4</td>
<td>Use professional judgment, consider potential for remediation exposure and size of contaminated area.</td>
<td></td>
</tr>
<tr>
<td>Concrete or tile block</td>
<td>1, 3</td>
<td>Use professional judgment, consider potential for remediation exposure and size of contaminated area.</td>
<td></td>
</tr>
<tr>
<td>Hard surface porous flooring</td>
<td>1, 2, 3, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard surface non-porous</td>
<td>1, 2, 3, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-porous, hard surfaces</td>
<td>1, 2, 3, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-porous, plastic, metal</td>
<td>1, 2, 3, 4</td>
<td></td>
<td></td>
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<tr>
<td>Water-based furniture &amp; drapes</td>
<td>1, 3, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood board (hardwood and plywood)</td>
<td>3, 4</td>
<td></td>
<td></td>
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<tr>
<td>Wood surfaces</td>
<td>1, 2, 3, 4</td>
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Helpful References

- EPA - Mold Remediation In Schools and Commercial Buildings
- EPA - Should You Have Your Ducts Cleaned
- EPA - Indoor Air and Toxic Materials
- EPA - Moisture, Mold and Mildew
- EPA - The Inside Story
- EPA - Fundamentals of Indoor Air Quality (IAQ) In Buildings
Thank You