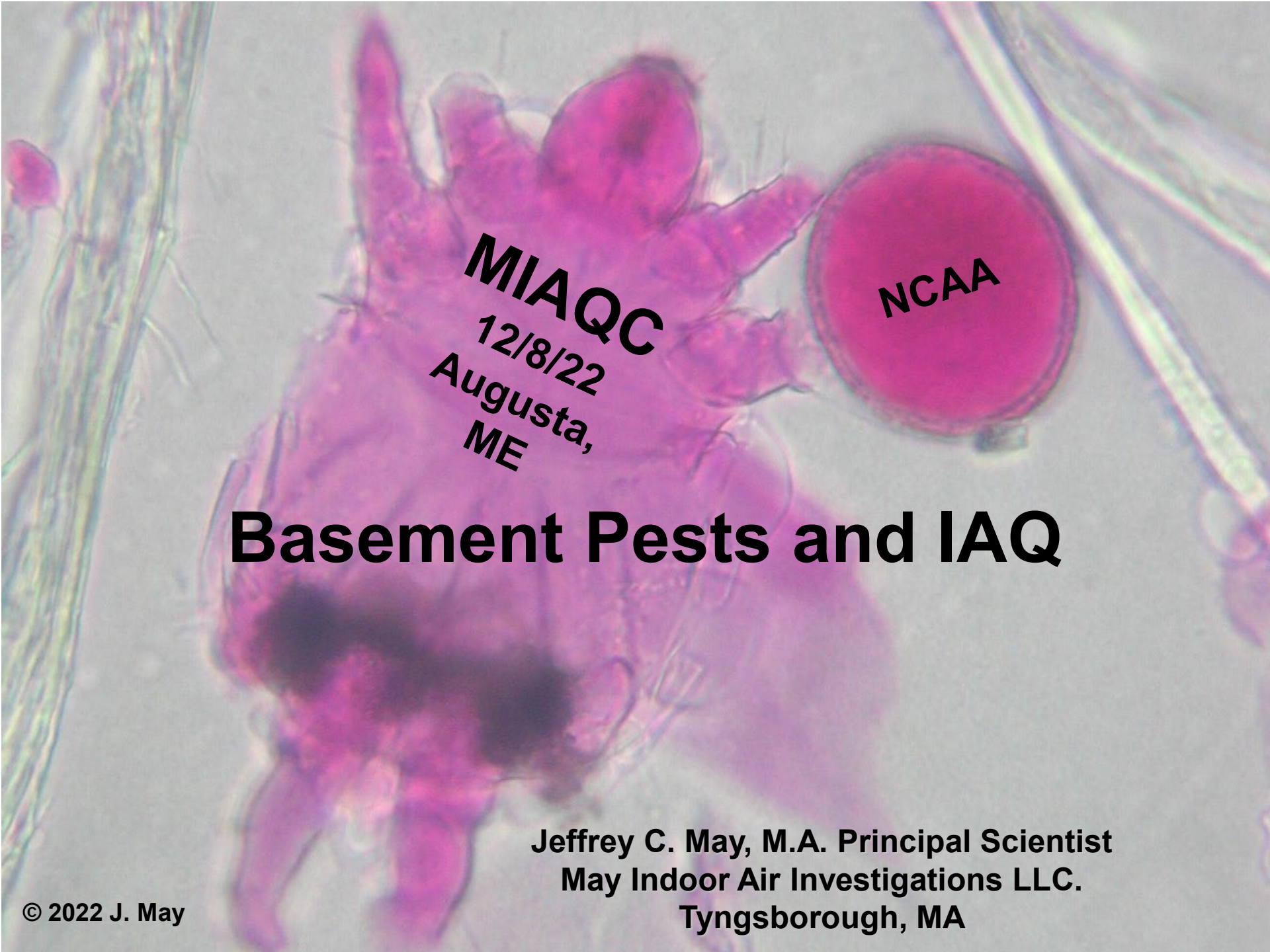


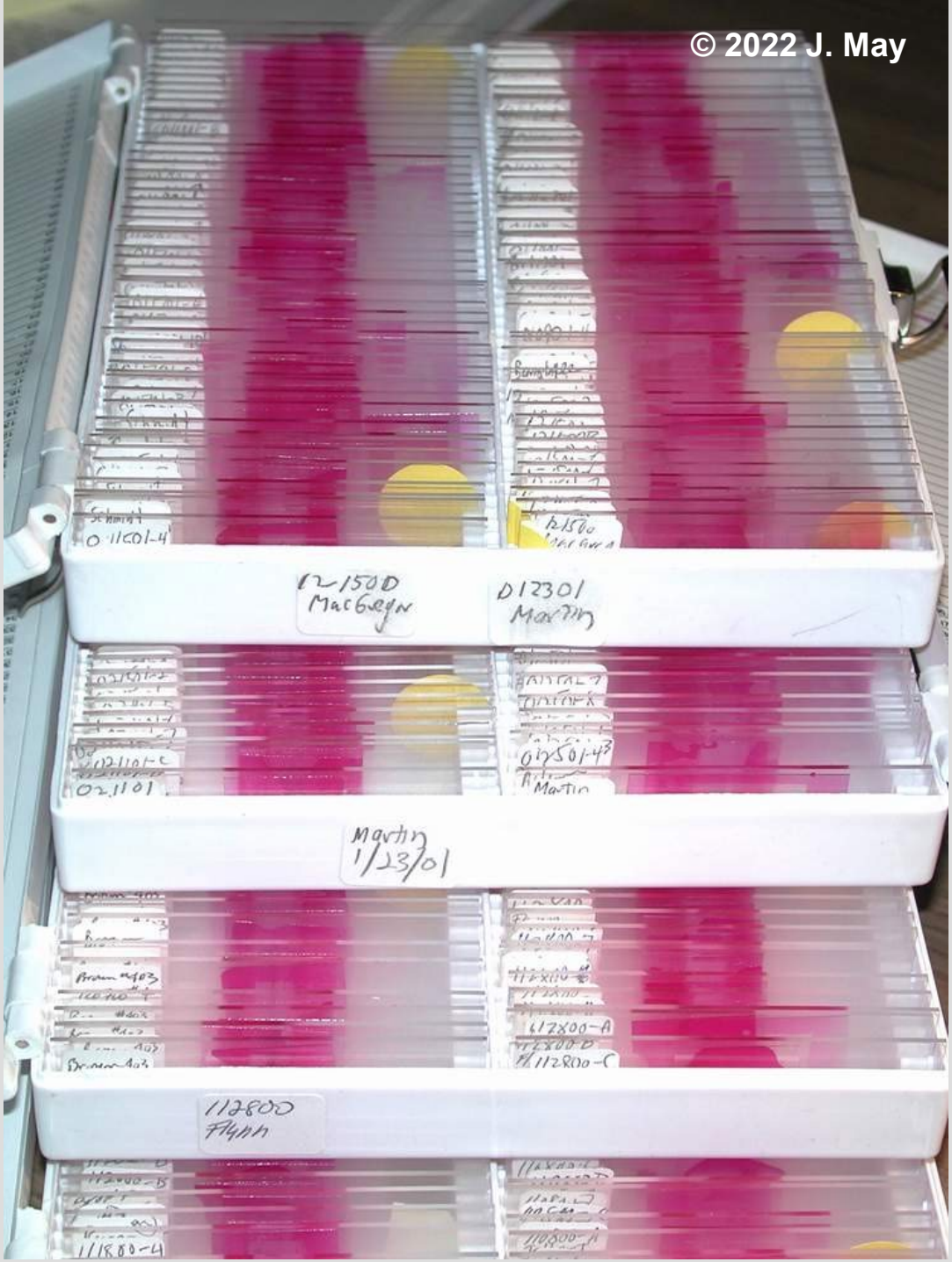
Basement Pests and IAQ

Jeffrey C. May, M.A. Principal Scientist
May Indoor Air Investigations LLC.
Tyngsborough, MA

Since 1992
MIAI has completed more than 3000 building inspections, including more than 1,000 "sick building investigations."

We have taken and analyzed by microscopy over 35,000 air and dust samples.

May Indoor Air Investigations LLC



Basement Ecology

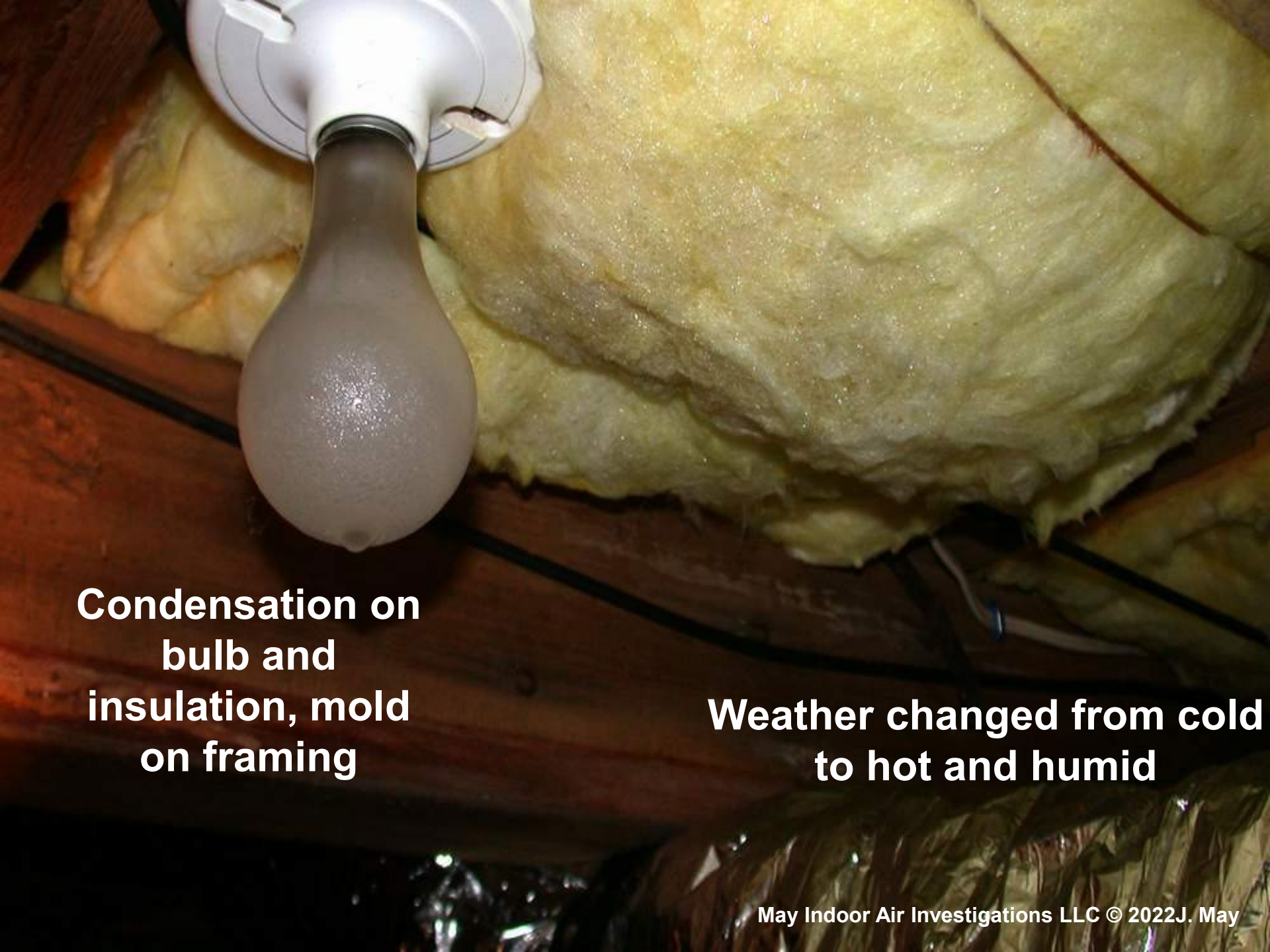
Damp from water entry

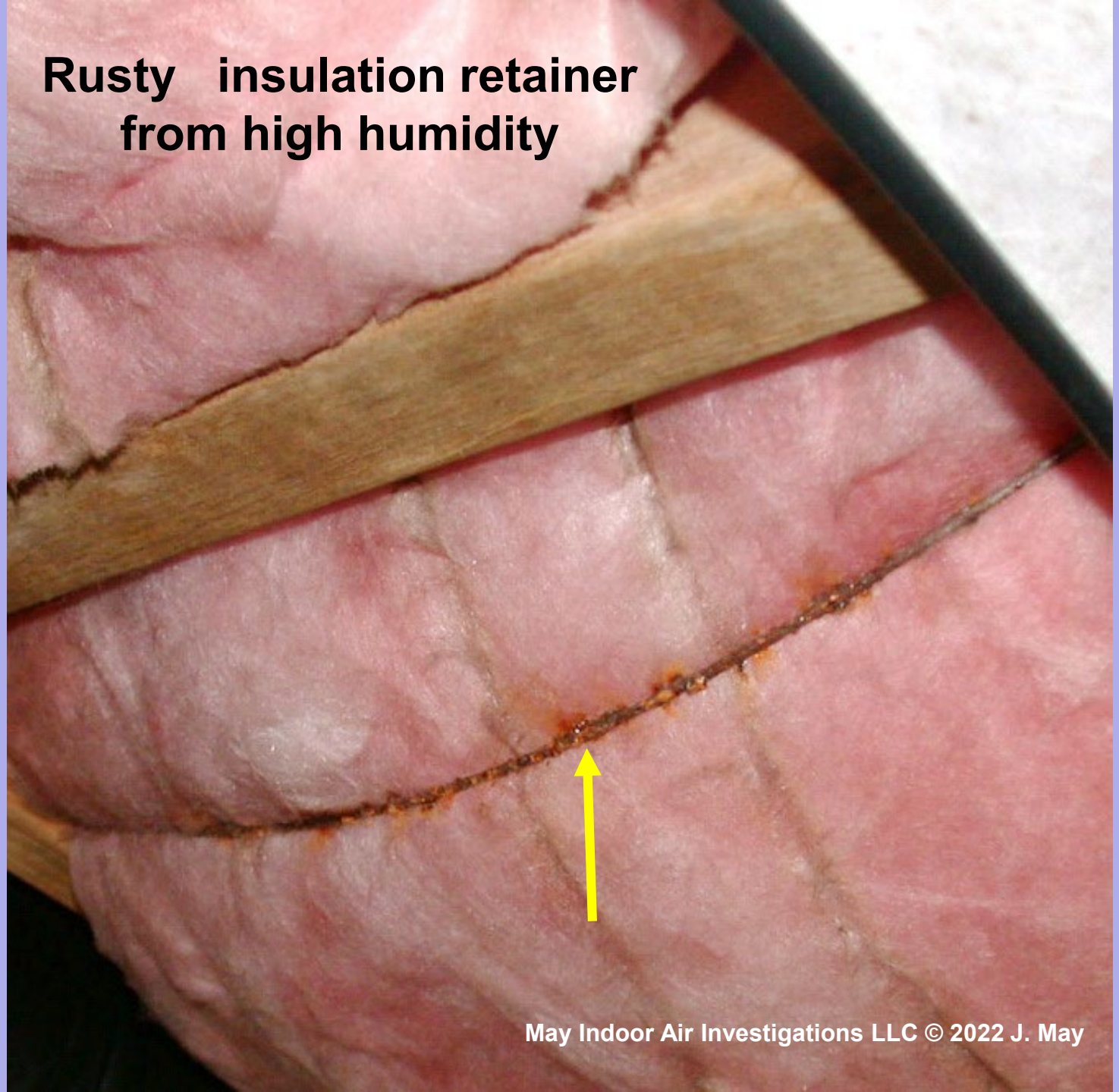
Damp from humidity

Moisture and chemicals from dryer

Neglected

Overstuffed with stored goods




Rusty insulation retainer
from high humidity
May Indoor Air Investigations LLC © 2022 J. May

Basements and Crawlspaces must be dehumidified

RH should be no more than 50%

Lint may have laundry chemicals

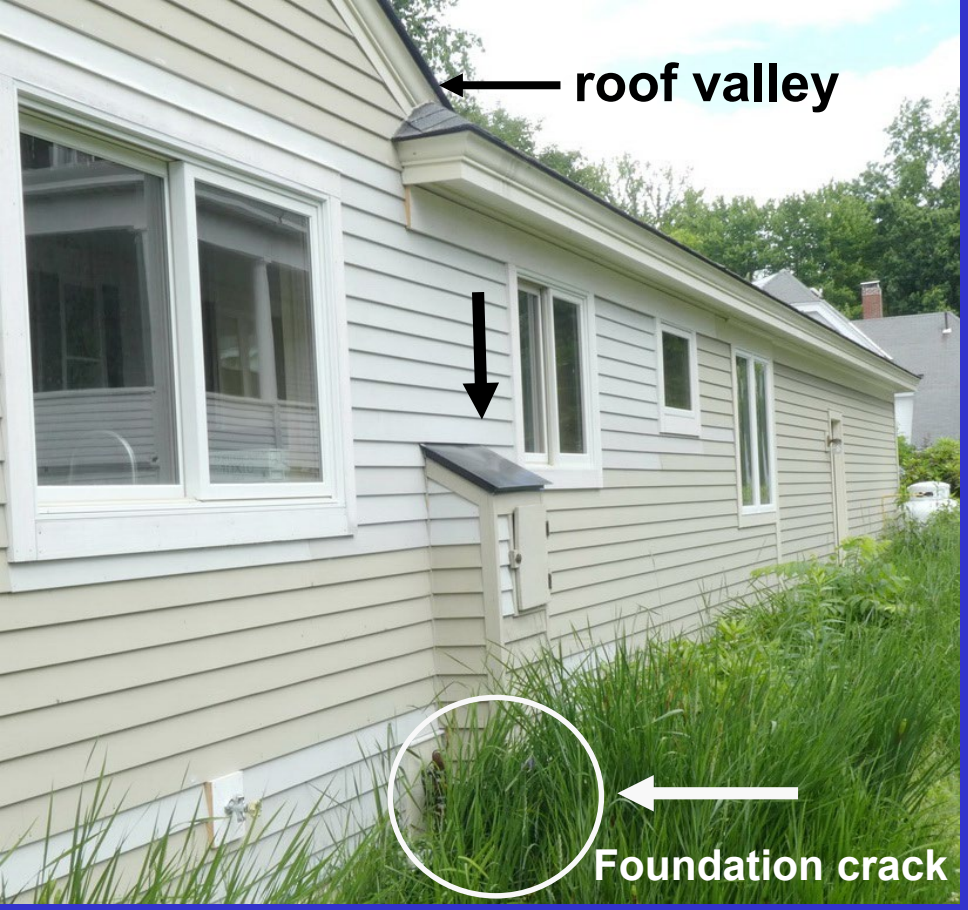
May Indoor Air Investigations LLC

Basement Ecology

Damp from water entry:

Small crack with lots of water flow

Crawlspace Flooding



Significant roof-water flow inundated crack between concrete foundation pours


Crawlspace Flooding
Do not ventilate crawlspaces
Damp from water entry
© 2022 J. May

Tips to Stop basement water

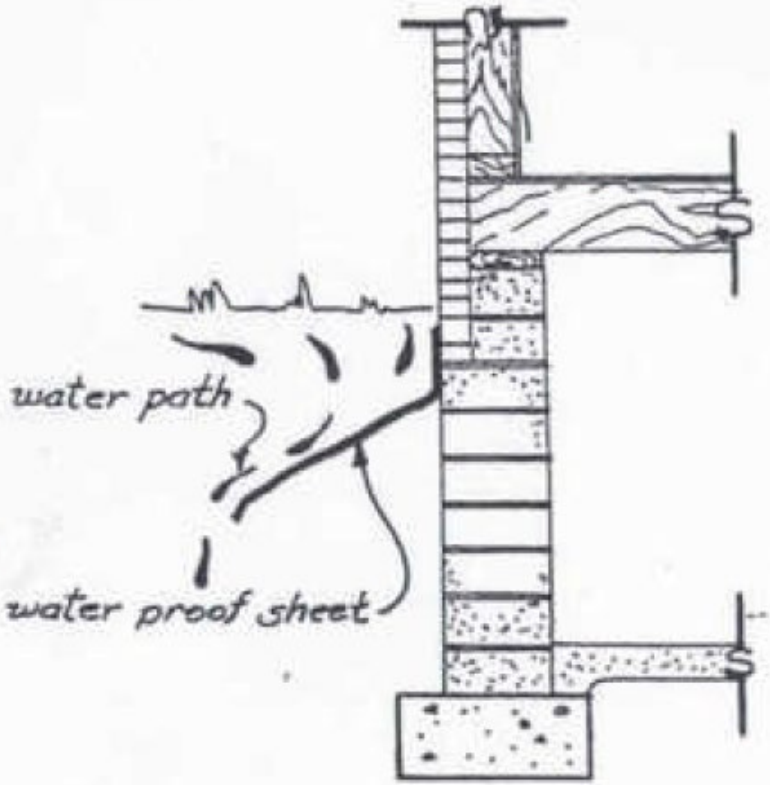
Over 90% of basement water problems are due to roof water

Check exterior during heavy rain to see where water ponds

Place a hose outdoors near an area where you have water in the basement

Consider installing a foundation skirt

Over 90% of basement water problems are due to roof water



A foundation skirt:

Waterproof sheet adhered to foundation and sloped away

Fig. 3-17 Surface water deflecting sheet.

58 DIAGNOSING AND REPAIRING HOUSE STRUCTURE PROBLEMS

Good drainage and grading are important but so is controlling relative humidity (RH) in the basement

Use dehumidification and keep the RH at no more than 50%

Basement Ecology

Damp from high humidity
Dehumidification is a must
but…

Dehumidifiers can get moldy
Dust + water = mold


Basement Ecology
Neglected
Over filled with stored goods
Use rolling metal shelving
STOR-ALL
ecco
Cardboard is food
© 2022 J. May
May Indoor Air Investigations

Basement Ecology

Activities:

Sawing wood

Sawdust is food:
Use vacuum collection

Basement Ecology

Rodents:

Mice
Shrews
Termites and Ants
Microarthropods:
Carpet beetles
Booklice
Mites
Insects
Wool Moths

Basement Ecology

Mouse Motel 6

Mice are Pests. .

for more than one reason

The reddish stains on the concrete under and to the right of the main beam are mouse urine trails

Mice communicate through mouse urine trails. The trails are associated with odor and allergens.

http://cen.acs.org/articles/89/i40/Mice-Urine-Powers-Social-Networking.html

Mouse urine trails

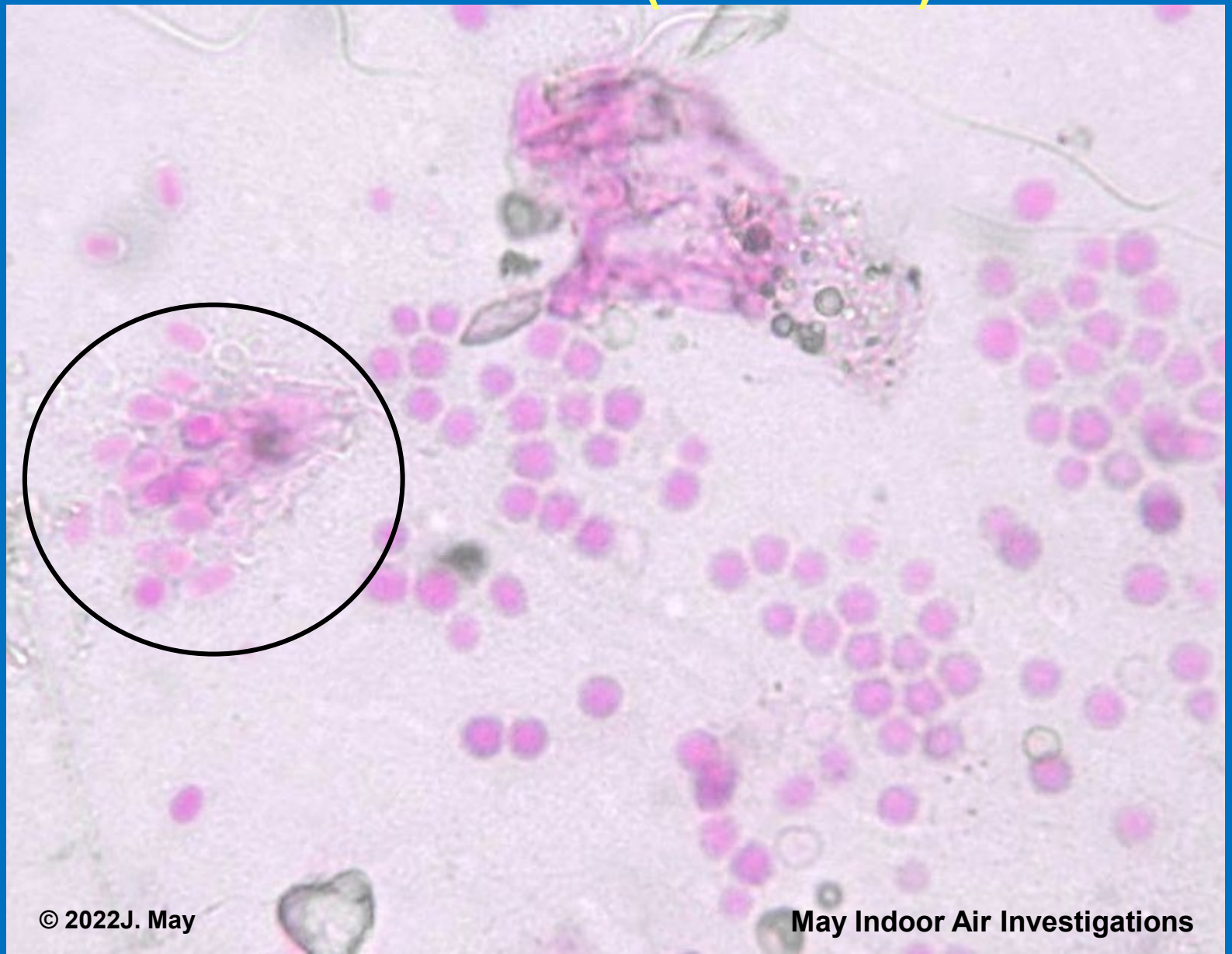
Homes with elevated levels of mouse allergens are associated with more frequent asthma symptoms.

Salo, P.M., Jaramillo,R., Cohn, R.D., London, S.J., Zeldin, D.C.,. 2009, "Exposure to Mouse Allergen in U.S. Homes Associated with Asthma Symptoms," Environmental Health Perspectives. 117(3):387-391.

Mice

Mouse-urine trails contain mouse allergens on DUST

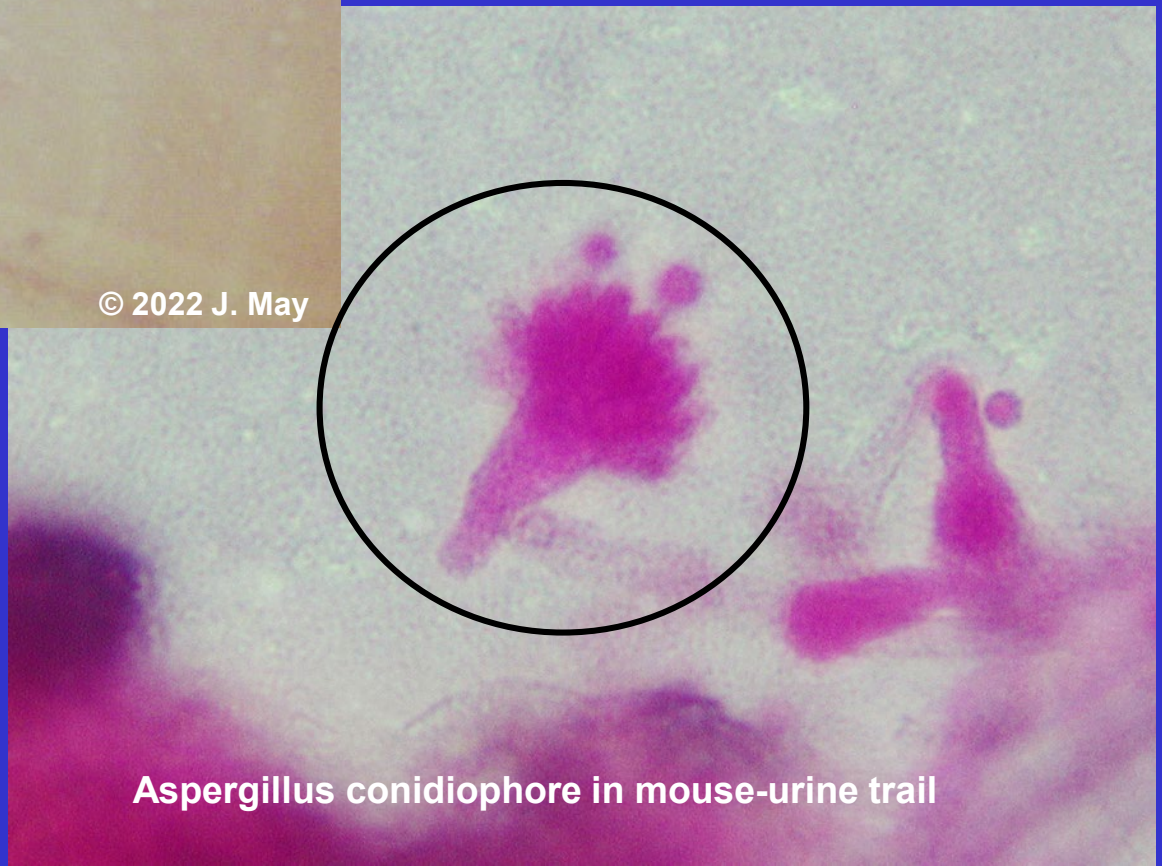
Aspergillus conidiophore and spores in mouse urine-trail (wet dust!)



Mice are Pests. .

for more than one reason

Mold-eating mite in mouse-urine trail



Aspergillus conidiophore in mouse-urine trail

May Indoor Air Investigations

Shrews

A New Source of Foul Odors in Buildings

Shrews

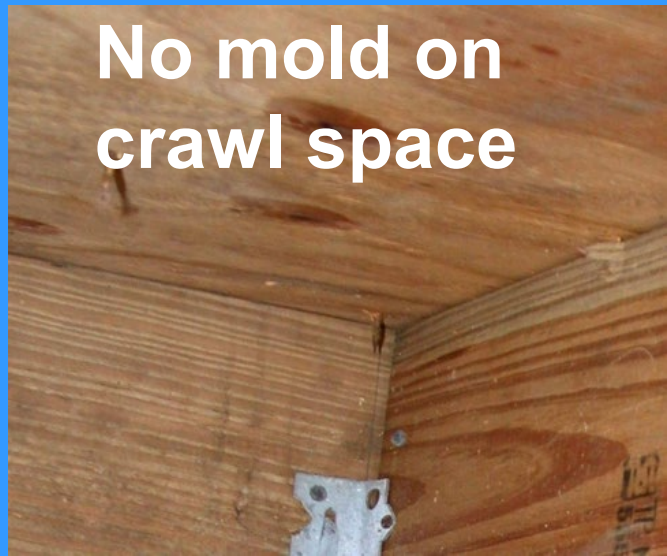
Find the entry with a mirror and flashlight

Shrews

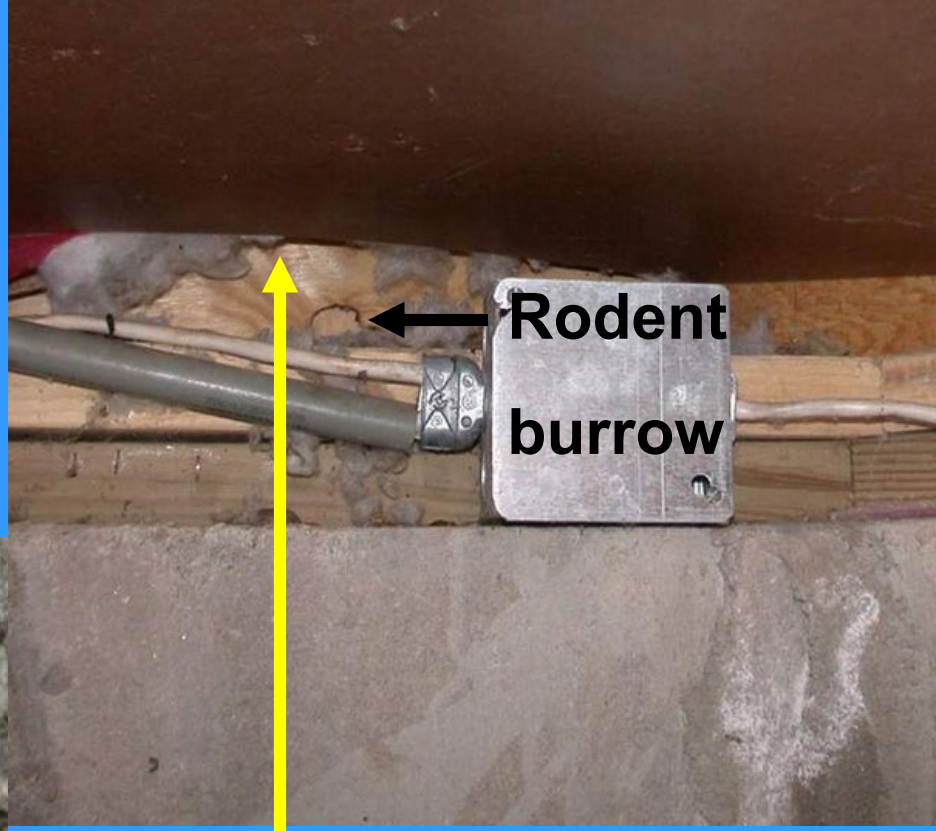
Rodent burrow

odors

Shrews in Crawl Space



Shrews in Crawl Space



Access to insulated parlor-floor cavity

Avoiding mouse and shrew problems

Check exterior for openings (flashlight and mirror are very useful)

Seal openings with appropriate materials:

Copper wool, wood, masonry, or foam with embedded metal mesh

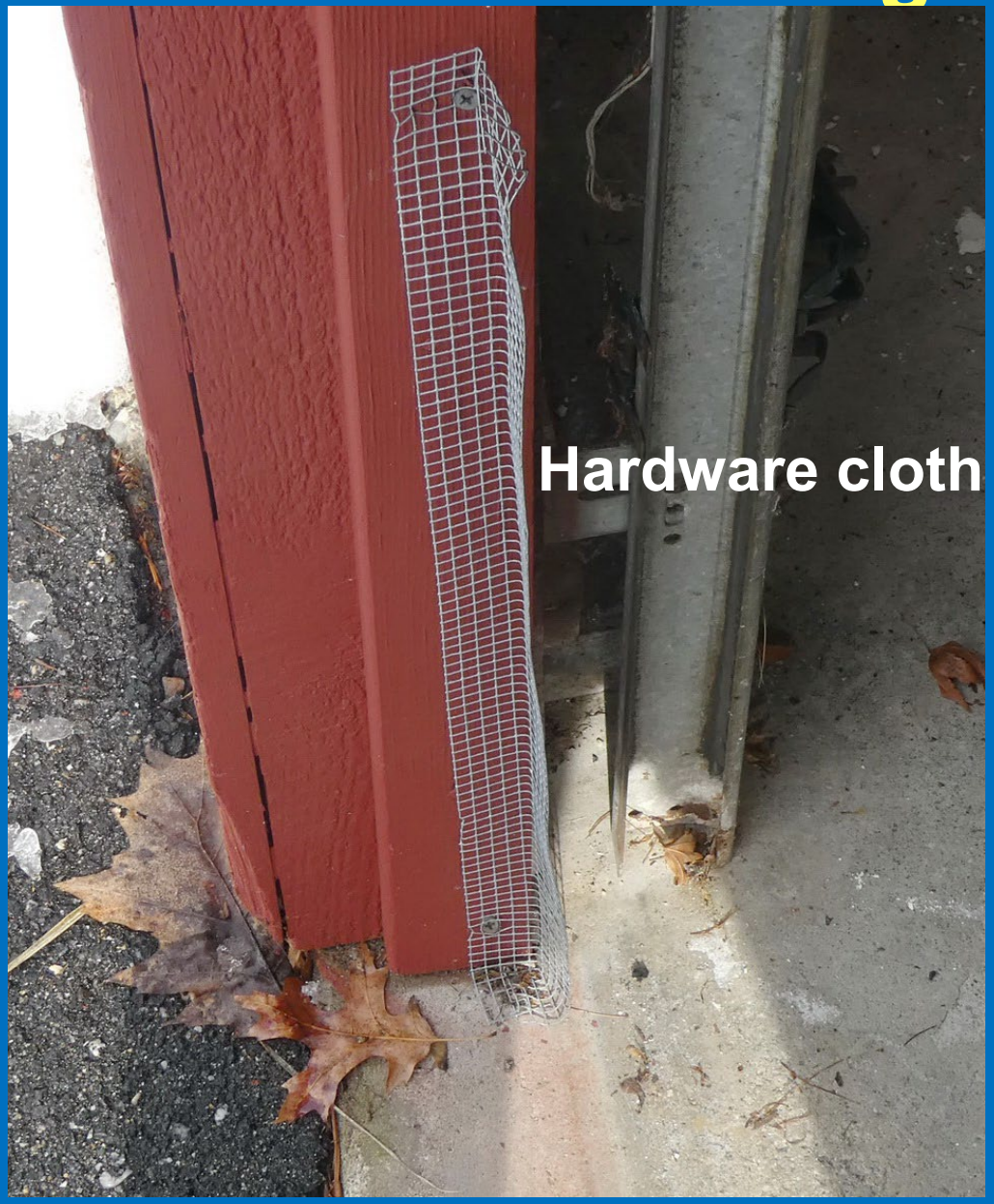
Store feeds, etc. in tight metal cans

Check that ridge and soffit vents are pest tight

Intact garage gaskets

No openings around garage pipes ducts or electric cables

Pest Exclusion on Garage Door



Termites Shelter Tubes

Termite workers are numerous but are blind and defenseless so they never exit the sand shelter tubes they build

Worker Termites in a Shelter Tube

When there is a break in the tube, soldier termites appear to fend off intruders (not shown)

Termite Ecology

Termites are in southern Maine and moving north
Termites may occur in southern Vermont

Prefer damp or decaying wood

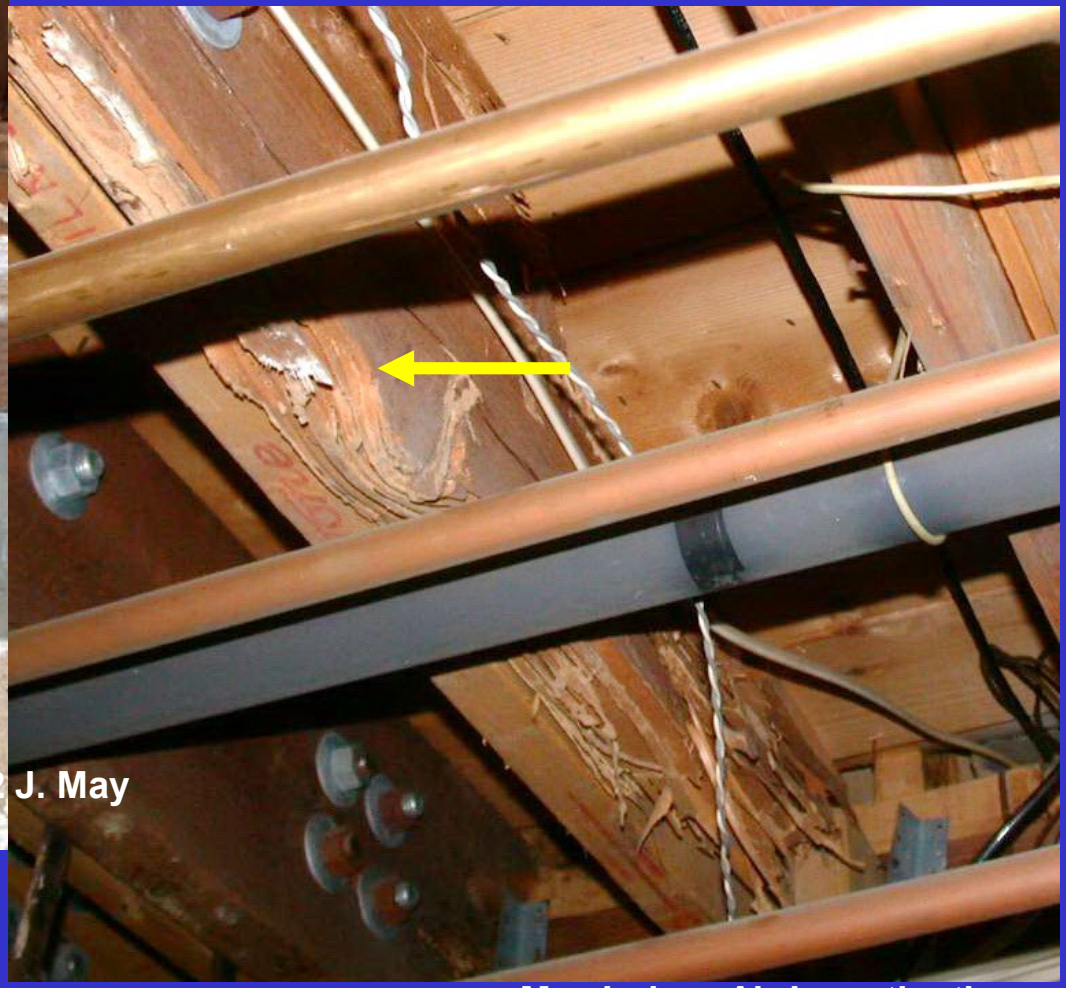
Always associated with sand so you can
distinguish termite galleries from ant galleries by crumbing the frass

Prevention: no wood buried in soil, inspect perimeter of exterior and basement

At least 2 inches, preferably 4 to 6 inches foundation visible
In spring produce winged reproductive

Nests are several feet underground; can be under a floor slab
Not aware of subterranean termites (*Reticulitermes virginicus*) allergens but Formosan termites (*Coptotermes formosanus*, found mostly in the South) have allergens that can cross-react with some cockroach allergens

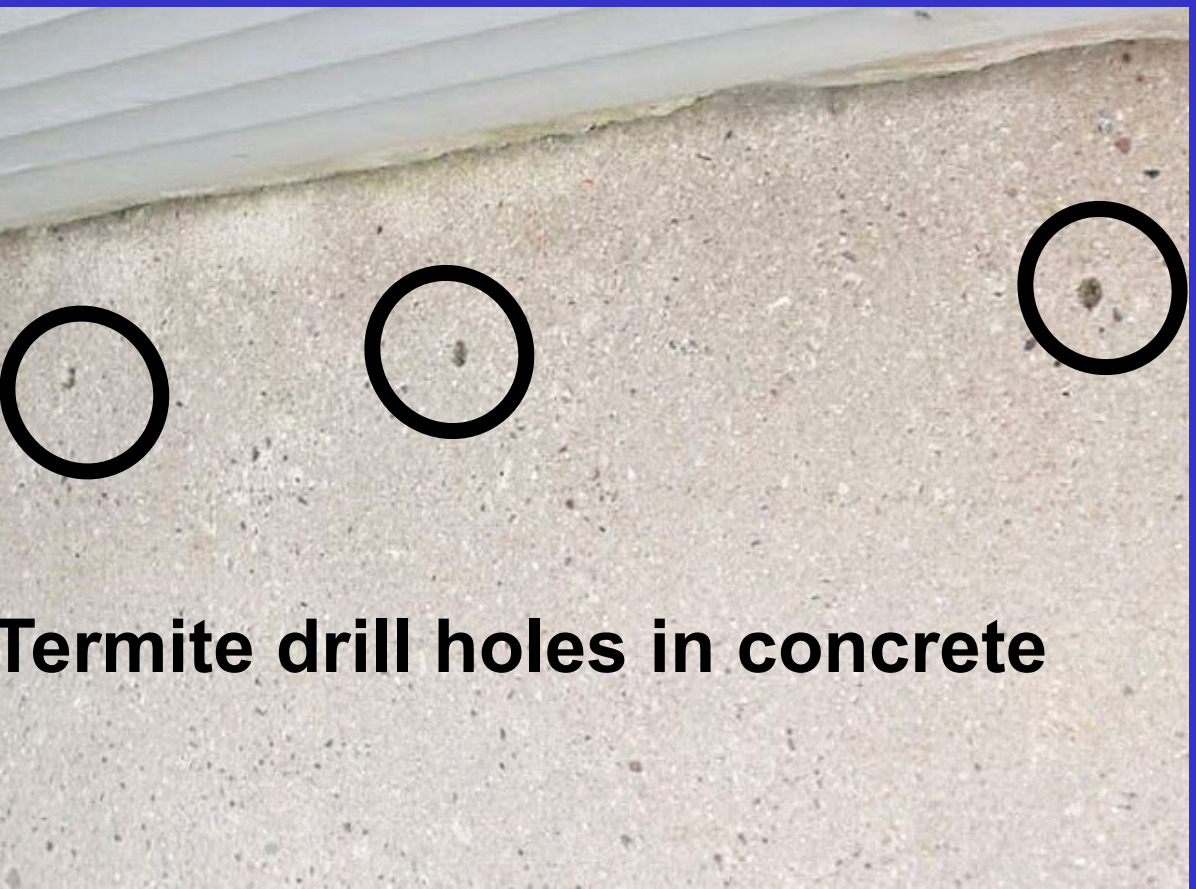
Termites



Termite Treatment

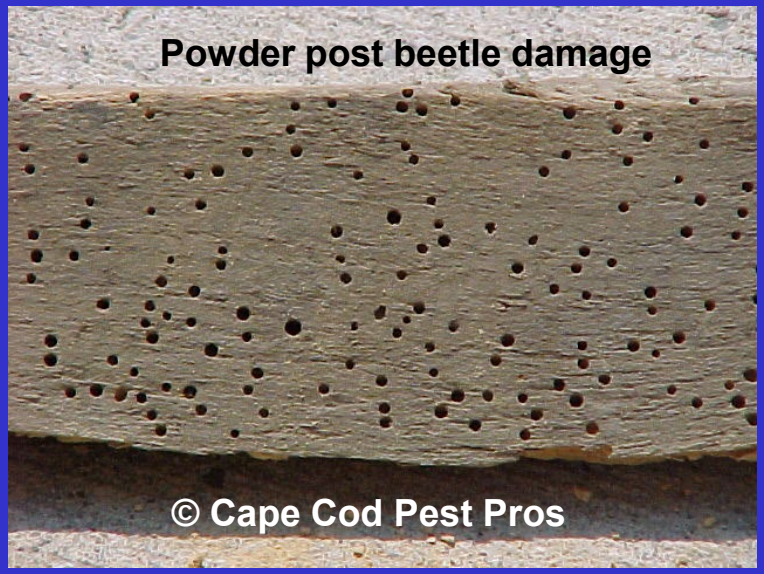
Broadcast spraying not allowed
Rodding with chemicals outside of foundation every few feet, block walls into cores, basement floors at the perimeter to create barrier

Odor of moldy wood acts as an attractant



Termite drill holes in concrete

Powder post beetles



Frass is very fine powdery brown dust readily aerosolized

No info on allergens

May Indoor Air Investigations

Female “tastes” wood and if starch and/or sugars present,
lays eggs in sapwood (layer under bark)

An egg hatches and the larva burrows through wood leaving galleries filled with frass

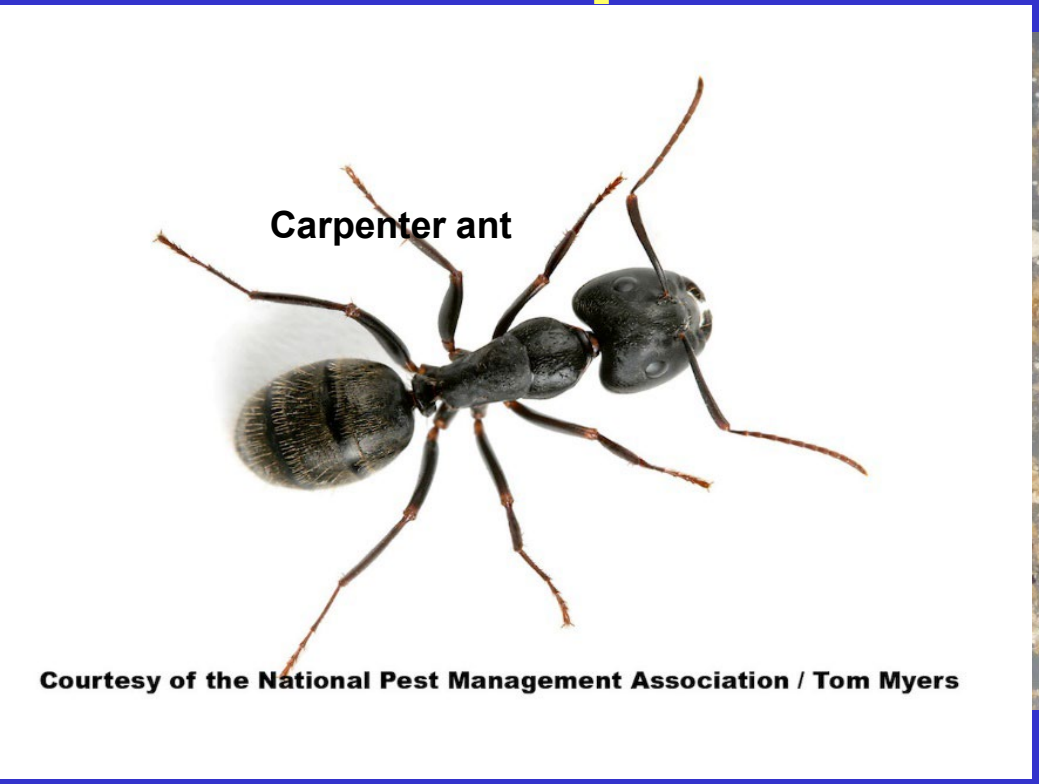
The frass consists of wood dust with starches and sugars removed

A larva undergoes metamorphosis and turns into a beetle that chews through the wood surface, leaving a small round hole.

Beetles rarely re-infest so damage is almost always old.

Generally no treatment needed

Carpenter Ants



Frass consists if similarly sized shards of wood

No info on allergens

Carpenter Ants

Pieces of ants often found in frass

Ants like termites produce winged reproductives

Future queens (smaller ants)

Carpenter Ants

To avoid carpenter ants, avoid damp wood

Treat with ant cups or borax

Be patient, follow ants carrying food back to nest


Dust is the Devil!!
May Indoor Air Investigations

What is dust?

Skin scales and pet dander

Inorganic particles (soil plaster, etc.)

Lint fibers (cellulose, cotton, etc.)

Sawdust in Basements

Pollen grains

Mold spores

Bug detritus

What is dust?
Dust is food for a host of microorganisms and microarthropods

Skin and pet dander are fat and protein
Pollen contains starch
Sawdust and Lint contain cellulose
Mold spores can serve as food for microarthropods
Basements are dusty!!!

Microarthropods

When microarthropods forage, dust appears “splotchy” rather than evenly spread due to presence of fecal pellets

House Dust Mite

Feed on skin scales,
Pet dander

Any high protein source
Including fish flakes

Must have high humidity
(above 70%)

Usually found in:
Mattresses
Quilts
Pillows
Cushioned chairs

Wherever body warmth
and moisture are provided

May Indoor Air Investigations LLC

Case Study

- 70+ year-old retired surgeon referred by allergist.
- Mild asthma and disabling rhinitis.
- Experienced sudden symptoms in den
- 25 gallon tropical fish tank in den.

- Fish food flakes all around tank and on cover.
- Live dust mites crawling around fish tank.
- Underside of tank cover covered with mite fecal pellets.

Mite and mite fecal pellets from dust around kitchen-sink rim

Fecal pellets contain digestive enzymes that are the main allergens

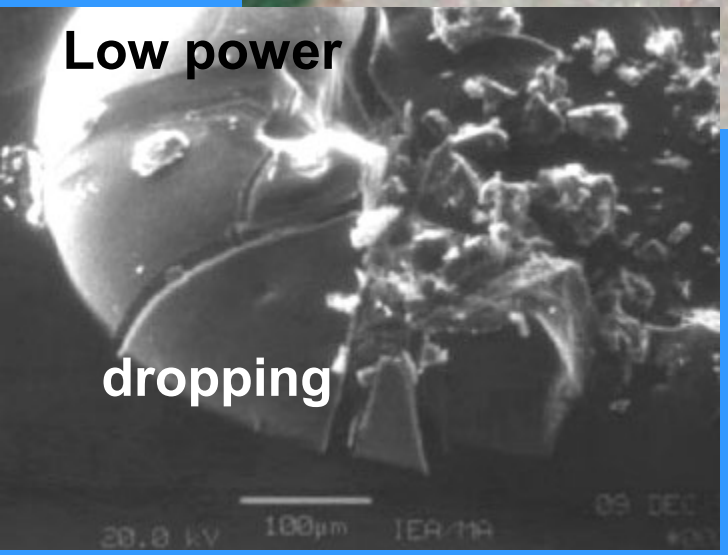
Dust-mite egg and mite fecal pellets from dust around kitchen-sink rim

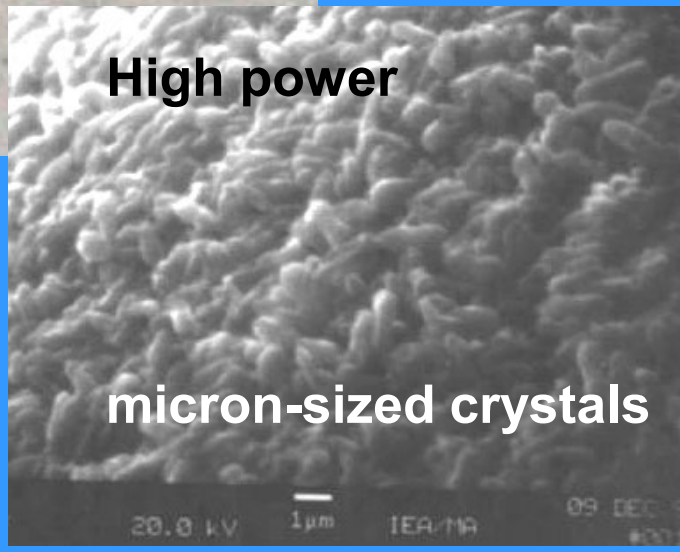
Mite fecal from a carpet

Colonization not usual in carpets unless carpet is over crawl space or slab

Are Spiders Good?

white droppings under web





SPIDERS

Misconception:
“Lots of spiders indoors is a good thing.”

Facts:
Spiders only eat live “insects.”

Spiders are at the top of the arthropod food chain

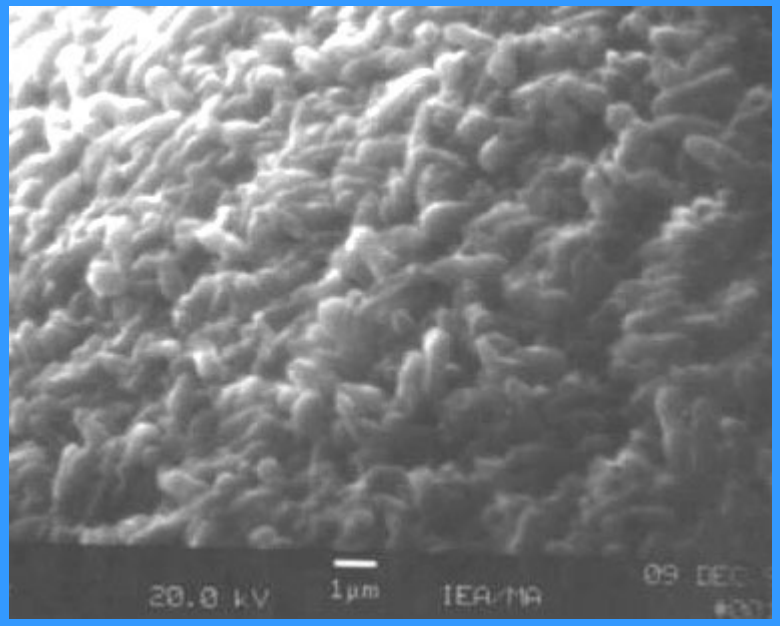
Bites may cause allergic reaction.

Spiders

Spiders are “liquid” feeders; inject digestive enzymes and suck out fluid

Spider-web net at ceiling means mites living on joist mold

Spider Droppings



Spider Droppings consist primarily of guanine crystals ~2 microns in size.
The crystals are stuck together possibly by allergen.

How Do We Avoid Having Microarthropods?

- Eliminate dust from hard surfaces, including walls, trim and furniture
- Avoid wall-to-wall carpeting, especially below grade
- Keep the relative humidity no higher than 50%
- Droppings may be allergenic

Allergy to Wool Moths

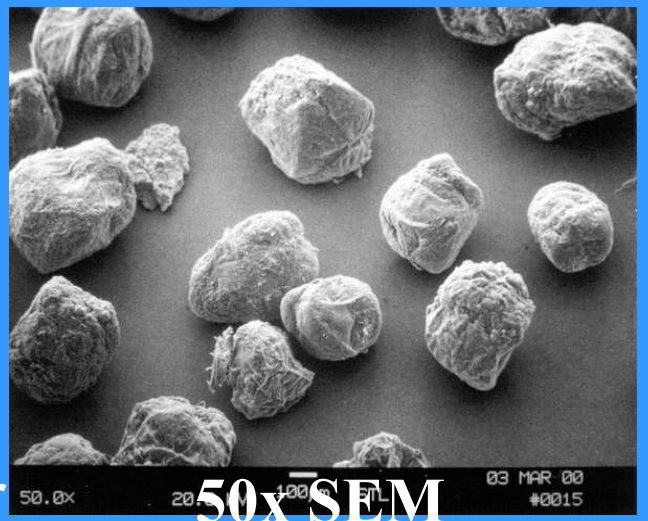
Baldo, B.A., Panzani, R.C. 1988. Detection of IgE antibodies to a wide range of insect species in subjects with suspected inhalant allergies to insects. Int. Arch. Allergy Appl. Immunol., 85(3):278-87.

A fecal pellet consisting of partially digested fibers is in the larger circle. Individual rug fibers in the digestive tube can be seen (small circle).

Wool-moth larval fecal pellets in rug

The color of the fecal pellet depends on color of the fiber being eaten. The crushed fecal pellets contain allergens that are in house dust.

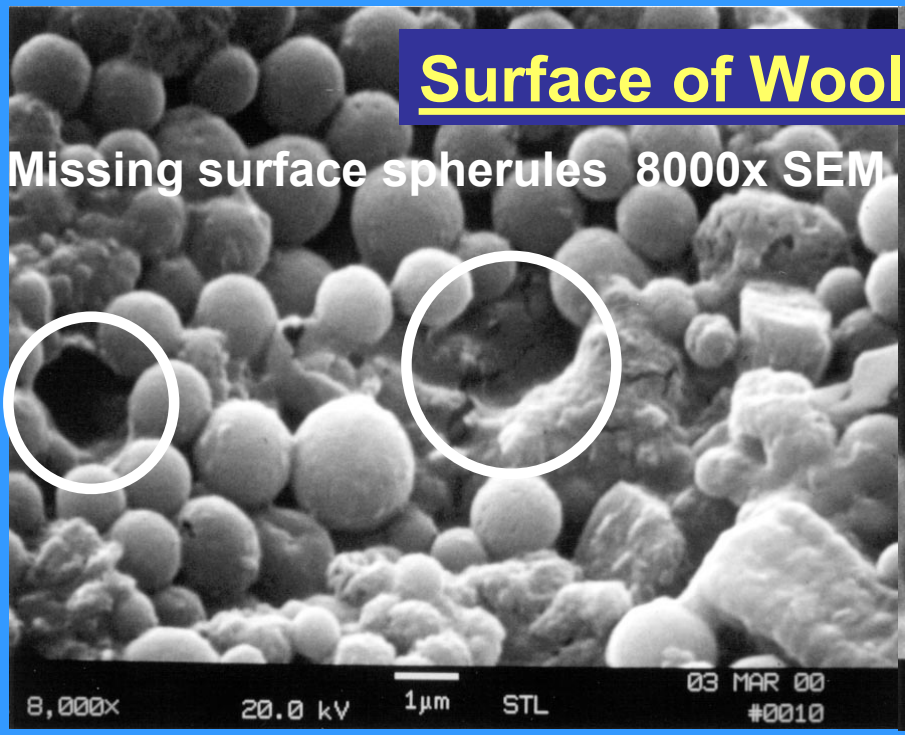
Wool Moth Fecal Pellets

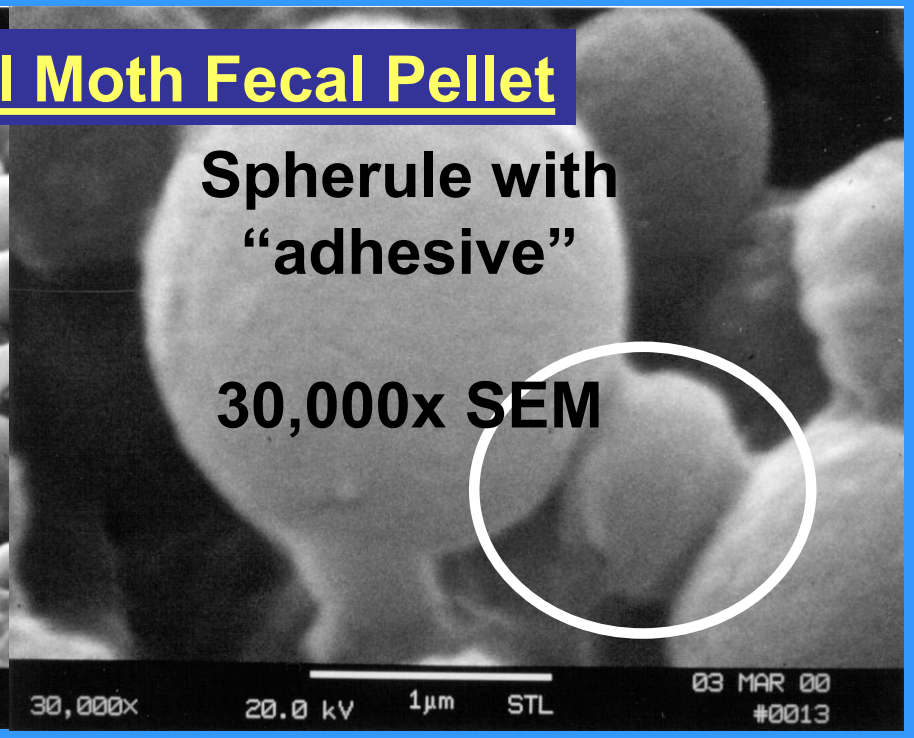


Pellet Color Depends on Fiber Color

50x SEM

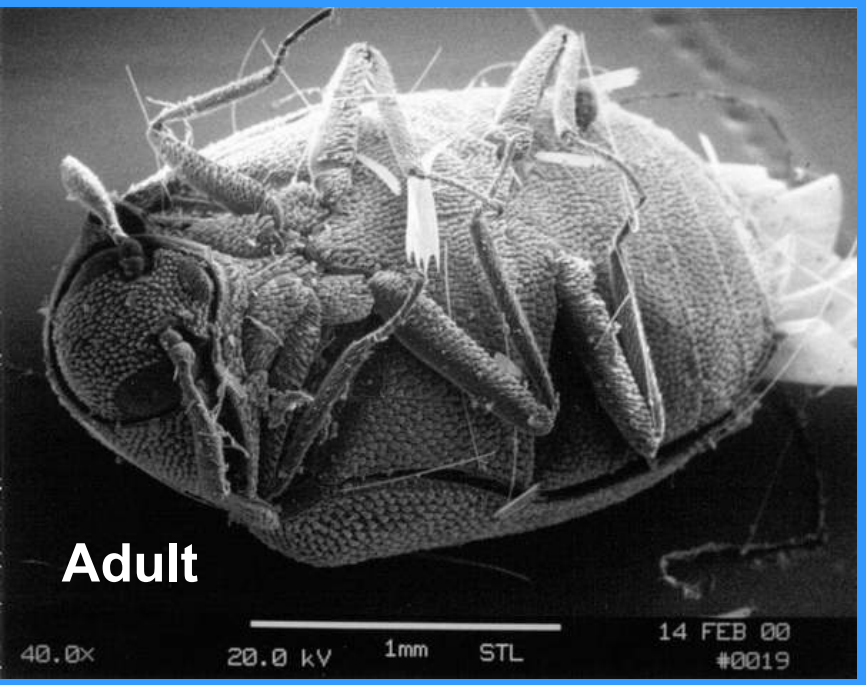
Surface of Wool Moth Fecal Pellet

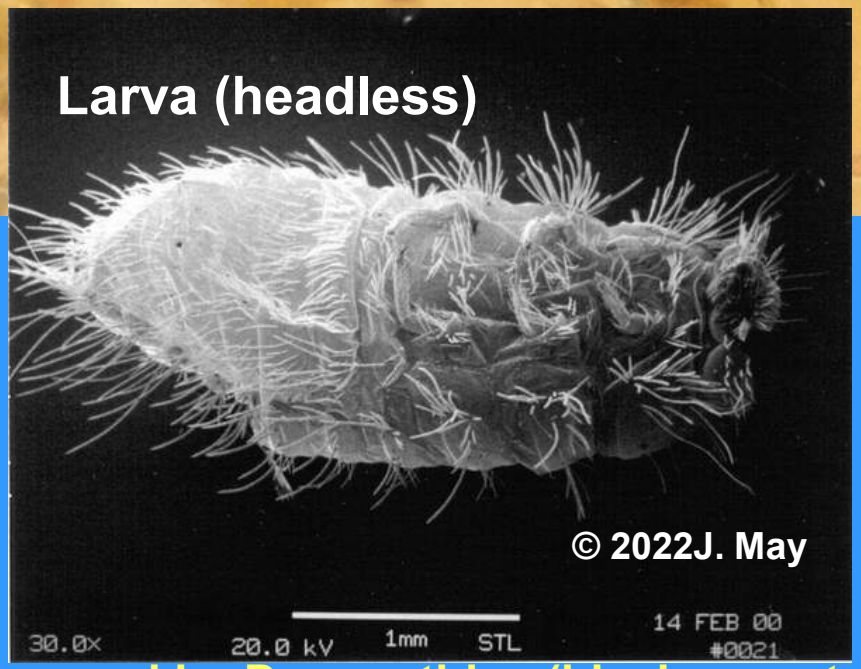




May Indoor Air Investigations

Allergy to carpet beetles, common indoor pests

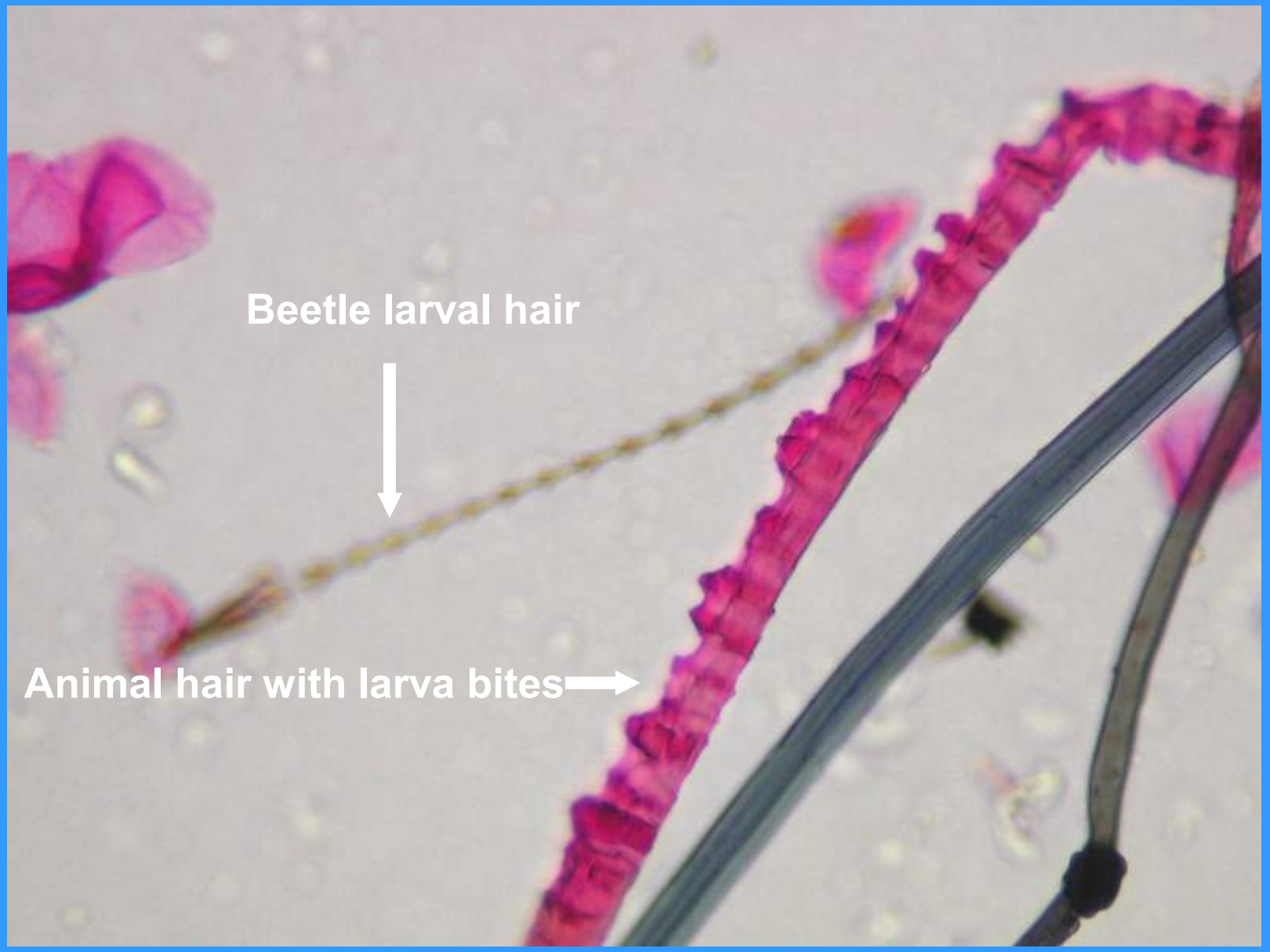




Cuesta-Herranz, J. et al. (1997): Asthma caused by Dermestidae (black carpet beetle); a new allergen in house dust. J. Allergy Clin. Immunol., 99: 147-149.

Brito FF, Mur P, Barber D, Lombardero M, Galindo PA, Gómez E, Borja J. Occupational rhinoconjunctivitis and asthma in a wool worker caused by Dermestidae spp. Allergy. 2002 Dec; 57(12):1191-4.

Allergy to carpet beetles:



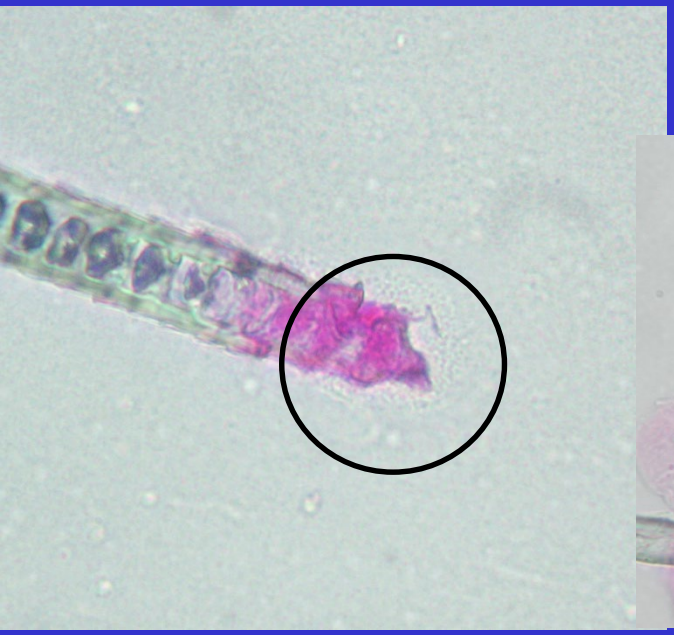
Carpet beetle

This bee was decimated by carpet beetle larvae. The brown dust is the frass (fecal pellets)

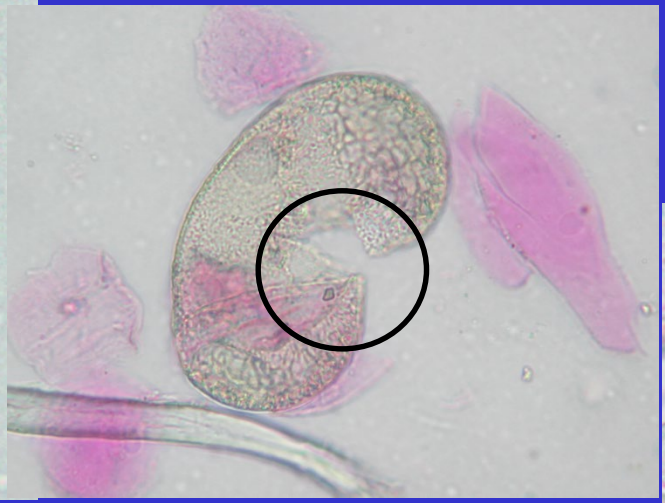
Allergy to carpet beetles

Basement Ecology

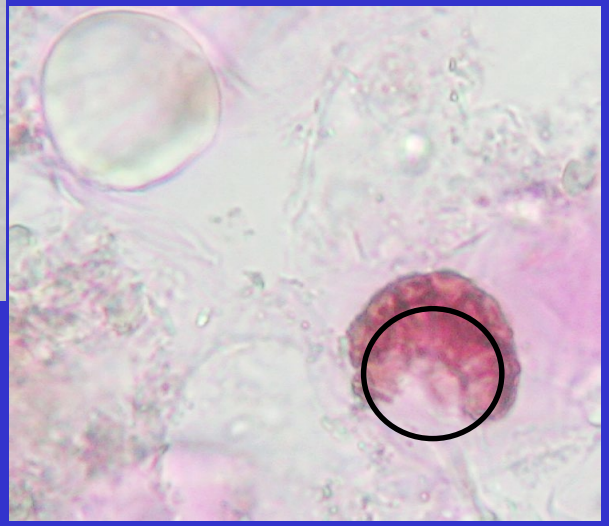
Dust is food:



Cat hair with carpet beetle larval bite



Pollen grain with carpet beetle larva bite



Fecal pellet with carpet beetle larval bite

Basement Ecology

Mold

Actinomycetes

Bacteria

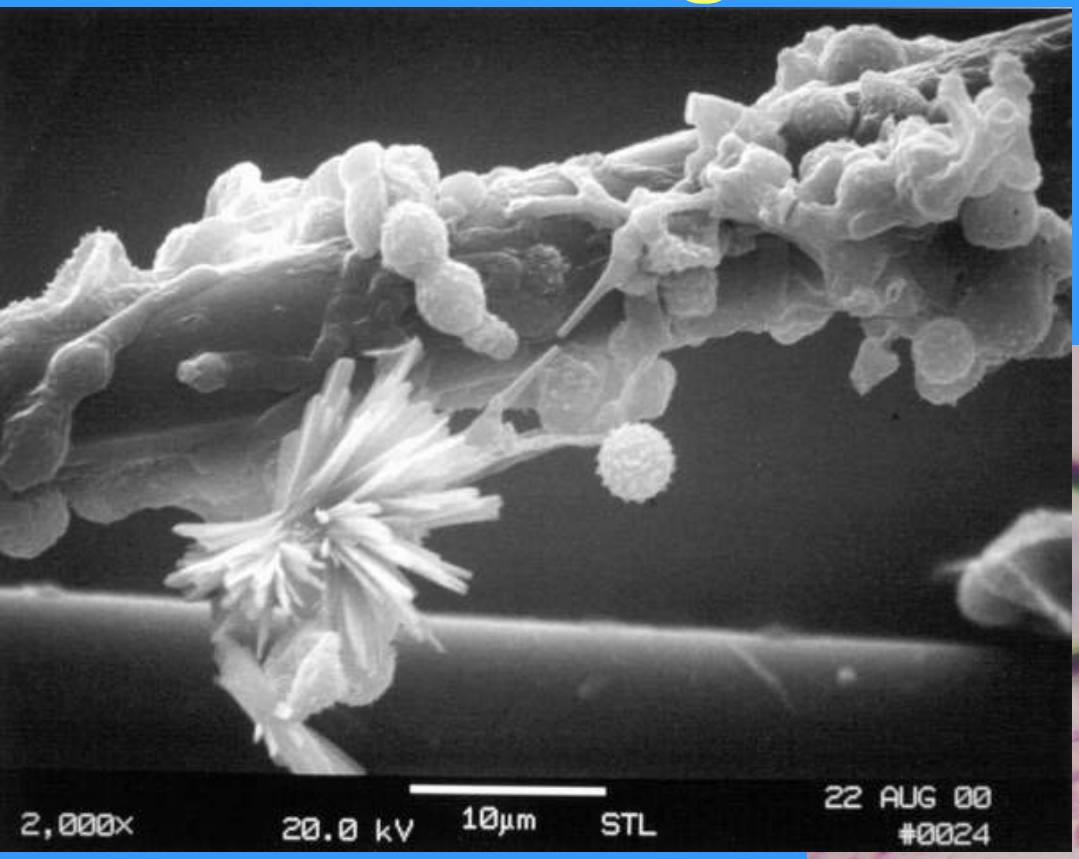
Mold on a basement door

Sawdust is food for mold

Mold growing in sawdust on a basement door

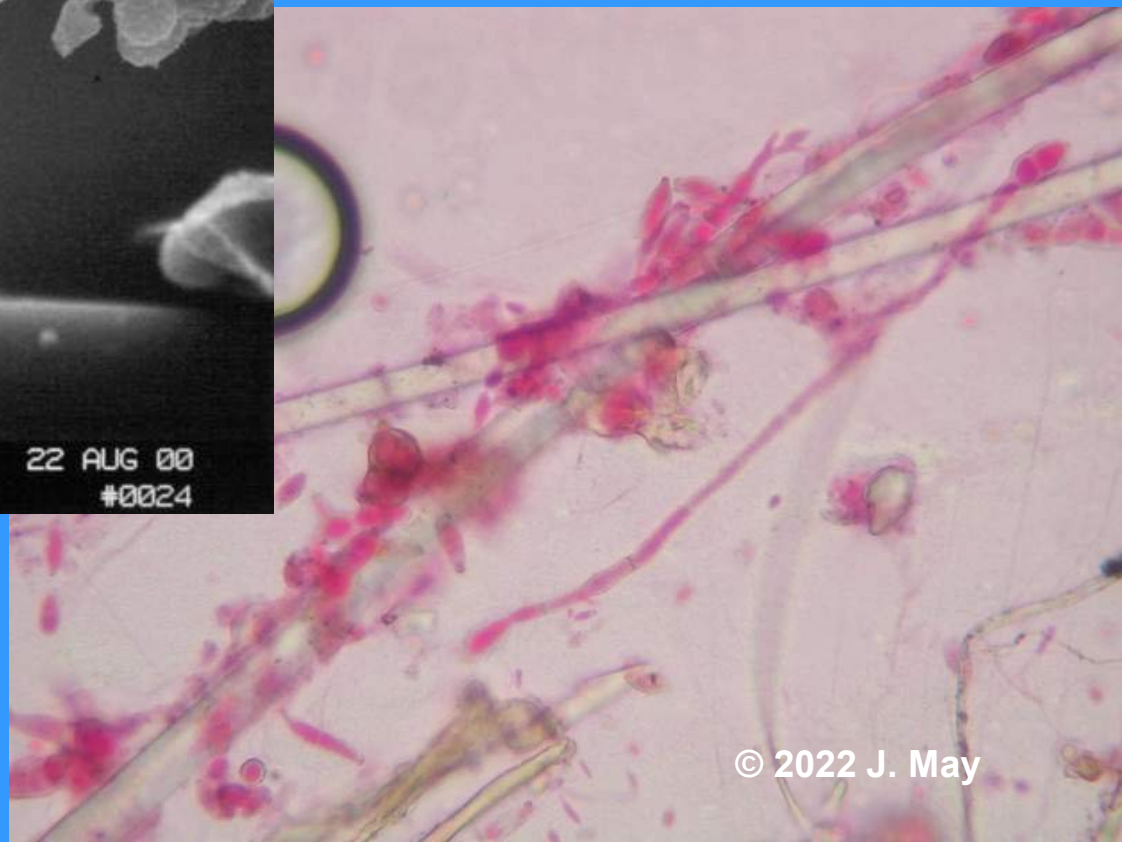
Shine flashlight at oblique angle to light up mold colonies

Mold in exposed, basement fiberglass insulation



can be a major source of mold exposure

RH not controlled!

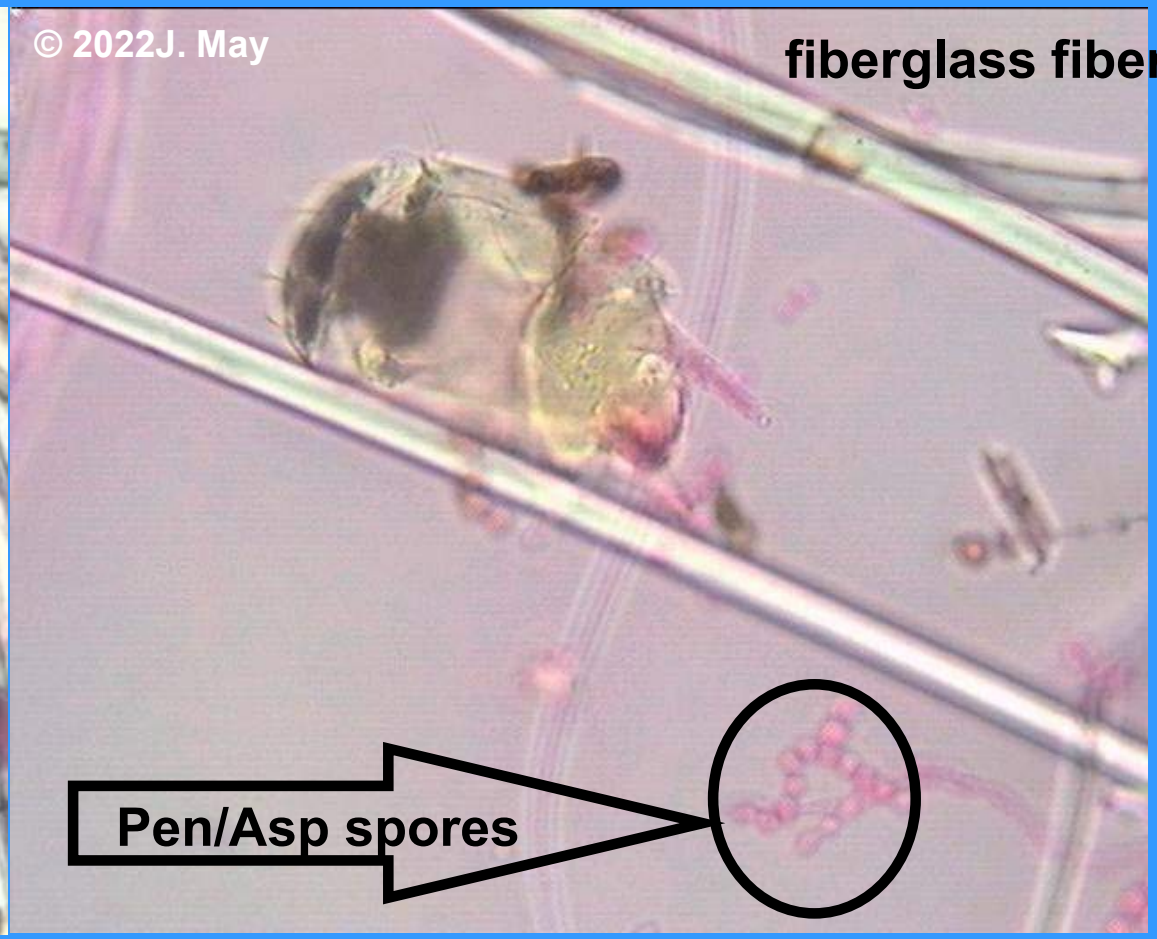


Often

Aspergillus versicolor

May Indoor Air Investigations LLC

Mites and Pen/Asp Spores at 400x
in “Pat” Air Samples from Exposed Basement Ceiling Fiberglass

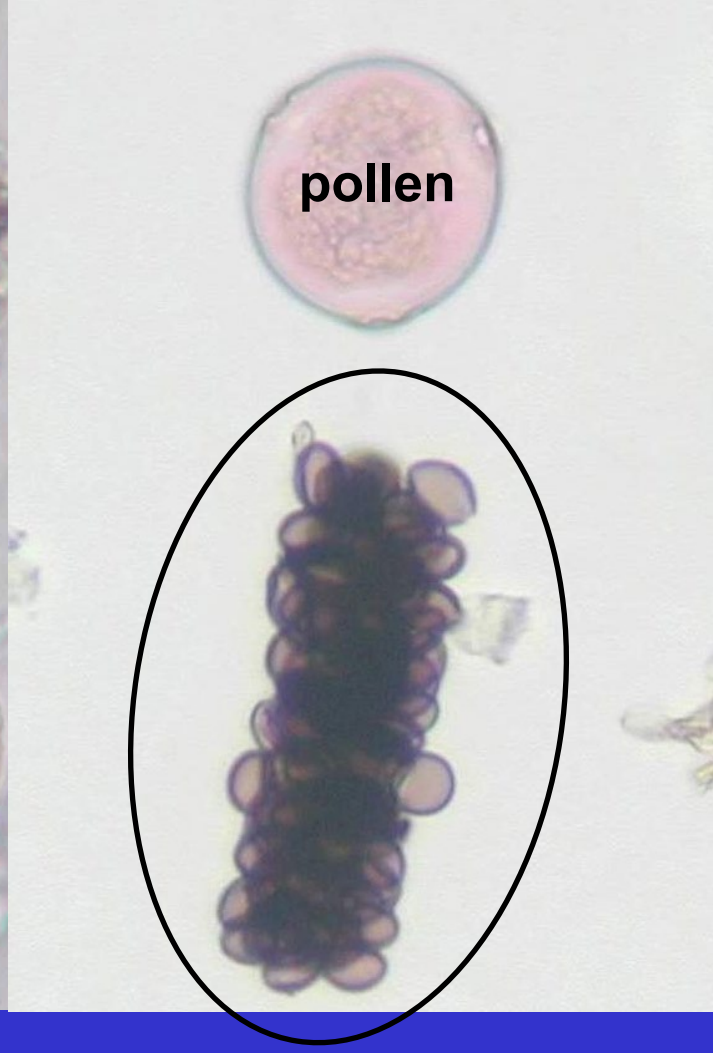


Mold-eating mites can be found almost anywhere mold is growing!

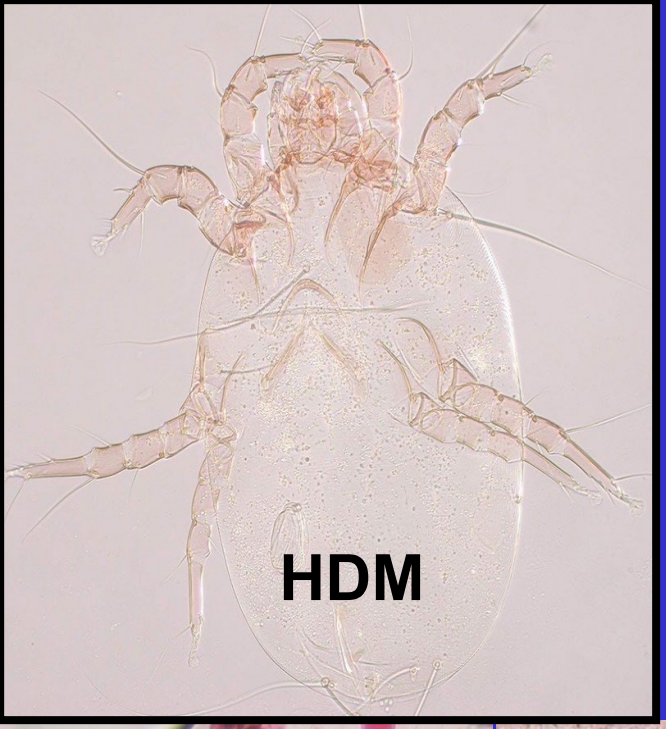
Mold-eating mite fecal pellets

full of *Aspergillus* spores

Mite fecal pellet full of spores 600x



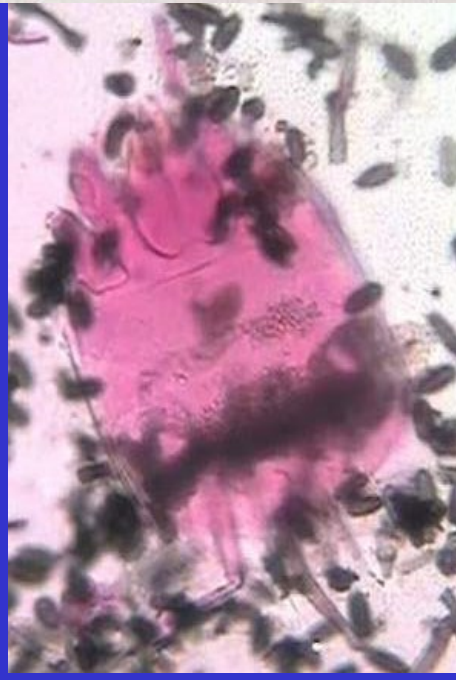
63-micron fecal pellet full of *Chaetomium* spores



More confusion:

Allergy testing to mites does not detect allergy to mold-eating mites!

Mold-eating mites from homes



Cross Reactivity

Asian ladybugs in a bulkhead

Asian ladybug and cockroach

If you are allergic to roaches, you are allergic to ladybugs

J. Allergy Clin. Immunol. 2007 Feb;119(2):421-7, *Asian ladybugs (Harmonia axyridis): a new seasonal indoor allergen.* Nakazawa T, Satinover SM, Naccara L, Goddard L, Dragulev BP, Peters E, Platts-Mills TA.

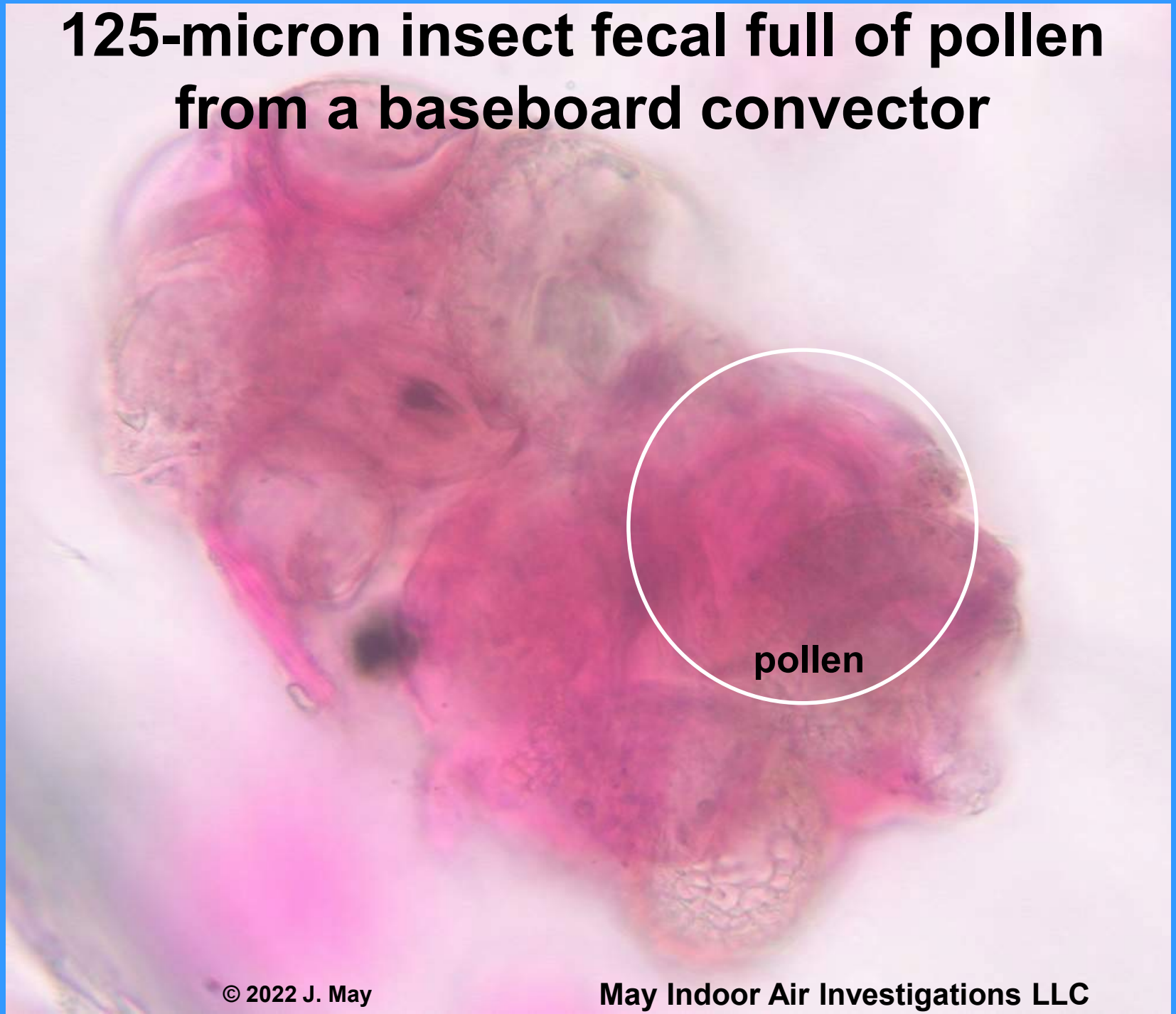
Book Lice

Allergy to book lice

Musken, H., Franz, J-Th., Fernandez-Caldas, E., Masuch, G., Maranon,F. Bergmann, K-C. 1998. Psocoptera. Allergologie, 21: 381-382.

Book lice are very common, barely visible indoor pests

125-micron insect fecal full of pollen from a baseboard convector



May Indoor Air Investigations LLC

Actinomycetes

Actinomycetes are microorganisms that require high moisture conditions, very frequently found on foundation walls

Actinomycetes

Actinomycetes are microorganisms related to bacteria but grow like molds with hyphae and spores.

Actinomycetes

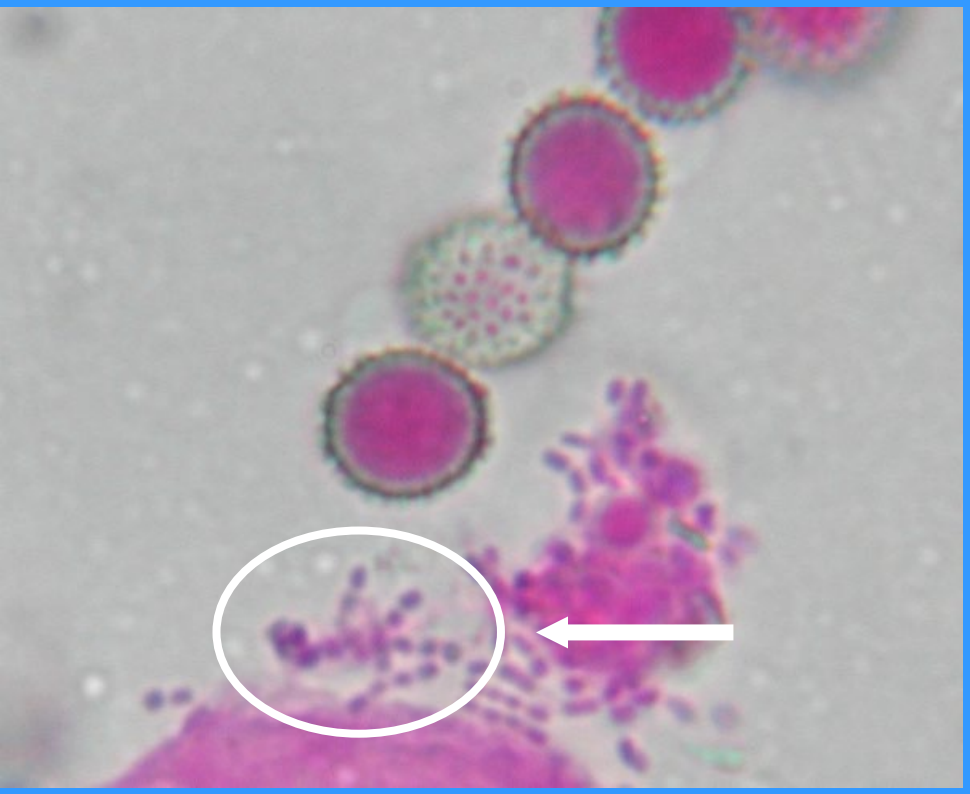
Inhalation exposures to one species of actinomycetes are associated with hypersensitivity pneumonitis.

Actinomycetes in basement air

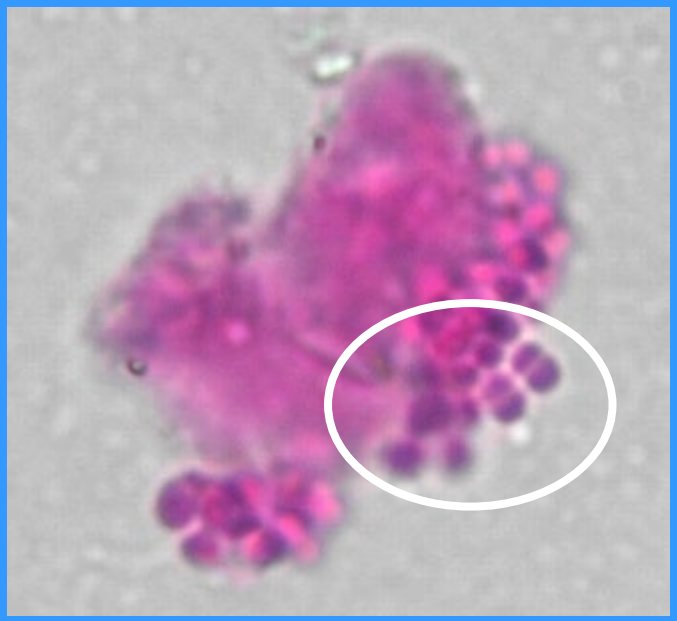
Eurotium mold spores

Actinomycetes on cellulose fibers are very common on foundation walls.

Problematic organisms that may cause allergy can often be observed by microscopy. They are not generally reported in “spore counts” and may not be culturable.



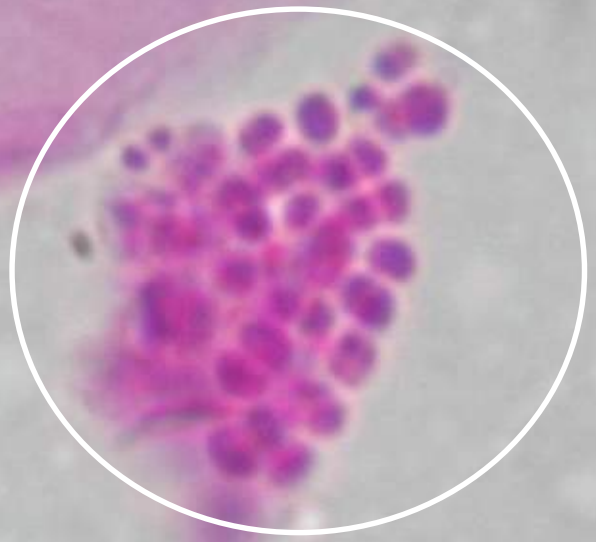
Actinomycetes in basement air



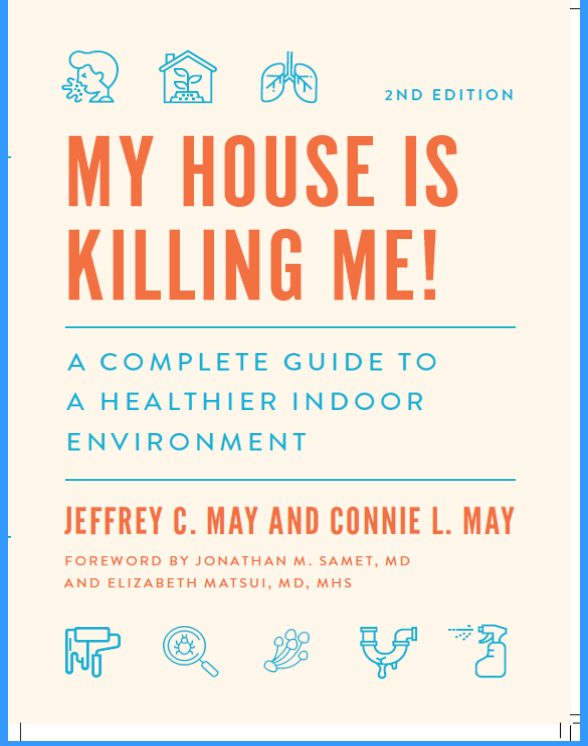
Large bacteria in bedroom air

Microscopy:
Bacteria cluster from carpet (1,200x)

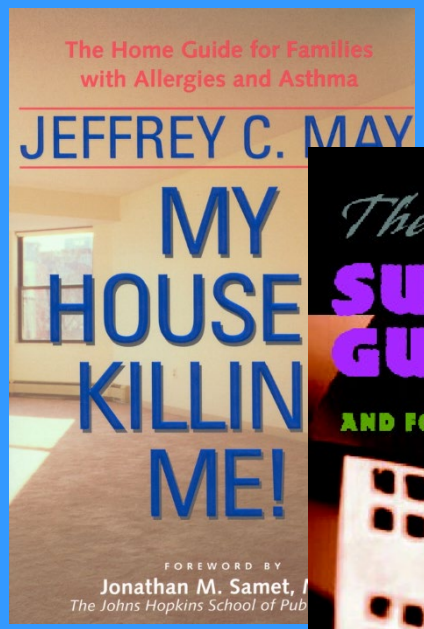
Skin scale



Questions??



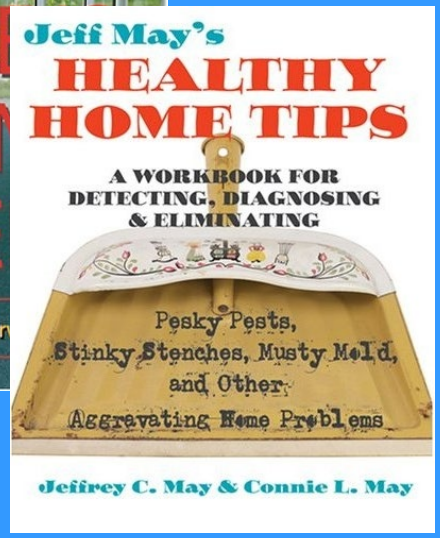
2020
Second edition



2001

2004

2006



2008

Request quarterly newsletter from website

May Indoor Air Investigations, Tyngsborough, MA
<www.MayIndoorAir.com>
<www.MyHouseIsKillingMe.com>