

# **Root Rot Diseases of Christmas Trees: *Phytophthora* and *Armillaria* Under the Spotlight**

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MCTA winter meeting  
February 27<sup>th</sup> , 2026

## Three question we often ask:

What is wrong with my tree?

What is causing it?

What disease is this?





- Symptoms
- Signs



Pc: Pratima Devkota



Pc: Bill Lindberg

## Symptoms



- What the tree shows.
- What is the pattern of damage/ symptom distribution ?
- Widespread mortality and uniform across a plantation - environmental (non-living)
- Patchy or scattered irregularly - a disease or other biotic factor more likely

## Signs

(What the pathogen shows 🔍)



- Physical evidence of the pathogen itself.
- Not always evident

## Two major root rot diseases affecting Christmas tree industry

- **Phytophthora root rot**

*“The Water Mold That Loves Wet Feet”*

- **Armillaria root rot**

*“The Hidden Wood-Rotter with Black Shoestrings.”*

# Phytophthora root rot

*Phytophthora* = “plant destroyer”

A water mold (not a true fungus)

Needs water to survive, spread, and infect

# Late Blight of Potato → Great Irish Famine (1845-1852)



*Phytophthora infestans*



wide-spread scarcity of food

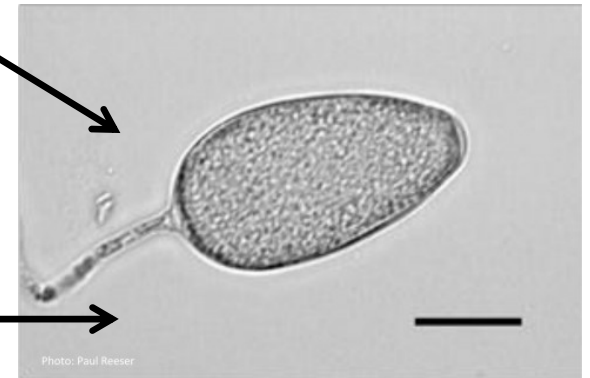


# Phytophthora Life Cycle

*Activated in wet conditions*  
thick walled chlamydospore

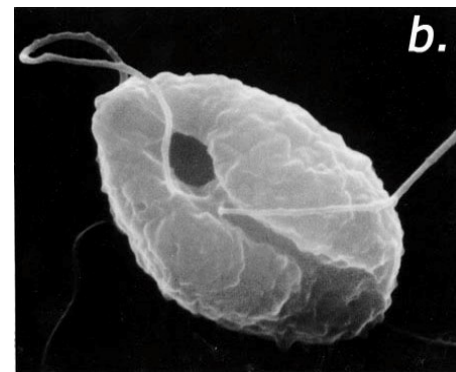


Produces sporangia

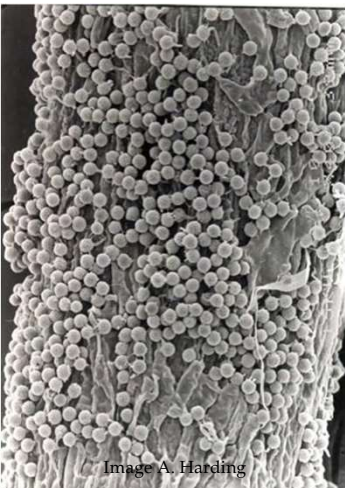


Sporangium with mycelium

Sporangia produce  
zoospores that can  
swim to host roots

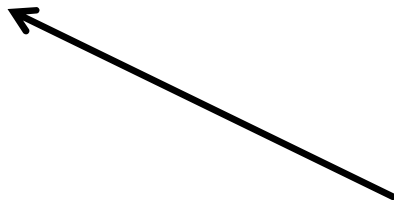


Zoospores with flagella



Zoospore-cyst on plant root

Mycelial growth  
in host

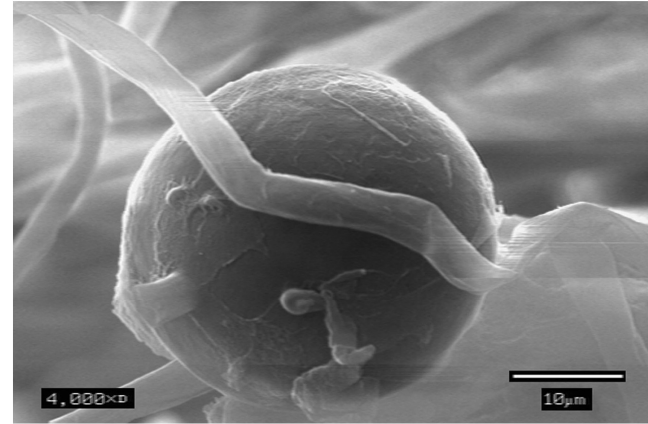


# spore types

Asexual:  
sporangia



A

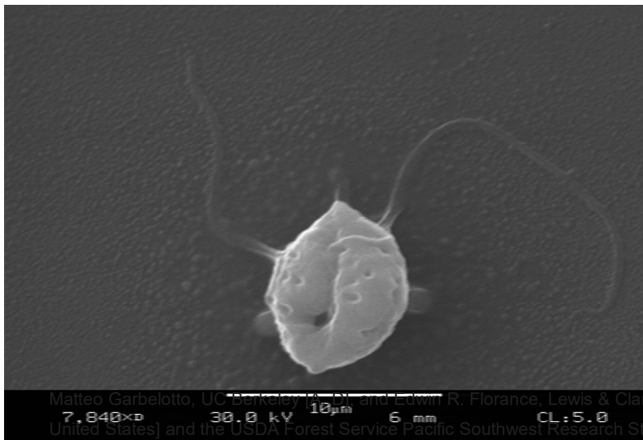


C

D



Asexual:  
zoospores



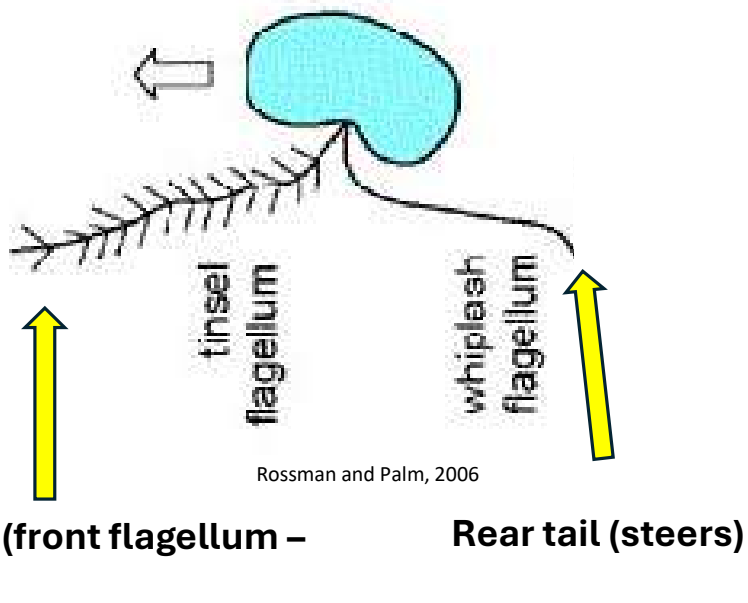
B

Asexual:  
chlamydospores

Sexual: oospores

Matteo Garbelotto, UC Davis, and R. Florance, Lewis & Clark College [Portland, Oregon, United States] and the USDA Forest Service Pacific Southwest Research Station in Albany, California [B, C.]

## How do zoospores swim ?



### Built for Swimming

- It has two tails (flagella)
- The front tail pulls it forward
- The back tail steers
- No standing water = no swimming.
- But even a short-wet period turns soil into a temporary swimming pool

“Zoospores move like something being pulled by a tow rope the front tail does the pulling, the back tail keeps it straight.”

## Survey of *Phytophthora* species associated with *Abies* species in US

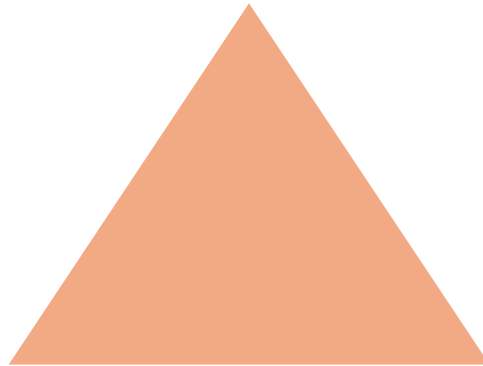
| Region                  | Representative States | Common <i>Phytophthora</i> spp.                                                                                                                                                         |
|-------------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Western U.S.            | WA, OR, ID, CA        | <i>P. cambivora</i> , <i>P. megasperma</i> , <i>P. pseudosyringae</i> , <i>P. gonapodyides</i> , <i>P. cinnamomi</i>                                                                    |
| Southeast               | NC                    | <i>P. cinnamomi</i> , <i>P. cryptogea</i> , <i>P. pini</i>                                                                                                                              |
| Great Lakes & Northeast | MI, WI, CT, NY        | <i>P. cactorum</i> , <i>P. plurivora</i> , <b><i>P. sansomeana</i></b> , <i>P. europaea</i> , <b><i>P. nicotianae</i></b> , <i>P. megasperma</i> , <i>P. cryptogea</i> , <i>P. pini</i> |

*Phytophthora* is not a single pathogen in U.S. Christmas tree farms.

McKeever & Chastagner (2016)

## Phytophthora root disease triangle

**Host-** true firs (*Abies* spp.), particularly Fraser (*Abies fraseri*), & Noble (*Abies procera*)



### **Pathogen**

Many *Phytophthora* spp.  
Present in the  
ground/waterways.  
Survival spores

### **Environment**

warm soil temp above 54F &  
saturated soils  
Heavy, wet clay soils  
Hard pans  
Periodic soaking

# Symptoms

- Stunted/wilting new growth, followed by chlorosis, reddening, and death
- Sporadic mortality down a slope in a field, wilted plants on top of the slope, not just clustered down bottom
- Extensive mortality in field & containers
- Infected larger trees may be off color, show smaller new growth and are less vigorous.
- Transplants and seedling may suddenly die



## Root “sloughing”



## *Disease management strategies*

### Selection of planting site-field



- Fine textured (clay) soils + poor soil drainage

### Purchase clean nursery stock



- *Be aware that even healthy-looking transplants can contain *Phytophthora**
- *But presence of *Phytophthora* does not guarantee disease*

### Water Source-> critical



- Stagnant ponds may be reservoirs for *Phytophthora*

# Disease management strategies

## Diseased Plant Material



- Regular scouting is essential
- Regularly remove or destroy diseased plant material

## Planting Material

- Use well-drained substrate (20–30% air space)
- Store media properly on concrete or in sealed/sanitized containers.
- Do not reuse media
- Disinfest media (steam or solarize)
- Composting alone is insufficient

## Disease management strategies

### Resistance

- High susceptibility: Fraser fir, Noble fir
- Medium susceptibility: Douglas-fir
- Low susceptibility: Grand fir, Nordmann fir, Turkish fir

### Chemical control

- Metalaxyl / Mefenoxam products (e.g., Subdue MAXX)
- Phosphonates / Phosphites (e.g., products containing fosetyl-Al or mono-/di-potassium phosphite)
- Etridiazole/Thiophanate-methyl combinations  
(other soilborne fungi and oomycetes in nursery or transplant production)
- No fungicide will eliminate *Phytophthora* from soil
- Products **reduce disease development and protect healthy roots** only when applied on a schedule before infection becomes severe.

*\*follow the product's federal label and any state-specific supplemental labeling to determine legal use.*

# Armillaria root rot disease

- A soilborne fungal disease that attacks roots and root collars
- Survives for years in old stumps and buried wood
- Spreads root-to-root through the soil
- Causes gradual decline and mortality
- Often appears as scattered tree death

## *Armillaria* mushrooms



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- The same fungus that produces honey mushrooms can kill Christmas trees.
- *Armillaria mellea*
- *A. solidipes*
- *A. gallica*

## *Armillaria* mycelial fan



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# Rhizomorph



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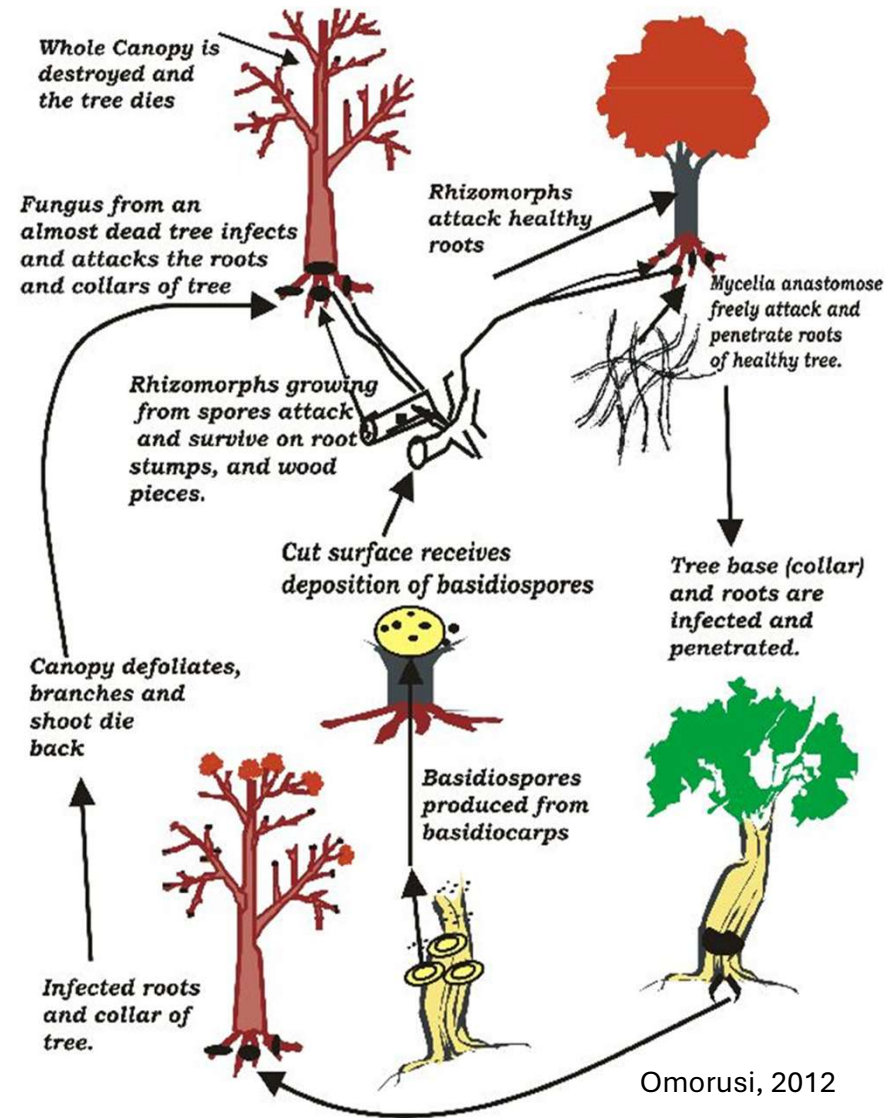


## Symptoms



# Disease Cycle

- Soil-borne
- Basidiospores (Dissemination)
- Rhizomorphs
- Root-root attachment



# Management

- Site selection
- Stump and root removal
- Plant selection
- Chemical
- Biological control



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## **Understanding Phytophthora and Armillaria root rot In Michigan Christmas tree farms (MDARD – SCBG)**

- We may often see the same symptoms, but the underlying cause may differ

### **Root Rot Is Not One Pathogen**

- Multiple species can cause similar symptoms
- Each species occupies its own ecological niche
- Each species has a distinct life cycle
- Aggressiveness varies among species and strains

Effective management requires knowing exactly which pathogen is present.

## Why is it important ?

- Identifies which pathogens are present locally – cultural to molecular tools for id
- Detects aggressive or emerging species
- Supports targeted management strategies
- Provides baseline data

## Objectives

- Survey grower fields for root rot pathogens
- Isolate and identify species present, optimize diagnostic tools
- Characterize pathogen diversity, soil status, fam history

## Grower Workshop

- Present survey findings
- Provide diagnostic tools and sampling guidance
- Develop species-specific management recommendations
- Inform long-term resistance and planning
- Build the foundation for targeted, evidence-based management strategies.
- Inform future management strategies.

## Acknowledgements

Bill Lindberg  
Dr. Bert Cregg



**MICHIGAN STATE**  

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**U N I V E R S I T Y**



**Thank you !**

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