

Phytophthora Diseases of Trees & Shrubs

Steven N. Jeffers

Associate Professor & Extension Specialist

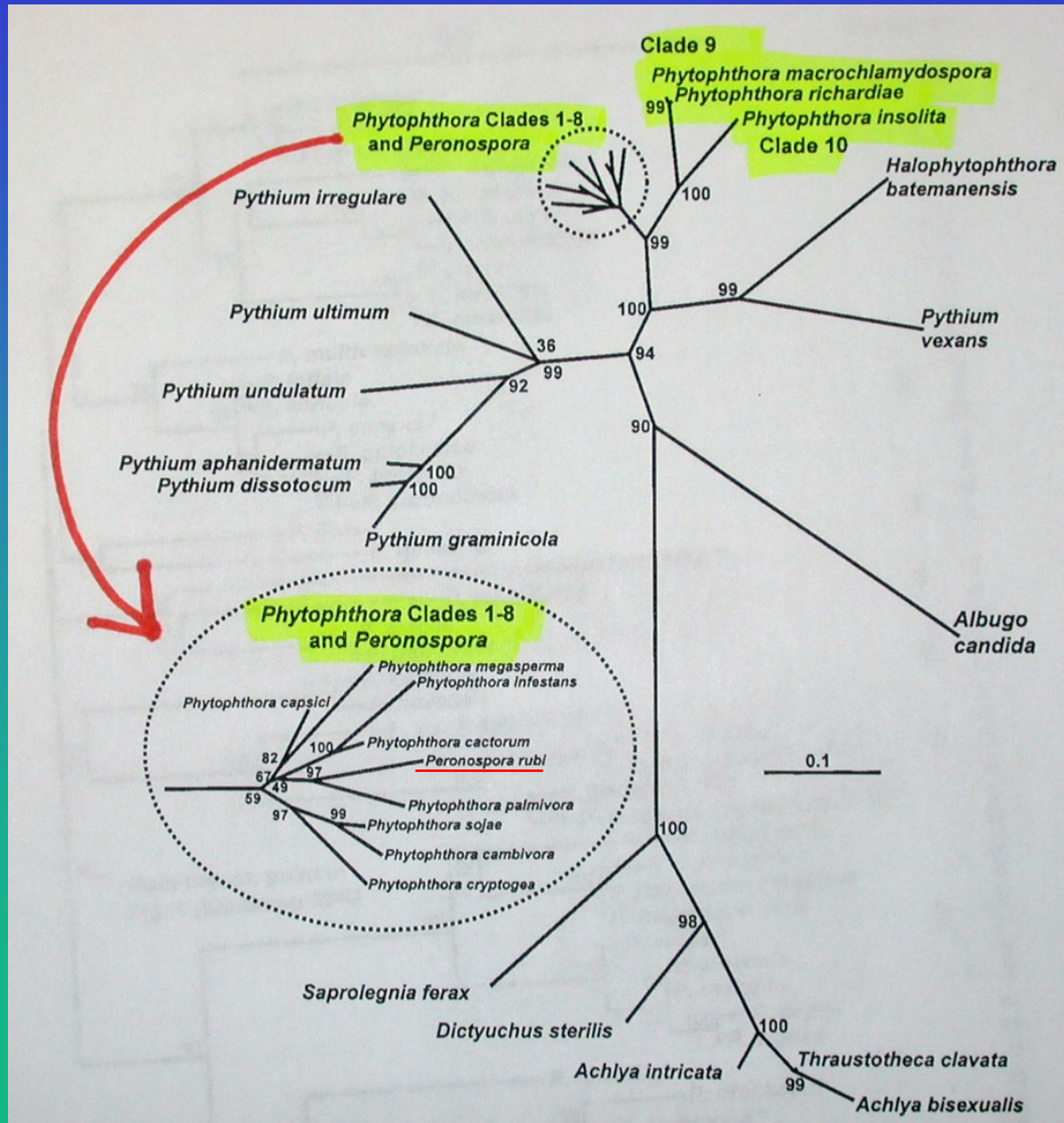
Department of Entomology, Soils, & Plant Sciences

Clemson University

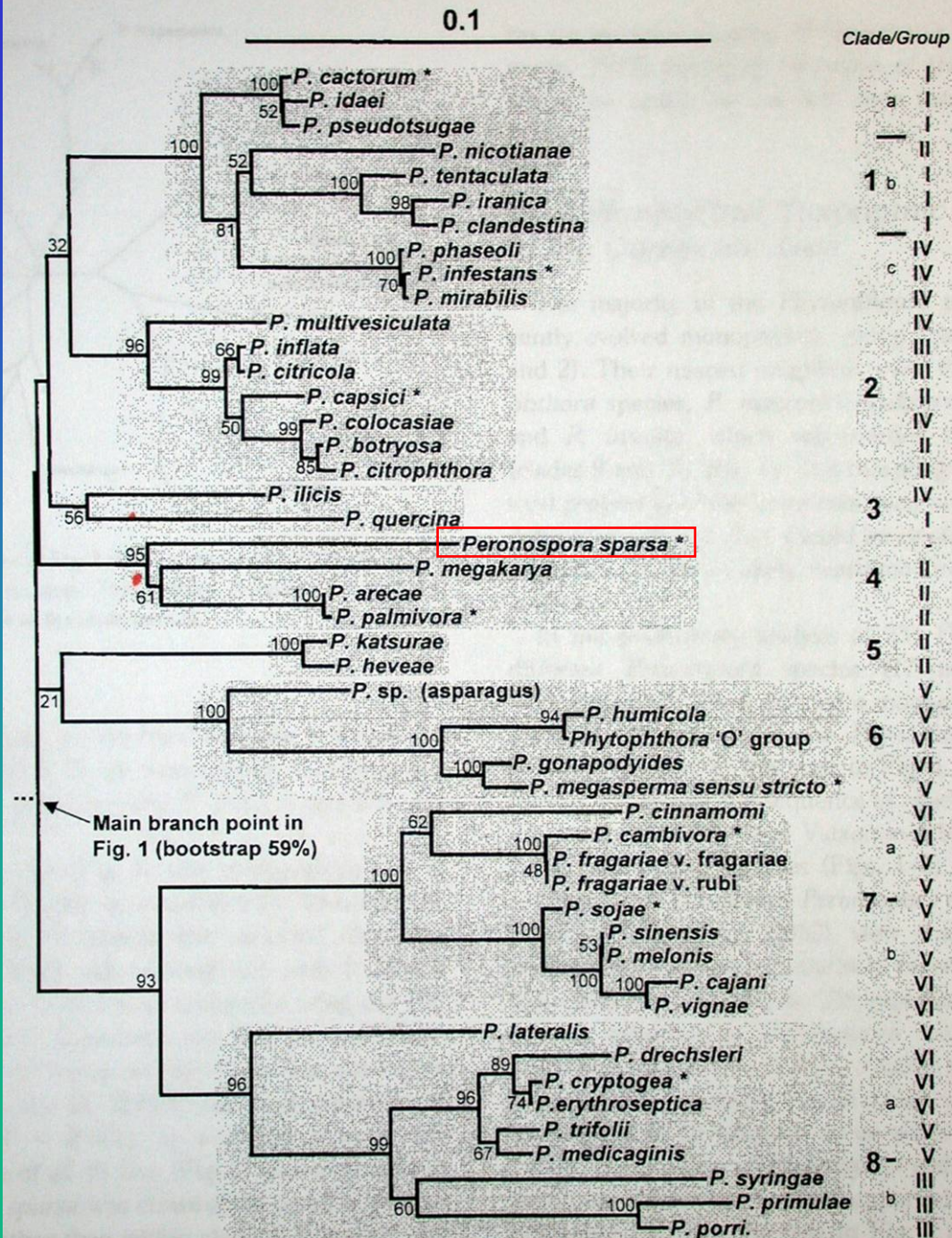
Phytophthora Taxonomy

Domain	Eukaryota
Kingdom	Straminipila [Chromista?]
Phylum	Oomycota
Class	Oomycetes
Order	Peronosporales
Family	Pythiaceae
Genus	<i>Phytophthora</i>

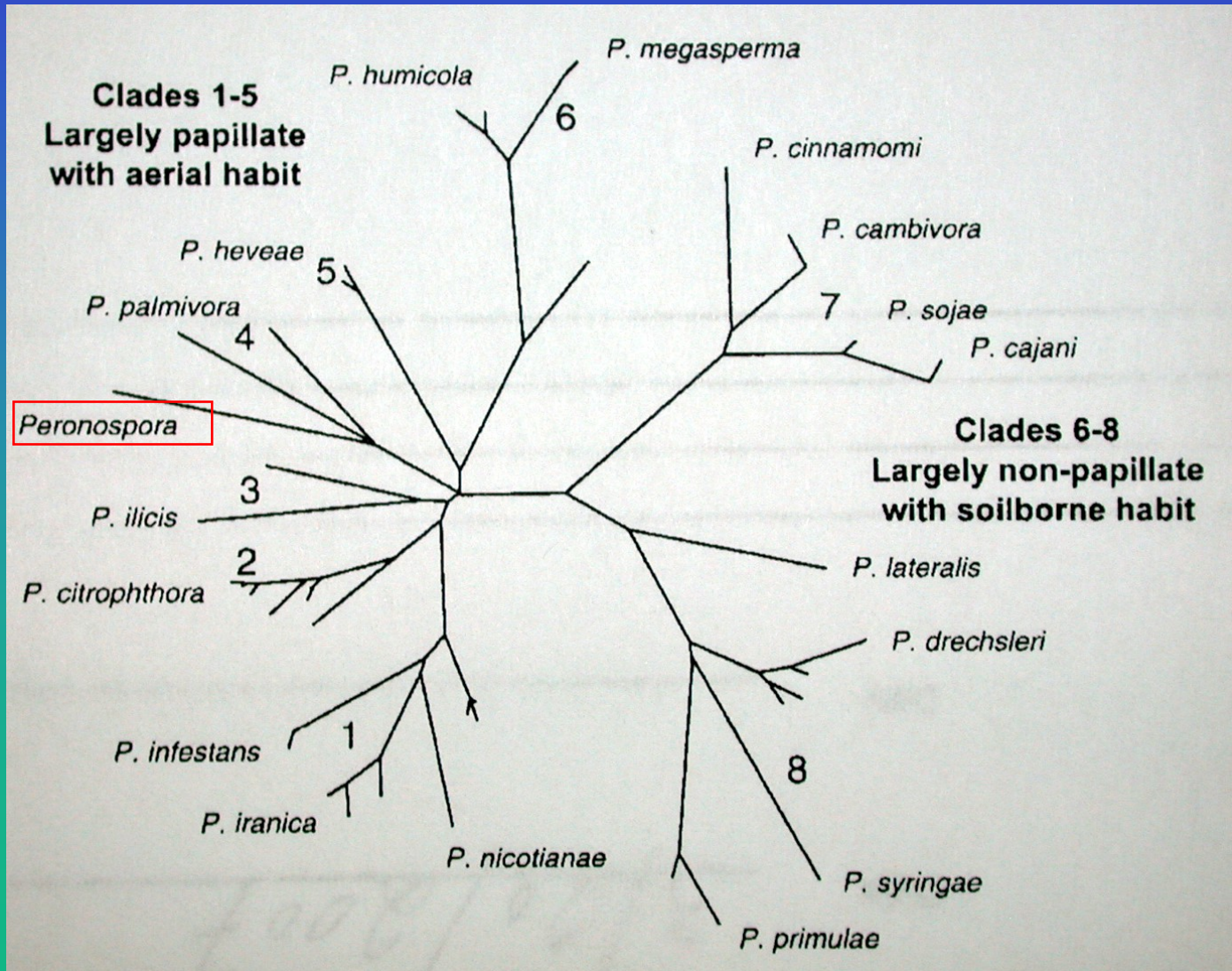
Phytophthora Taxonomy



Phytophthora Taxonomy: Clades based on Molecular Genetics



Phytophthora Taxonomy: Clades 1-8

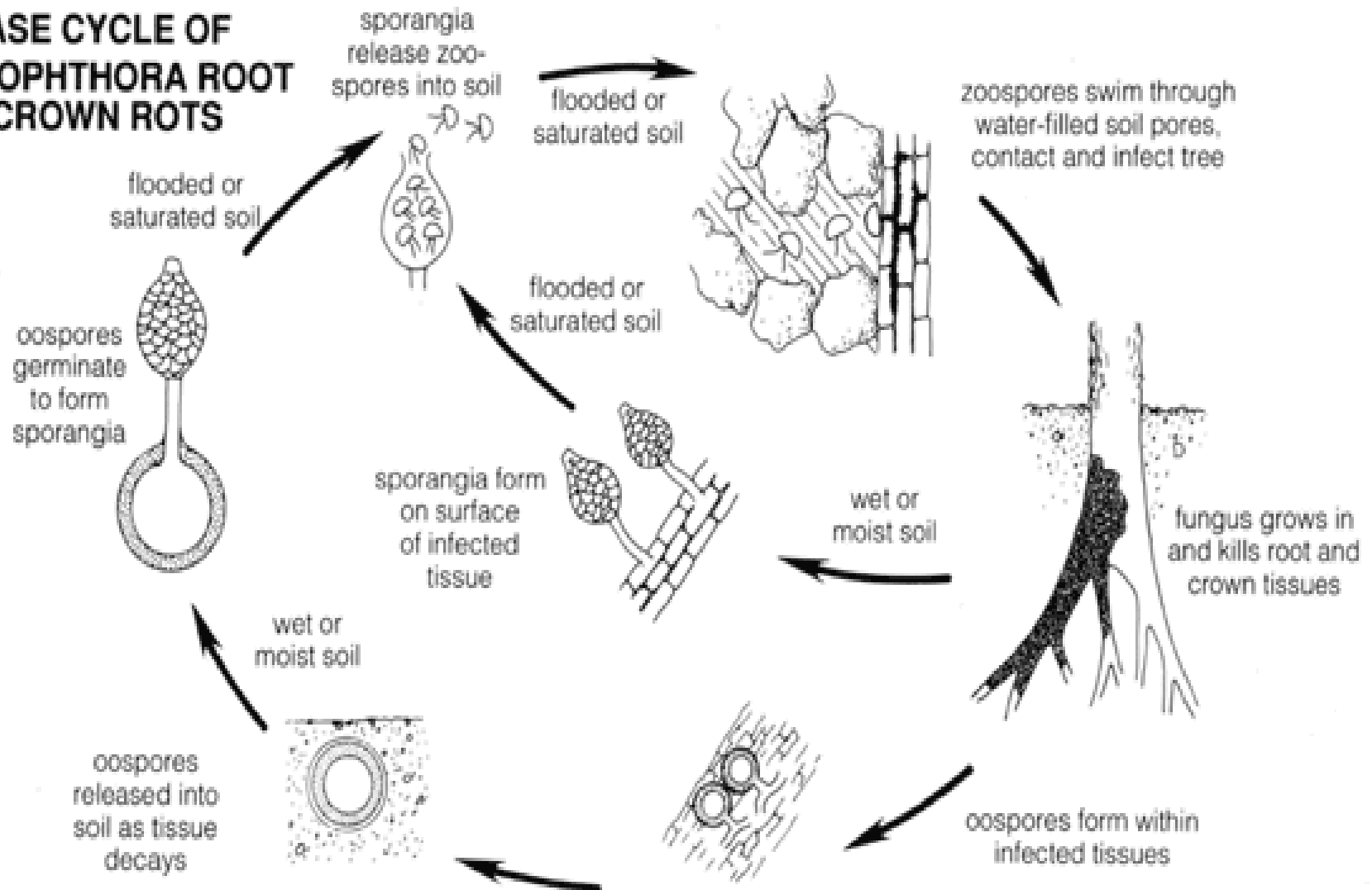


Phytophthora 101: Pathogen Life Stages

- ◆ Mycelium & hyphae—vegetative body
- ◆ Zoosporangia—asexual reproduction
 - ▶ produced in soil or on plants
- ◆ Zoospore—motile, swimming spore
 - ▶ present in water & water films
- ◆ Chlamydospore—thick-walled asexual spore
 - ▶ capable of long-term survival
- ◆ Oospore—thick-walled sexual resting spore
 - ▶ capable of long-term survival

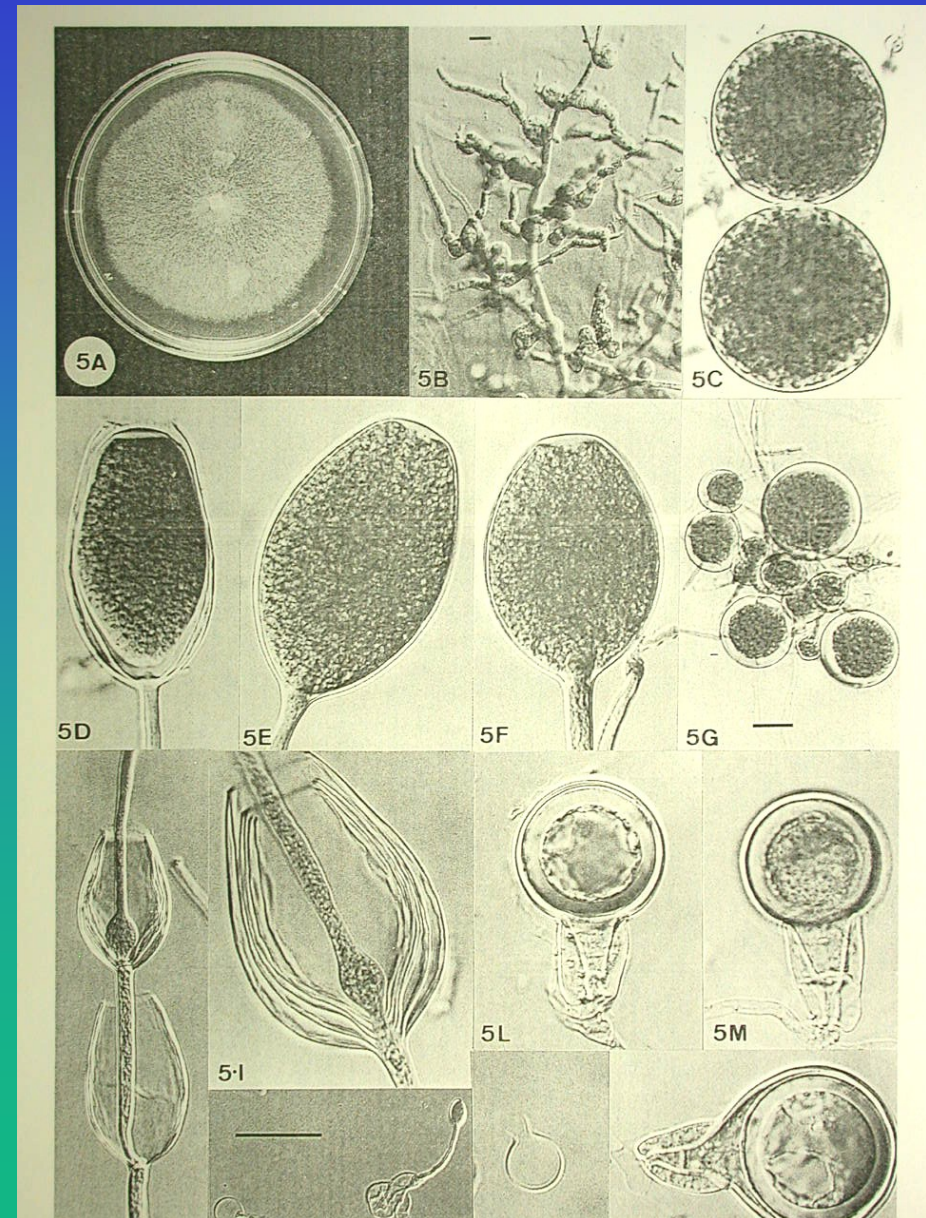
Disease Cycle: Phytophthora Root Rot

DISEASE CYCLE OF PHYTOPHTHORA ROOT AND CROWN ROT



Phytophthora cinnamomi

- ◆ colony on agar [A]
- ◆ hyphae [B]
- ◆ chlamydospores [C]
- ◆ sporangia [D,E,F,H,I]
- ◆ hypha swellings [G]
- ◆ oospores [L,M,N]



Diseases Caused by *Phytophthora* spp.

- ◆ Some of the most economically important and damaging diseases on woody plants in the Southeast, USA, and worldwide
- ◆ Cause problems annually
- ◆ Particularly serious in or following “wet” years
- ◆ Diseases often are associated with wet or saturated soils

Phytophthora Diseases of Forest Trees—Some Examples

◆ United States

- ▶ Southeast: Little leaf disease on short-leaf pine
- ▶ Northwest: Root rot on Port-Orford-Cedar
- ▶ East: Ink disease on chestnut (1930s, currently)
- ▶ South Carolina: Laurel oaks on the coast (new!)

◆ Other countries

- ▶ Mexico: mortality on oaks & understory shrubs
- ▶ Australia: root rot & decline on eucalyptus
- ▶ Europe: oak decline

Some Trees & Shrubs Attacked

- ◆ *Abies*—fir
- ◆ *Acer*—maple
- ◆ *Arbutus*—madrone
- ◆ *Betula*—birch
- ◆ *Buxus*—boxwood
- ◆ *Camellia*—*C. japonica*
- ◆ *Castanea*—chestnut
- ◆ *Cedrus*—cedar
- ◆ *Cercis*—redbud
- ◆ *Chamaecyparis*—false cypress
- ◆ *Citrus*—orange, lemon, etc.
- ◆ *Cornus*—dogwood
- ◆ *Cryptomeria*—Japanese cedar
- ◆ *Cupressus*—cypress
- ◆ *Elaeagnus*—Russian olive
- ◆ *Eucalyptus*
- ◆ *Fagus*—beech
- ◆ *Ficus*—fig
- ◆ *Forsythia*
- ◆ *Ilex*—holly
- ◆ *Juglans*—walnut
- ◆ *Juniperus*—juniper
- ◆ *Kalmia*—laurel
- ◆ *Malus*—apple

More Trees & Shrubs Attacked...

- ◆ *Persea*—avocado
- ◆ *Picea*—spruce
- ◆ *Pieris*—andromeda
- ◆ *Pinus*—pine
- ◆ *Platanus*—sycamore
- ◆ *Prunus*—cherry, plum, etc.
- ◆ *Pseudotsuga*—Douglas fir
- ◆ *Pyrus*—pear
- ◆ *Quercus*—oak
- ◆ *Rhododendron*—rhodo., azalea
- ◆ *Robinia*—locust
- ◆ *Rosa*—rose
- ◆ *Rubus*—raspberry
- ◆ *Syringa*—lilac
- ◆ *Taxus*—yew
- ◆ *Thuja*—arborvitae
- ◆ *Tsuga*—hemlock
- ◆ *Vaccinium*—blueberry, cranberry
- ◆ *Viburnum*—arrowwood
- ◆ *Ulmus*—elm

Species of *Phytophthora* that Attack Trees and Shrubs (<1999)

- ◆ *P. cactorum*
- ◆ *P. cambivora*
- ◆ *P. cinnamomi*
- ◆ *P. citricola*
- ◆ *P. citrophthora*
- ◆ *P. cryptogea*
- ◆ *P. gonapodyides*
- ◆ *P. ilicis*
- ◆ *P. lateralis*
- ◆ *P. megasperma*
- ◆ *P. nicotianae* = *P. parasitica*
- ◆ *P. palmivora*
- ◆ *P. pseudotsugae*

"New" Species of *Phytophthora* that Attack Trees and Shrubs

- ◆ *P. quercina* – oaks/European [1999]
- ◆ *P. pistaciae* – pistachio/Turkey [1999]
- ◆ *P. ramorum* – viburnum, rhododendron/Europe; oaks, tanoak, bay laurel, etc./CA & OR [2001]
- ◆ *P. psychrophilia* – oaks/Europe [2002]
- ◆ *P. europaea* – oaks/Europe [2002]
- ◆ *P. uliginosa* – oaks/Europe [2002]
- ◆ *P. pseudosyringae* – hardwoods/Europe, PNW [2003]
- ◆ *P. nemorosa* – oaks/CA, OR [2003]

“New” Species of *Phytophthora* that Attack Trees and Shrubs

- ◆ *P. hedraiandra* – shrubs/The Netherlands, USA [2004]
- ◆ *P. alni* – *Alnus* spp./Europe [2004]
- ◆ *P. kernoviae* – hardwoods, rhod/Europe [2005]
- ◆ *P. captiosa* – eucalyptus/New Zealand [2006]
- ◆ *P. fallax* – eucalyptus/New Zealand [2006]
- ◆ *P. foliorum* – azalea/USA [2006]
- ◆ others??

Phytophthora spp. as Pathogens of Woody Plants

- ◆ These fungi can attack all parts of the plant
- ◆ Blight & dieback on shoots & foliage—*uncommon*
- ◆ Cankers on stems & trunk—*common*
 - ▶ e.g., “bleeding” cankers
- ◆ Root & crown rots—*most common*

Symptoms—Above Ground

- ◆ Appear *after* roots are diseased
- ◆ Chlorosis & yellowing of the foliage
 - ▶ very slight at first, then becoming obvious
- ◆ Stunted growth
- ◆ Overall wilting & decline
- ◆ Cankers—orange/red/brown discoloration
 - ▶ on stems and trunk
 - ▶ distinct margin between healthy & diseased tissues
- ◆ Plant death

Phytophthora Foliage Blight



Phytophthora Cankers on Trees



American



American chestnut



American chestnut

Phytophthora Canker on Laurel Oak in SC



Symptoms—Below Ground

- ◆ Must expose roots for examination
 - ▶ this usually requires digging!
 - ▶ need to know what healthy roots look like!
- ◆ Reduced root volume / lack of feeder roots
- ◆ Roots discolored—red, brown, dark brown
 - ▶ healthy roots are white or off-white
- ◆ Cortex sloughing / root rot
- ◆ Cankers on root crown
 - ▶ may move up stem above ground

Phytophthora Root Rot on Shore Juniper



Phytophthora root rot on *Pieris*



Phytophthora root & crown rot on chestnut seedlings



Phytophthora root & crown rot on apple



Field Diagnosis

- ◆ Above-ground symptoms alone usually are *not* diagnostic—merely indicate vascular dysfunction
- ◆ Therefore, look below ground at roots & crown
- ◆ Together, these *may* be diagnostic
- ◆ Other pathogens also can cause root rot
 - ▶ *Armillaria*, *Fusarium*, *Sclerotium*, *Thielaviopsis*, etc.
 - ▶ maybe even *Pythium* spp. occasionally...

and then came...

Phytophthora ramorum

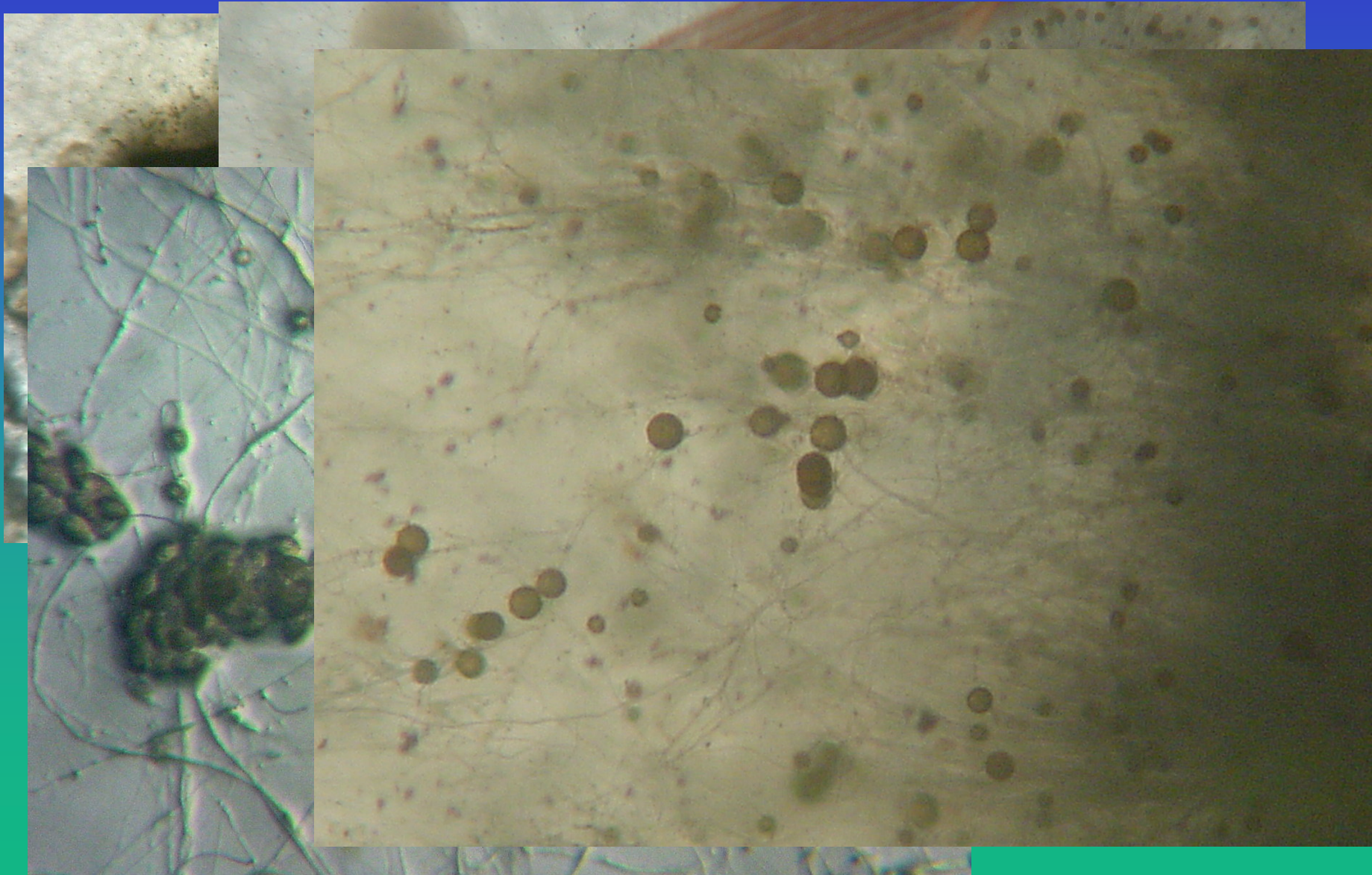
Phytophthora ramorum

- ◆ A newly described species: 2001
- ◆ Causes **sudden oak death (SOD)**
 - ▶ on trees—primarily oaks & related species
 - ▶ occurs in coastal forests in Calif. & SW Oregon
 - ▶ found on landscape trees in Europe
 - ▶ often lethal
- ◆ Causes ramorum or foliage blight
 - ▶ on understory trees & shrubs in the forest
 - ▶ on **many** different nursery crops—USA & Europe
 - ▶ usually not lethal

P. ramorum: Leaf Bait Symptoms



P. ramorum: Growing from Baits



P. ramorum: In Culture...



sporangia on agar surface

chlamydospores in agar



Questions??

A scenic view of a mountain range with vibrant autumn foliage in shades of green, yellow, orange, and red. The text "Questions??" is overlaid in large, 3D, orange-yellow letters.