



Sudden Oak Death and other *Phytophthora* diseases of *Rhododendron*

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What we will talk about



- Sudden Oak Death
- *Phytophthora* diseases on Rhododendron
- SOD on rhododendrons – research results

What is *Phytophthora*?

Phytophthora ramorum



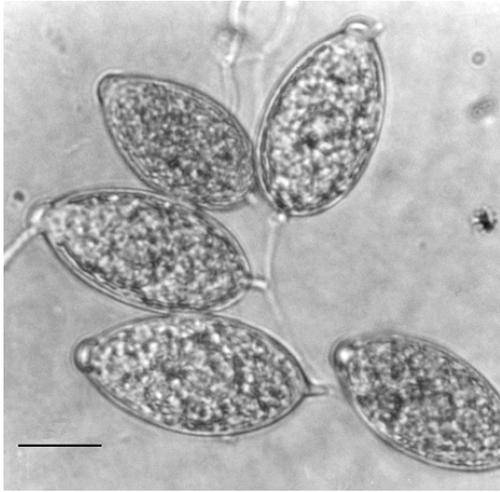
Photo: Garbelotto lab, UC Berkeley

Cystoseira osmunacea, a brown algae

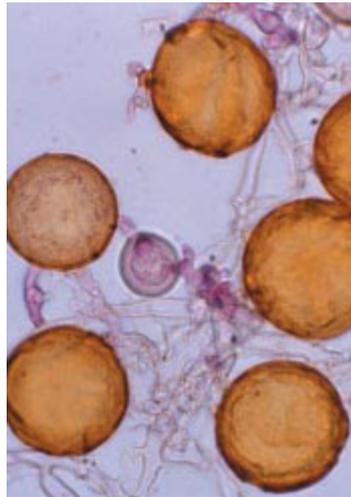


Photo: pt-lobos.com

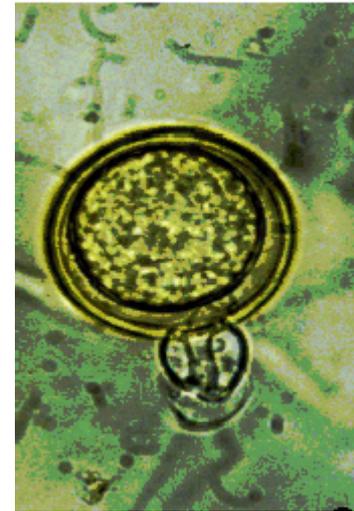
Phytophthora spore stages



Sporangia containing swimming zoospores



Chlamydospores



Oospores (*P. infestans*)

Zoospores



Each sporangium can hold about
30 swimming zoospores!

Phytophthora – the plant destroyer



P. infestans – responsible for the Irish potato famine in 1845

P. sojae - soybean stem and root rot

Several *Phytophthora* spp. cause disease on cacao

P. cinnamomi – causes damage to forest ecosystems worldwide

P. ramorum – causes Sudden Oak Death (SOD)

Sudden Oak Death in forests

California and SW Oregon

- On tanoak, black oaks, and coast live oak

Not present in WA forests

UK – SW England, Wales, Northern Ireland

- On Japanese larch
- Also on chestnut, birch, beech, oak, Douglas-fir, and western hemlock



Symptoms on trees

P. cambivora on Beech

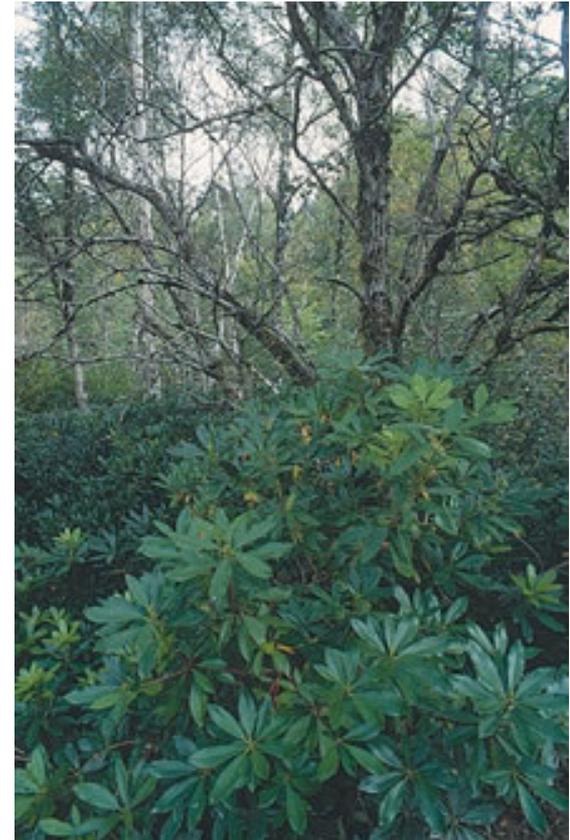
- Bleeding cankers
- Cankers can girdle the tree and kill it
- Host species in Fagaceae: oaks, beech, tanoak
- Other *Phytophthora* spp can cause the same symptoms



P. ramorum on Oak

Foliar hosts carry the disease

- California bay laurel (*Umbellularia californica*)
- *Rhododendron ponticum*

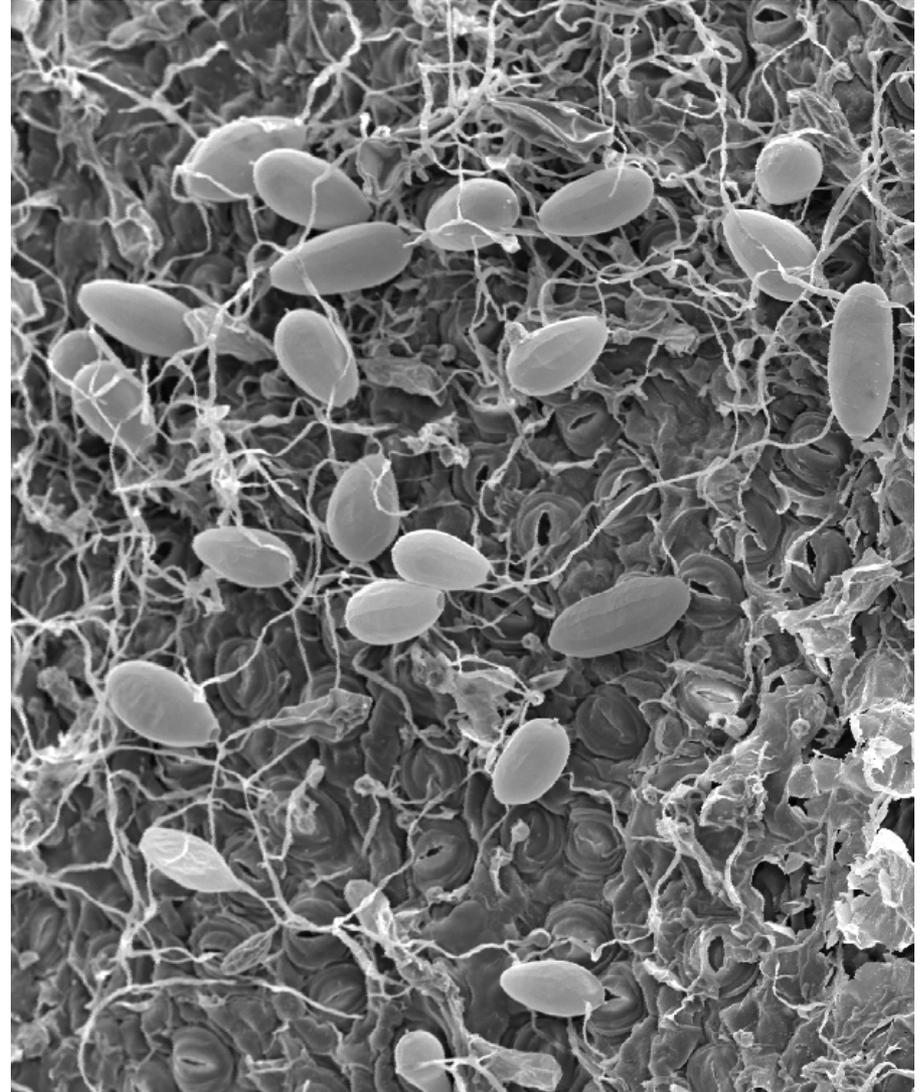


Foliar hosts

Epidemiologically important hosts produce large numbers of sporangia



Rhododendron 'Purple Splendour'



SEM Photo by K. McKeever, WSU

Chlamydospores in infected foliage are another source of Pr inoculum



How does SOD impact WA's economy?

Nurseries who ship interstate

Forest products: Douglas fir and western hemlock timber

Non-timber forest products: greenery, transplants, floral products

Christmas trees



P. ramorum in WA nurseries

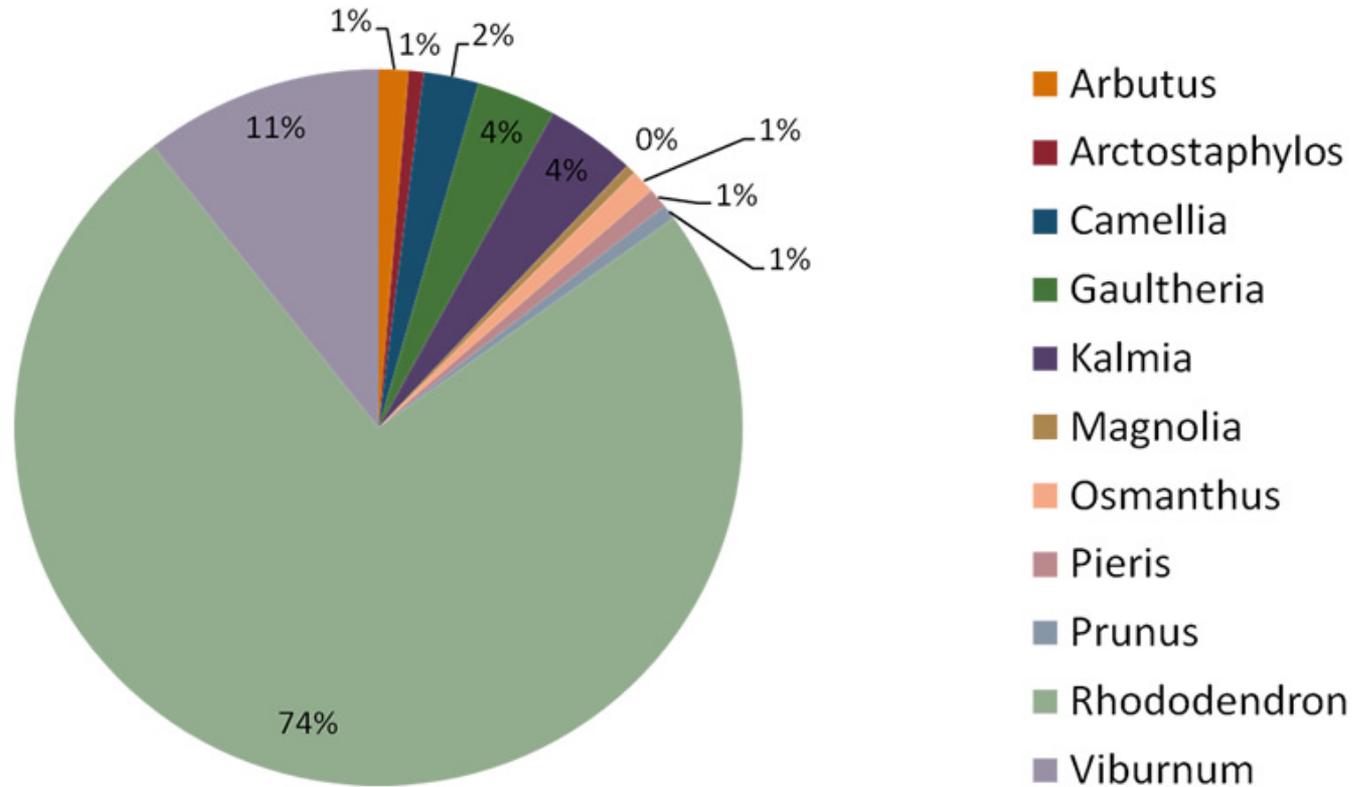
45 nurseries in western WA have been Pr+ between 2004-2010

8 have gone out of business



Host material

Most Pr detections in WA nurseries are on Rhododendrons



2004-2010

Data from WSDA

Monitoring for *P. ramorum*

WSDA monitors Pr+ nursery sites and perimeters year round

DNR monitors selected waterways during late winter-early summer as part of USFS national *P. ramorum* survey

WSU volunteers monitor additional sites near nurseries that had been Pr+ in the past and not currently being monitored by WSDA or DNR



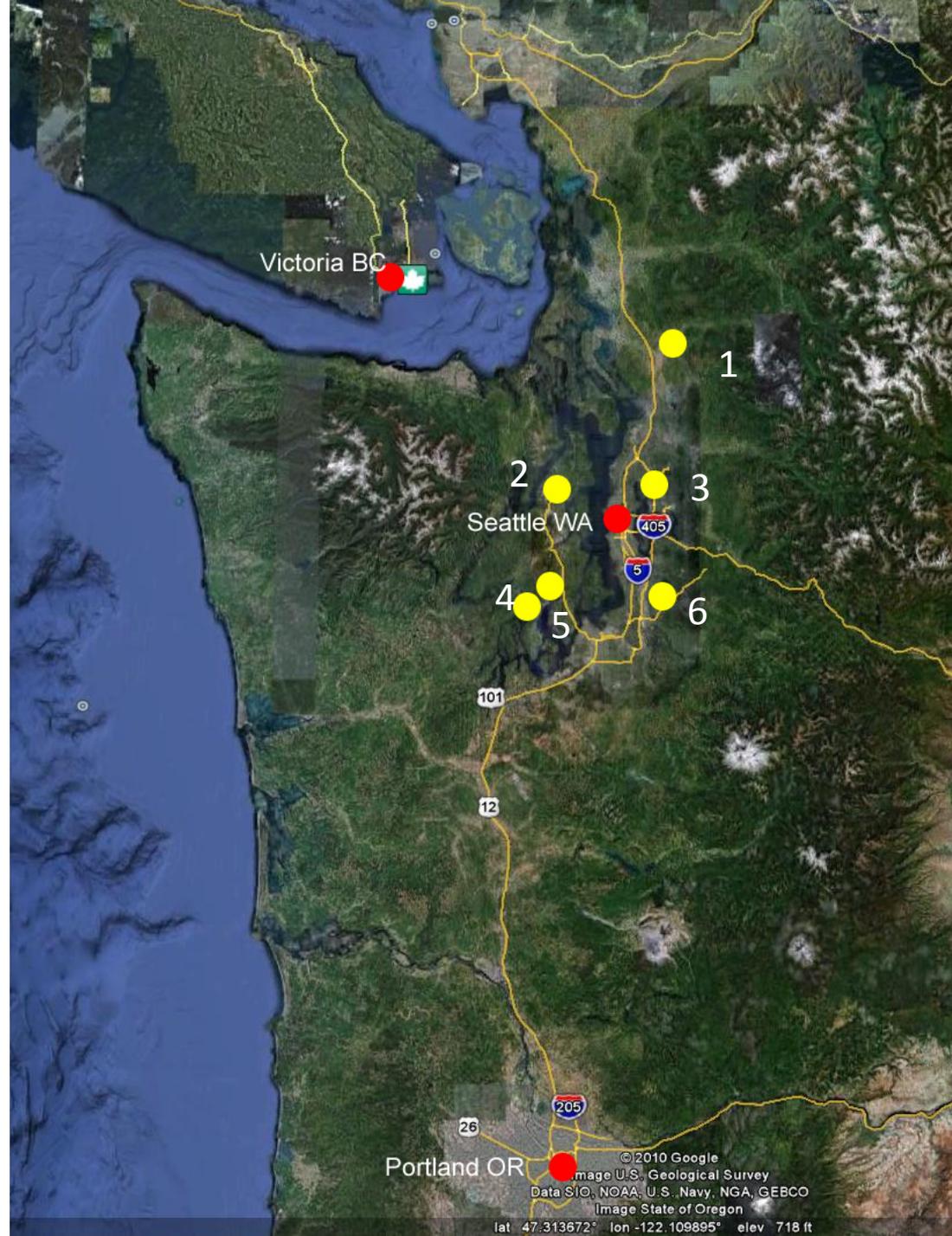
WSU Stream Monitoring

- 2010 pilot study – 4 sites
- 2011
Plan to increase monitoring to 10 sites, some recommended by WSDA, include more schools and student projects
- Funded by USDA Forest Service Pacific Northwest Region



Locations of selected nurseries and bait sites in Western WA

1. Stilliguamish River
2. Dogfish Creek
3. Sammamish River
4. Rosedale stream
5. Wollochet Creek
6. Green River



Soil and water positive

| Nursery # | Soil or water + | Nearest waterway | Years + |
|-----------|------------------|---------------------|-----------|
| 33 | 0 | Dogfish Creek | 0 |
| 31 | 2006 | Green River | 0 |
| 35 | 0 | Green River | 0 |
| 36 | 2007 | Anderson Creek | 0 |
| 43 | 0 | Stilliguamish River | 0 |
| 21 | 2007 | Stilliguamish River | 0 |
| 45 | 2009 | Wollochet Creek | 2010 |
| 19 | 2005 | Rosedale Stream | 2006-2010 |
| 34 | 2007, 2009, 2010 | Sammamish River | 2007-2010 |
| 22 | 0 | Sammamish River | 2007-2010 |
| 26 | 0 | Sammamish River | 2007-2010 |

Symptoms of *Phytophthora* diseases on Rhododendron

Leaf and shoot blight

Root disease

Look-alikes



Phytophthora leaf and shoot blight

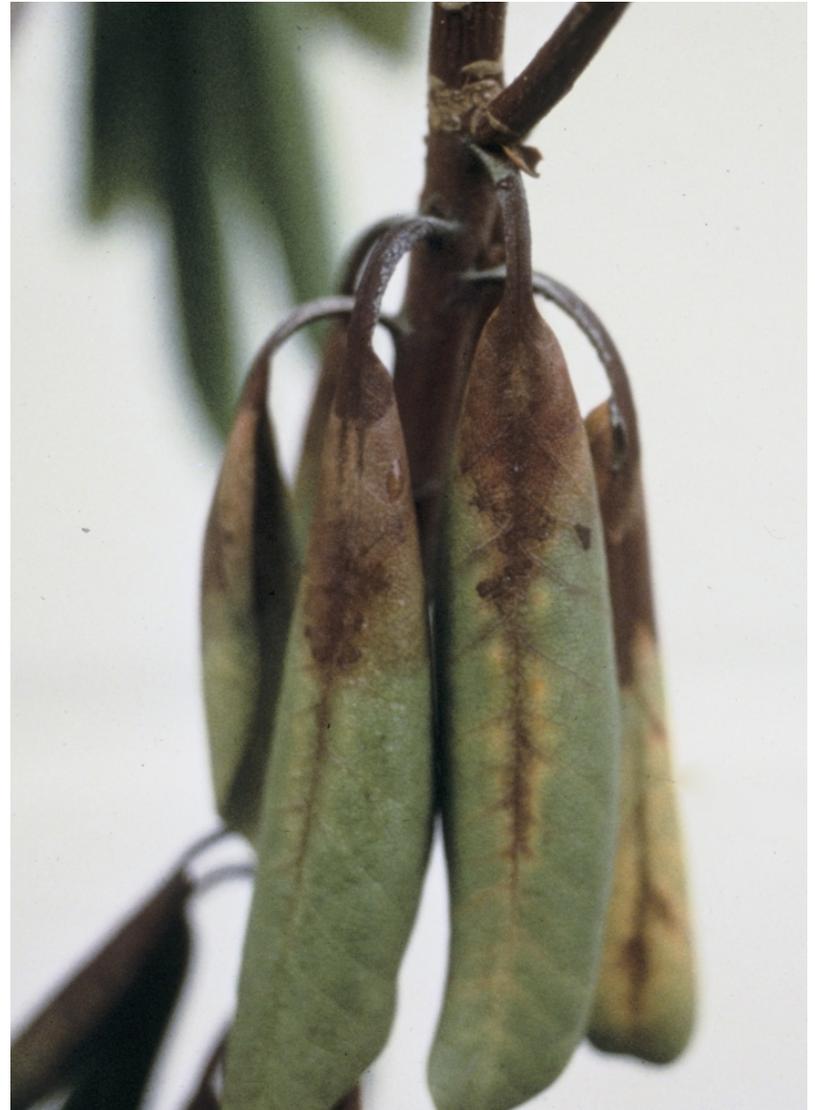
P. citricola

P. cactorum

P. syringae

P. ramorum

P. kernoviae



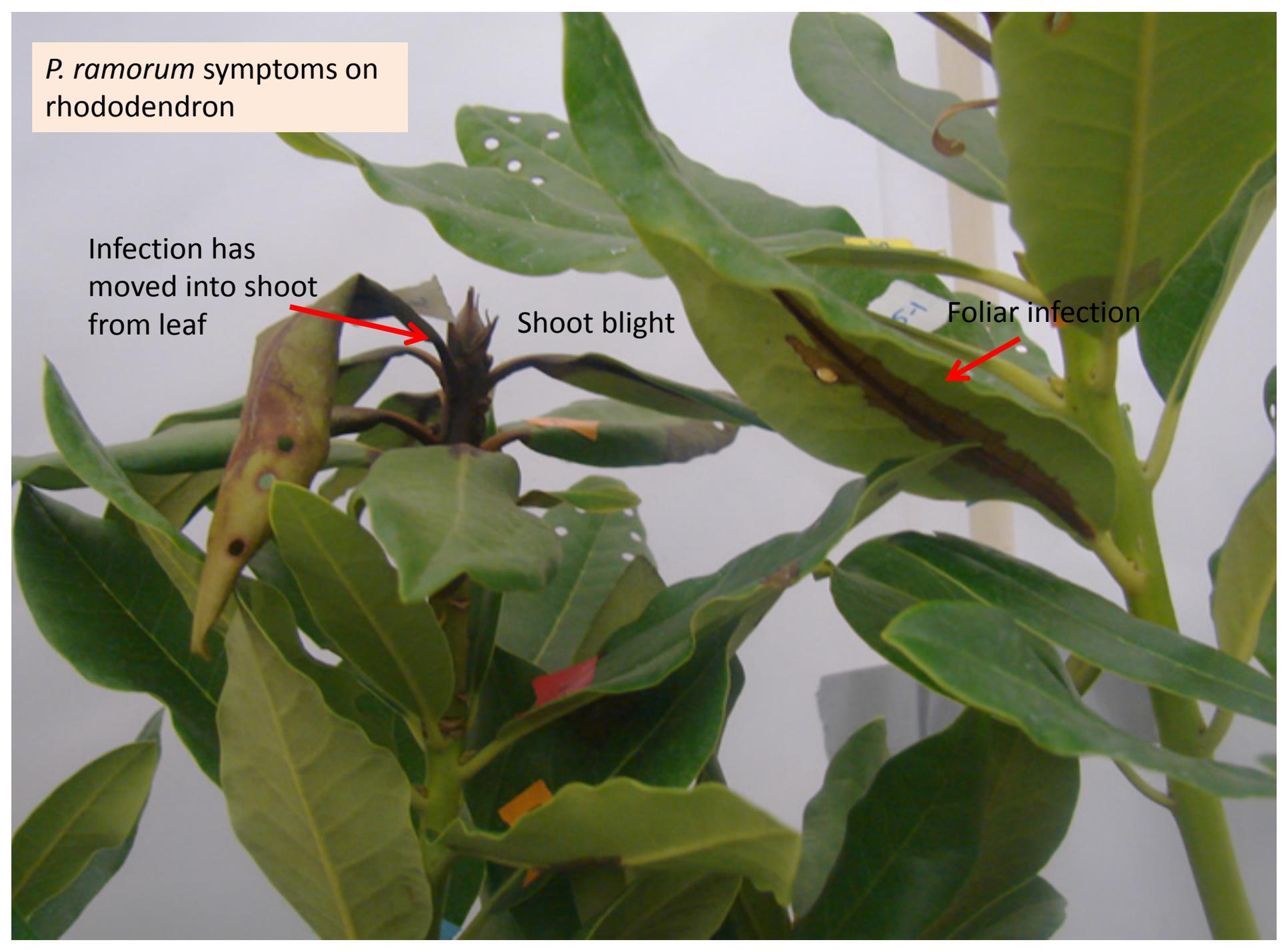
P. ramorum symptoms on
rhododendron

Infection has
moved into shoot
from leaf



Shoot blight

Foliar infection



Phytophthora kernoviae



In UK – more aggressive than Pr on Rhododendron.

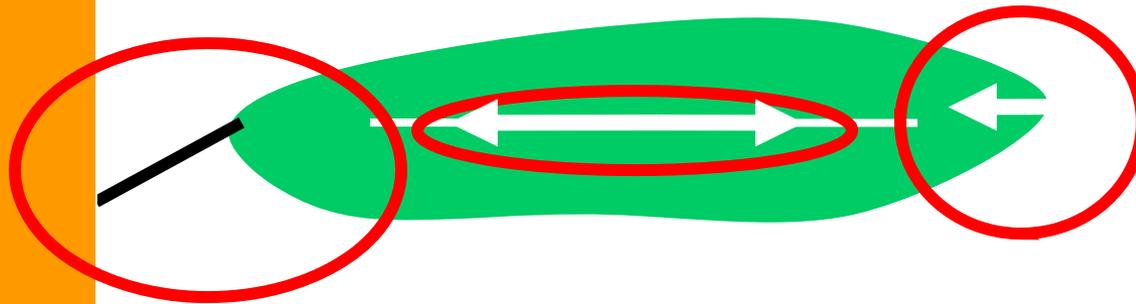
May be endemic in New Zealand

Not present in North America



Summary of typical *P. ramorum* symptoms of rhododendrons

Look for symptoms where water collects – at the leaf tip



Disease symptoms develop along mid rib, from leaf tip, or from petiole

Phytophthora can move into the shoot from leaf, and back out to new leaves

Sun scorch of rhododendron



Sun scorch, lesion does not extend down leaf midrib



Gray blight can develop on sun scorched rhododendron

Some common foliar diseases of Rhododendron



UGA1415273

Pestalotiopsis blight



Powdery mildew

5337063



Leaf and flower gall or blister blight – caused by the fungus *Exobasidium vaccinii*



Flea beetle damage can resemble fungal infection

Phomopsis and *Botryosphaeria* shoot blight



Photo: North Carolina Cooperative Extension Service

Wilting
Cankers
Black fruiting
bodies
Brown staining of
wood



Photo: University of Georgia Extension



Photo: Virginia Cooperative Extension

Phytophthora root rot

Several species including

P. cinnamomi

P. citricola

P. cactorum

P. parasitica

P. ramorum has not been observed to cause root rot symptoms on *Rhododendron*



Phytophthora root rot

Look for it where water collects – at the bottom of a slope or low-lying area.

Also areas with poor drainage or heavy clay soils.



Rhododendron research

Susceptibility of
Rhododendron foliage to
infection by *P. ramorum*

42 species and 58 cultivars
screened

A more detailed study on 10
species



Rhododendron Species Garden, Federal Way, WA

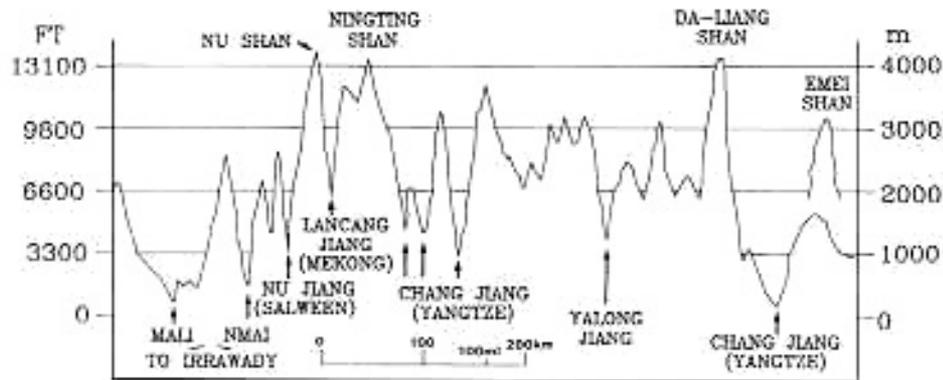
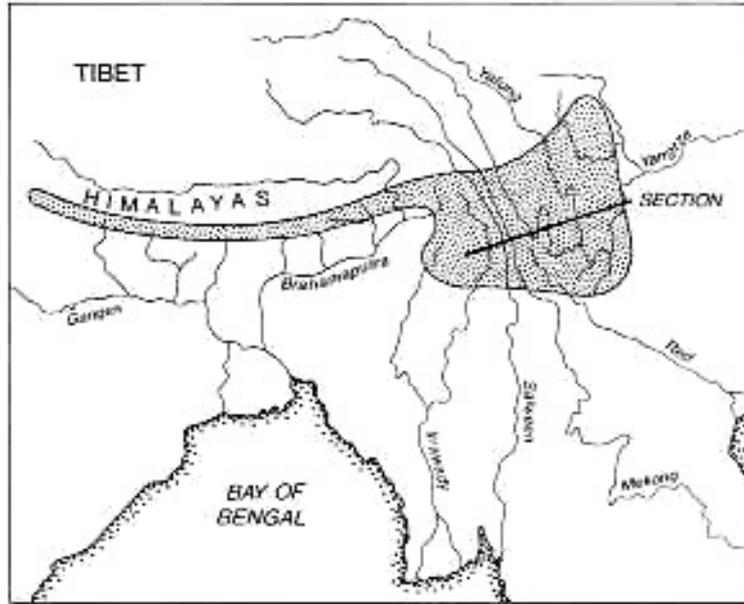
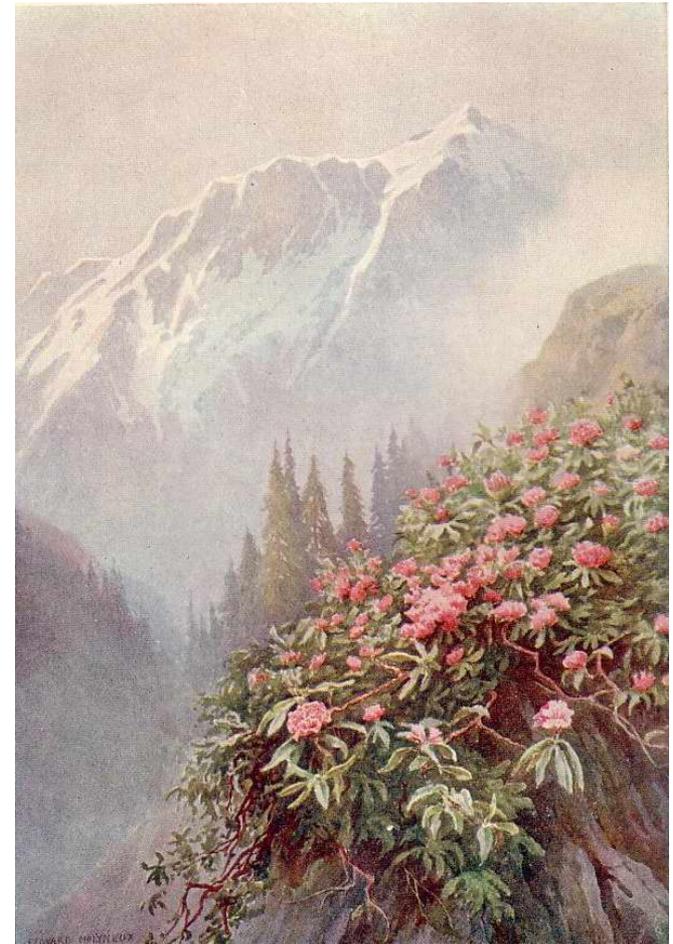


Figure 2. The region of extreme relief and heavy rainfall (stippled in upper diagram). The cross-section below is along the line indicated in the upper diagram. Emei Shan in Szechuan, with its numerous rhododendron species, is a little to the north of the line of section.

E. Irving and R. Hebda 1993. **Concerning the Origin and Distribution of Rhododendrons.** JARS V47:No3:p139



Wild Rhododendrons in Kashmir - Image taken from the painting by Major Edward Molyneux (died 1913) and published in the book *Kashmir* by Francis Younghusband in 1917.

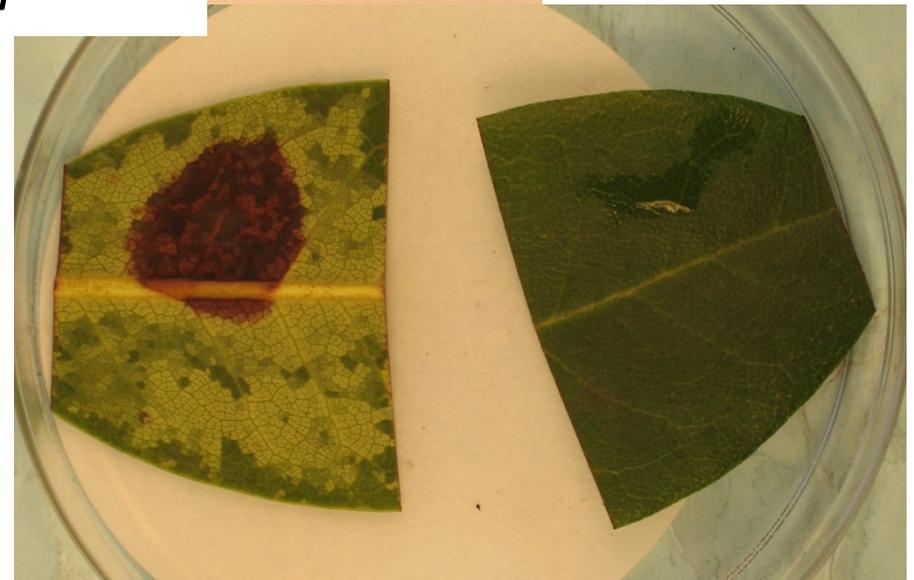
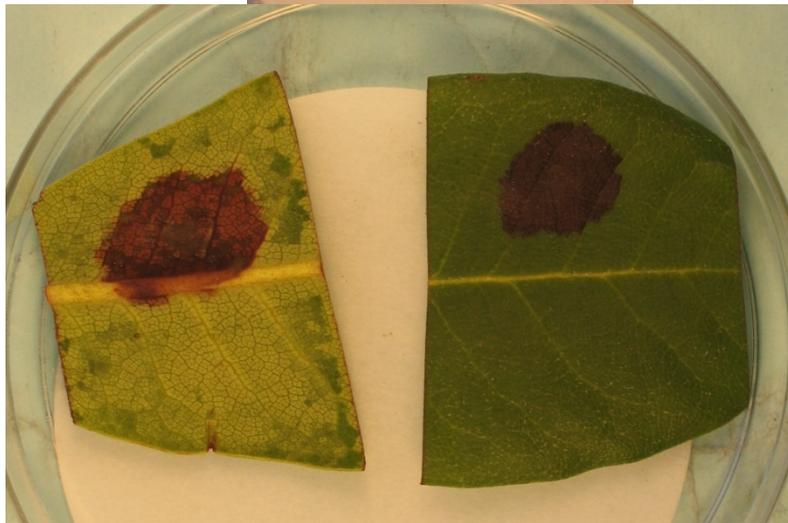
Measuring susceptibility

wounded



R. keiskei

unwounded



R. 'Besse Howells'

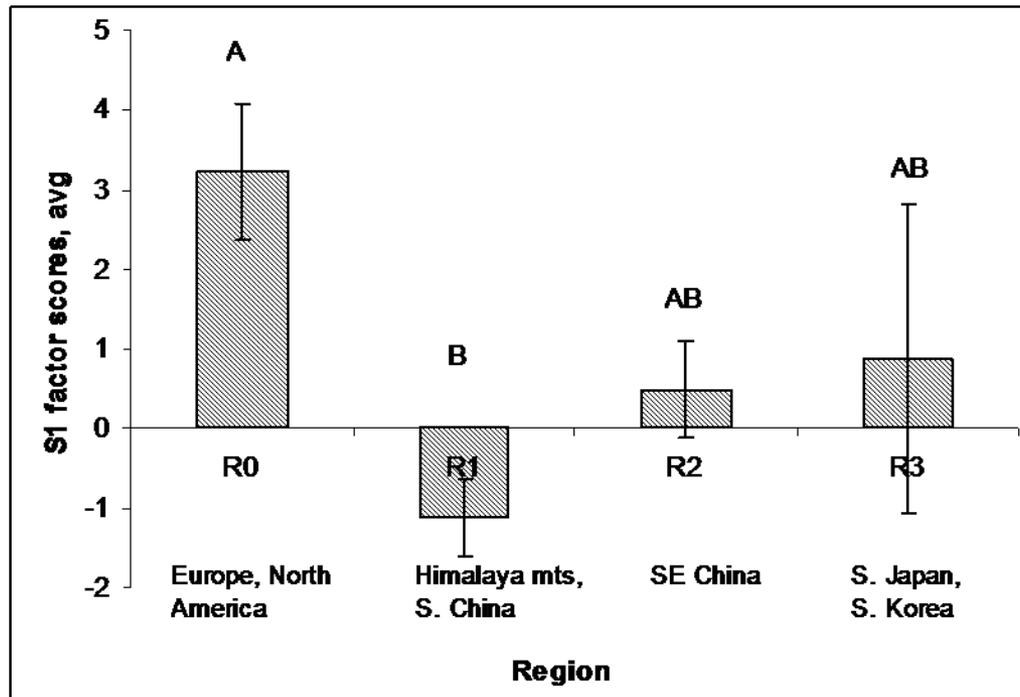


Figure 1. Relative susceptibility of *Rhododendron* species originating from four geographic regions. A higher score for factor S1 indicates greater susceptibility to foliar infection by *P. ramorum*. Regions with different letters are significantly different at $\alpha = 0.05$. One way ANOVA, Tukey's HSD multiple comparisons.

Most susceptible species, >75% infection frequency

- *R. augustinii*
- *R. dauricum*
- *R. macrophyllum*
- *R. ponticum*
- *R. sutchuenense*
- *R. mucronulatum*



Resistant species

- *R. keiskei*
- *R. griffithianum*
- *R. macabeanum*
- *R. mallotum*
- *R. racemosum*
- *R. arboreum*
- *R. degronianum* ssp.
Yakushimanum

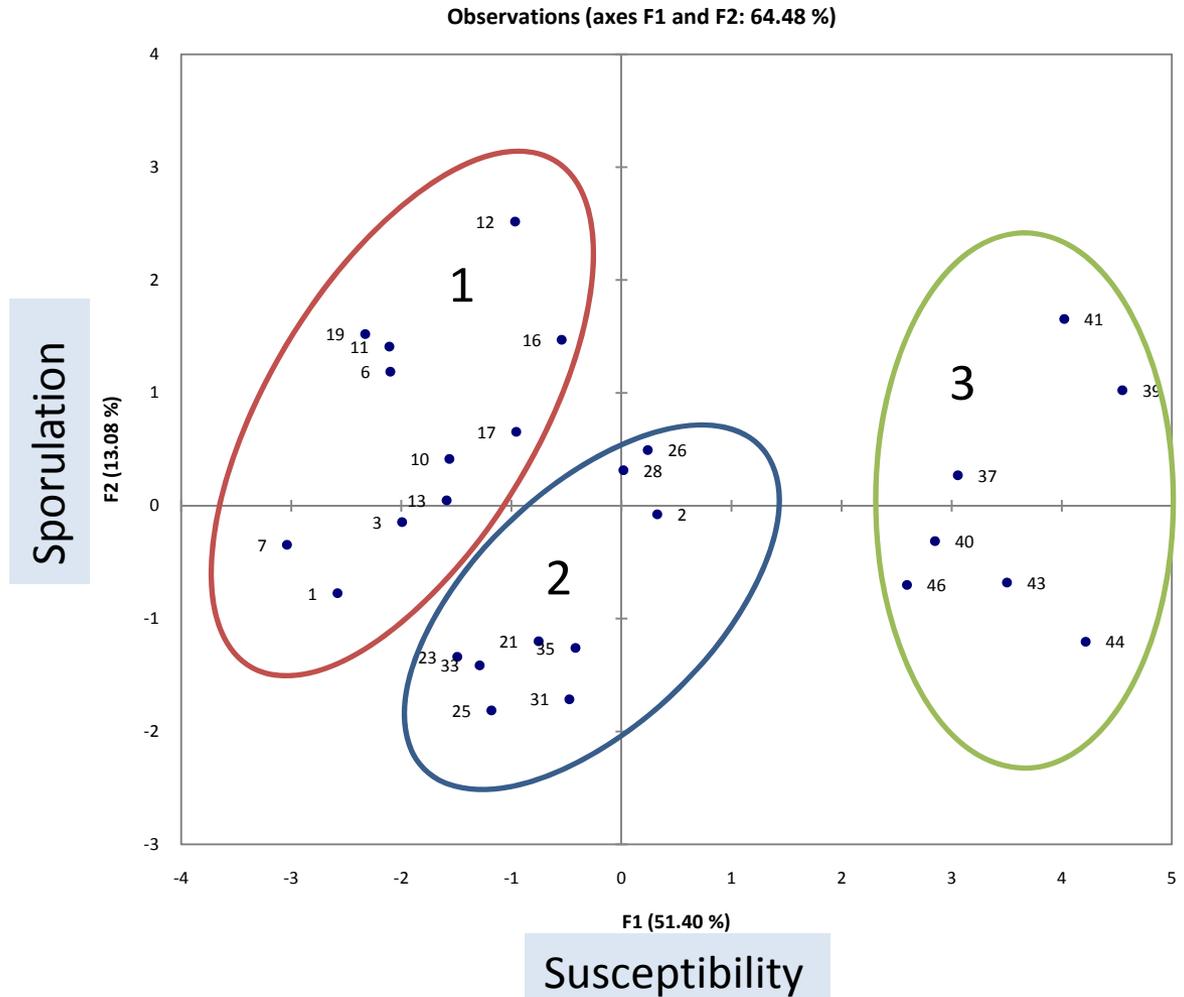


R. macabeanum

Group 1 – *R. keiskei*, *R. arboreum*, *R. griffithianum*, *R. macabeanum*

Group 2 – *R. mallotum*, *R. degronianum ssp. Yakushimanum*, *R. racemosum*

Group 3 – *R. macrophyllum*, *R. ponticum*, *R. catawbiense*



Group 1

Low infection frequency

Small lesions

High asymptomatic infection%

High chlamydospore production

R. keiskei, *R. arboreum*,
R. griffithianum, *R. macabeanum*

Group 1 has the highest amount of asymptomatic infection and chlamydospore production.

Sporulation can occur on tissue that does not have a necrotic lesion.

Pr can spread on this host and persist in leaf litter.



R. keiskei

Group 2

Intermediately resistant

Low chlamydospore production

Group 2 had the least sporulation and lesion size was relatively small.

These species are the lowest risk.

R. mallotum, *R. racemosum*,
R. degronianum ssp. *yakushimanum*



R. racemosum

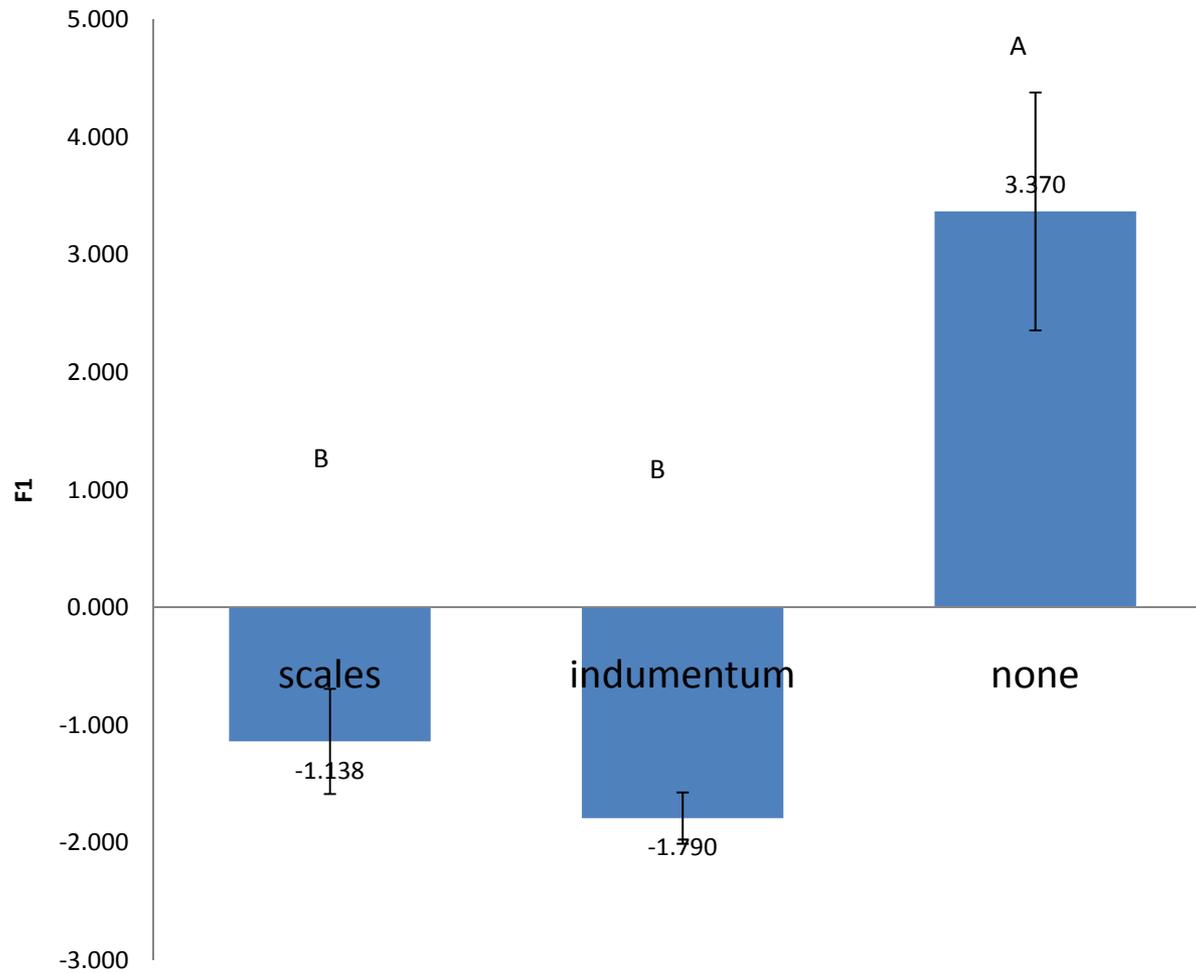
Indumentum



Rhododendron "Ken Janeck"



R. arboreum ssp. *cinnamomeum*



Species with surface features such as indumentum and scales were more resistant than species with no surface features. (ANOVA, Tukey's multiple comparisons).

Group 3

High infection frequency

Large lesions

Low asymptomatic infection %,
Intermediate chlamyospore
production

High sporangia production

R. macrophyllum, *R. ponticum*,
R. catawbiense

Group 3 is the biggest threat –
largest lesion size, highest infection
frequency, and highest sporangia
production.

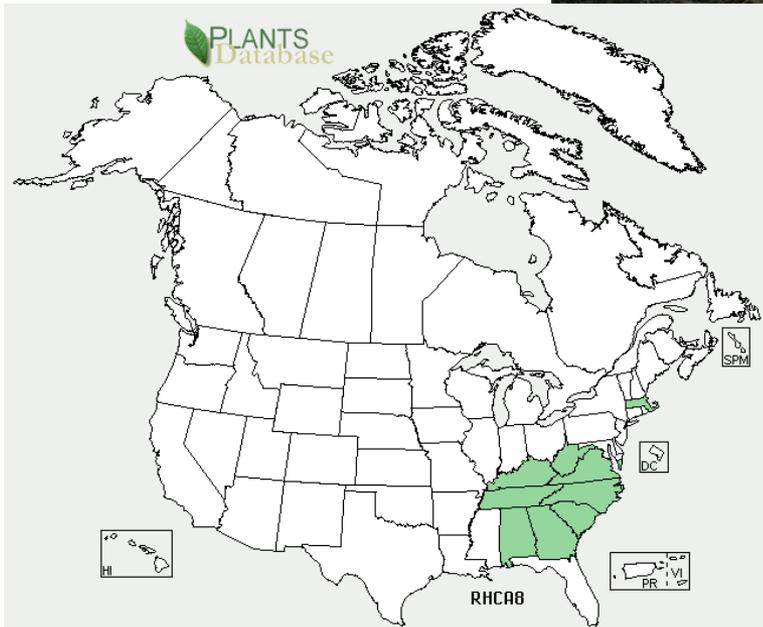


R. macrophyllum

R. catawbiense

Most common
Rhododendron in
eastern US forests

Hybridizes easily
with *R. ponticum*



R. ponticum

- Invasive shrub in UK forests
- British *R. ponticum* is at least partly hybrid between Spanish *R. ponticum*, American *R. catawbiense* and other species
- Spreads SOD to beech and oak trees
- Heavy sporangia producer



Summary

- *Phytophthoras* are very destructive plant pathogens that prefer wet conditions
- Susceptibility to foliar infection by Pr varies considerably within the genus *Rhododendron*
- Many resistant species and cultivars have indumentum

On the web



- Visit our website:

<http://www.puyallup.wsu.edu/ppo/sod.html>

- Join the WA SOD Facebook group
“Washington Sudden Oak Death”

The Facebook logo, consisting of the word "facebook" in white lowercase letters on a blue rectangular background.

- Read the WA SOD Blog

<http://washingtonsod.blogspot.com/>

