

# **PHYTOPHTHORA CINNAMOMI**

## **Tree death in Sydney attributed to Pc – an alternative perspective**

**A short talk prepared for the Sydney Harbour Dieback Working Group**

**24 July 2005**

**by**

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# PHYTOPHTHORA CINNAMOMI (Pc)

## *What is it?*

A fungus-like soil borne organism that causes root rot in a wide variety of plant species, including many natives and introduced ornamental plants

Phytophthora species are soil borne pathogens often associated with several declining oak woods in Europe and the Mediterranean regions, as well as in most temperate forests of North and South America, and in a few tropical forests (Bianco et al 2001)

At least 950 species of Phytophthora are known (Zebtnter1980)

For example, a species of Phytophthora was responsible for the potato blight in Ireland in 1845 (and probably the presence of most of the Irishmen in Oz)

Pc is also related to the Downy Mildews that effect ornamental species and agricultural crops

# PHYTOPHTHORA CINNAMOMI (Pc)

## *What is it?*

Pc was detected in Burma in 1922 and has been introduced in Australia, probably c.1810 by settlers bringing in citrus trees (Summerell 2003)

In 1948 Pc was associated with disease symptoms in native vegetation in Australia

Pc is endemic in Australia soils (Weste 1979, Pratt et al 1973). This is a point of debate between experts.

State Forests (then Forestry Commission NSW) surveyed soils throughout NSW and found it present in a majority of soil samples (FC 1974?)

**Although of scientific interest, for management purposes it is largely irrelevant and it is probably not important to debate whether Pc is native to Australian soils or not. The reality is that it here to stay, and we have to learn to manage it more effectively (McDougall 2005, ANPC Journal)**

# PHYTOPHTHORA CINNAMOMI (Pc)

*Where else has it been detected as a problem?*

*In other countries...*

Italy – Walnut

France & Italy – Sweet Chestnut

USA South Carolina – Camellia, Juniper

USA California – Oaks and other native trees

Uganda – Citrus, native forest and savannah species

New Zealand – Avocado

South Africa – range of species, including *Eucalyptus smithii*

Sweden – Alders

# PHYTOPHTHORA CINNAMOMI (Pc)

*Where else has it been detected as a problem?*

*In Australia...*

Western Australia – Jarrah Forests, *Banksia grandis*

South Australia (Kangaroo Island) – range of native species

Queensland – Citrus

NSW (Royal National Park) – Waratah, *Xanthorrhoea* and others

Barrington Tops and Northern Tablelands – Snow Gum Woodland (*E. pauciflora*)

Tropical forest between Cardwell & Mossman in Queensland

...and others

The *Phytophthora* species implicated is not always Pc, but it often is

Most Pc problems in Australia have occurred in the last 50-60 years (Newhook 1978)

# PHYTOPHTHORA CINNAMOMI (Pc)

## ***Susceptibility...***

There is some debate about which species are susceptible to Pc and which are not.

For example:

The NSW Scientific Committee states that *Angophora costata*, *Banksia spinulosa*, *Kunzea ambigua* and *Pultenaea daphnoides* are susceptible to Pc, while an Australian-based website 'Organic Matters' says that all of these species are tolerant of Pc.

Other research indicates that individual species may be susceptible in some situations, and tolerant in others.

Obviously, despite extensive research world-wide, there is much that is not understood about Pc.

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Pc Testing in Sydney Soils by Royal Botanic Gardens...*

### **Defence sites**

- ❖ RBG asked to investigate the potential for presence of Pc root rot on its holdings at HMAS Penguin & HMAS Waterhen (paper dated July 2002)
- ❖ 65 sampling sites chosen on advice of Department of Defence
- ❖ Trees on sites chosen did not show evidence of dieback

### *Results:*

1. Of the 65 samples taken, only one (1) site tested positive for Pc
2. Trees at the single positive site did not show signs of dieback

### *Interpretation:*

1. Difficult to assess this potential as no 'control' sites (in this case, sites with trees suffering from dieback) were sampled
2. Nevertheless, the Sydney Harbour Foreshore Trust and several Councils concluded that Pc was the cause of tree dieback and death in the region

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Pc Testing in Sydney Soils by Royal Botanic Gardens...*

### **North Sydney Council**

- ❖ RBG asked to identify cause of dieback in *Angophora costata* on Cremorne Point (paper July 2002)
- ❖ Preliminary work in previous years failed to elucidate the cause of the decline and a request was made to NHT for funds to more effectively investigate the problem
- ❖ Samples taken from a number of locations where dieback was evident (no quantitative data presented, and no control sites (non-die back areas) were selected)

### *Results:*

1. Results highly variable (but not quantified in paper provided by RBG)
2. High levels of Pc at some sites, but moderate to low in others (all trees in decline)
3. Testing for other (?) pests and diseases carried out were negative

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Pc Testing in Sydney Soils by Royal Botanic Gardens...*

### **North Sydney Council (cont)**

#### *Interpretation:*

1. Tree decline and death is attributed to Pc
2. Other factors such as a high level of soil nutrients may be a contributing factor to tree decline and death in the presence of Pc (but the author states that high nutrient levels would not be sufficient to cause tree decline/death on its own)
3. Climatic factors such as variability in rainfall (soil moisture levels) may also be a factor (e.g. waterlogged soils)

#### *Queries:*

1. Why were control sites not selected at each of the trial sites?
2. Lack of quantitative data for analysis provided (statistically relevant?)
3. Were site characteristics at each trial site recorded? If no, why not? Why was opportunity to correlate soil analysis with presence/absence of Pc taken?

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Pc Testing in Sydney Soils by Royal Botanic Gardens...*

### **Sydney Harbour Federation Trust (July 02)**

- ❖ RBG was asked by SHFT to investigate the cause of plant deaths within its holdings at Middle Head
- ❖ Sites chosen for sampling were again only from dieback affected areas – no control sites selected

#### *Results:*

1. Indicated that Pc was present in high concentrations
2. Pc evenly distributed throughout area and no 'hotspots' were evident

#### *Interpretation/Query:*

1. The tests carried out by RBG are a simple 'presence/absence' sampling approach
2. It seems no attempt was made to systematically sample sites where no dieback was present despite the brief being to 'investigate cause of plant death'
3. Do these tests therefore lack scientific rigour?

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Pc Testing in Sydney Soils by Mosman Council...*

### *ROUND 1 (April 2004)*

- ❖ Trials conducted in 5 bushland reserves
- ❖ Each site chosen had significant 'dieback' of native canopy species (at least 3 affected trees/site)
- ❖ At each reserve 5 samples were taken in a dieback area, and 5 samples from a non-dieback (control) area (total 50 samples)

### *Results:*

1. Pc found in 8 of 50 samples
2. 6 of the 8 were in sites that contained Pc
3. Conversely, Pc was found in 2 control sites that had no obvious dieback

### *Interpretation:*

1. Pc not as widespread as initially thought in Mosman LGA
  2. Dieback observed throughout most of bushland sites in the region may not necessarily be due to Pc
- cont...

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Pc Testing in Sydney Soils by Mosman Council...*

### *ROUND 1 (cont)*

#### *Soils Analysis:*

Comprehensive soils analysis was carried out for those soils where Pc was present (testing for: pH, phosphorus, nitrogen, zinc, iron, ammonium, manganese, aluminium and calcium)

#### *Results:*

1. Cation exchange variable (no particular trend)
2. Generally high pH (common in sandstone soils)
3. Slightly elevated phosphorus levels (with acidity, probably due to lack of fire)
4. Zinc a particular problem in dieback area in Balmoral (likely to be from urban runoff)

#### *Interpretation:*

No significant positive correlation between soil properties and the presence of Pc, or dieback in trees

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Pc Testing in Sydney Soils by Mosman Council...*

### *ROUND 2 (February 2005)*

- ❖ Trials conducted in the same 5 bushland reserves
- ❖ At each reserve, 5 samples were taken in a dieback area and 5 samples were taken from a non-dieback (control) area, plus
- ❖ 10 additional samples at Balmoral (dieback area) were tested at pre-determined locations (5 with dieback and 5 without) - total 60 samples

### *Results:*

1. 9 of 60 samples tested positive for Pc
2. Only 5 of the 9 were from sites that contained Pc
3. Each reserve tested had at least one site testing positive for Pc
4. These results are consistent with the 2004 trials, however results per site were not consistent - some Pc sites in 2004 now testing negative and vice versa

cont...

# PHYTOPHTHORA CINNAMOMI (Pc)

*Pc Testing in Sydney Soils by Mosman Council...*

## ROUND 2 (cont...)

*Interpretation:*

1. Although Pc is most likely widespread in Mosman, it may not be solely responsible for the dieback observable in bushland in the LGA

*Query:*

1. The information provided by Council does not say whether site characteristics (position below drainage outlets, past history/land use, disturbance events on site and/or upslope, weed density etc) were recorded at each of the testing sites  
If such information was collected, was this correlated and compared to the results of the soils analysis?

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Research Findings Summarised...*

*Behaviour of Pc in soils both suppressive and conducive to root rot*  
Broadbent & Baker (1974) (*Aust. J of Agricultural Research* 25(1): 121-137)

Trials conducted on root rot in Avocados at Mt Tambourine in Queensland found that:

1. Suppressive soils were found to have higher populations of bacteria and actinomycetes than soils conducive to root rot
2. The suppression of Pc sporangium formation was found to be microbial, and not related to the nutrient level of the soil leachate
3. Exchangeable calcium and magnesium nitrogen and organic matter were higher in soils suppressive to root rot than in conducive soils
4. Rainforest soils, where the pathogen is not damaging, was comparable in this respect to suppressive soils

cont...

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Research Findings Summarised...*

*Behaviour of Pc in soils both suppressive and conducive to root rot*  
Broadbent & Baker (1974) (*Aust. J of Agricultural Research* 25(1): 121-137)

We should therefore ask:

1. Are the microbial components and/or general 'health' of the soil a major factor in plant resistance to Pc?
2. In our own testing and elsewhere, has soil 'health' been evaluated in those sites where Pc has been identified, and where tree death has been attributed to Pc?

Further, in another paper 'Certain soils in Queensland have a suppressive effect on Pc' the same authors state that:

*'Suppressive soils have a higher total nitrogen and calcium content and an abundant microflora and are high in organic matter'*

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Research Findings Summarised...*

### *Phytophthora Diseases Worldwide*

Erwin & Ribeiro 1996. APS Press, Minnesota.

1. Wet soils and temperatures of 26°C and above favour disease development
2. Severity of disease is reduced on sandy soils
3. High nitrogen levels in soil increase plant susceptibility to infection
4. Very wet or very dry soil conditions increase soil stress and increases susceptibility to Pc
5. In Western Australia, where summers are usually hot and dry, unseasonable high summer rainfall leading to waterlogging sees a concurrent increase in Pc activity

# PHYTOPHTHORA CINNAMOMI (Pc)

## ***Research Findings Summarised...***

*The origin and distribution of Phytophthora cinnamomi Rands in Australian native plant communities and the significance of its association with particular plant species*

Pratt & Heather (1973) in *Australian Journal of Biological Science* (26): 559-573

1. Although 90% of known diseases of woody plants are attributed to Phytophthora, tree death may also be due to the closely related genus Pythium or Fusarium
2. Fungal diseases are often associated with diseased plants, but are not necessarily causal (the symptom or the cause?)
3. Phytophthora is harder to detect and isolate than most other fungi, and its presence is often overlooked (or tests give different results at different times)

cont...

# PHYTOPHTHORA CINNAMOMI (Pc)

## ***Research Findings Summarised...***

*The origin and distribution of Phytophthora cinnamomi Rands in Australian native plant communities and the significance of its association with particular plant species*

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4. A negative result in soil tests does not necessarily mean that Pc is not present as it may not have been detectable in the soil sample (or may be at a different stage of its life cycle)
5. Phytophthora may infect the roots of healthy woody plants months or even years before foliage symptoms appear, and a tree may lose 50% of its lateral roots without loss of top growth

# PHYTOPHTHORA CINNAMOMI (Pc)

## ***Research Findings Summarised...***

*The origin and distribution of Phytophthora cinnamomi Rands in Australian native plant communities and the significance of its association with particular plant species*

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Detection methods:

1. If you are going to test for Pc, record other site characteristics as well and look for some correlation
2. To control Pc in the field, integrated control, involving a combination of cultural, biological and chemical methods, with the use of host-resistant plants should be used (Coffey 1992)

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Points Gleaned from the Research That we Should Pursue Further...*

### *Point 1:*

That Pc is probably (now) endemic in most soils in Australia, particularly those that have been altered in some way by past or present land uses; stressed by drought and/or un-seasonal rainfall, changes in macro and micro plant nutrient concentrations due to factors such as urban runoff.

Therefore:

**Assume that Pc is potentially present, and we must learn how to manage it more effectively**

### *Point 2:*

That soil with a healthy population of microflora appear not to show symptoms of dieback, even though Pc has tested positive

Therefore:

**Recognise that soil health seems to be a major factor, or at least an important contributing factor to managing Pc and initiate further research**

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Points Gleaned from the Research That we Should Pursue Further...*

### *Point 3:*

That management is required to contain known outbreaks and other measures (buffer zones, inoculation of susceptible trees with phosphite, hygiene) should be used to prevent spread of Pc

Therefore:

**Determine soil health and take remedial measures to improve conditions in highly susceptible areas, in areas with a high public profile or economic value (etc)**

**Information taken from elsewhere (eg foot & mouth outbreak in the UK)**

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Points Gleaned from the Research That we Should Pursue Further...*

### *Point 4:*

Hygiene measures designed to prevent spread of disease are relatively ineffective unless site is quarantined

Most disinfectants (viricides, fungicides etc) are rendered ineffective once they are contaminated by organic matter (e.g. mud)

Standard treatment for Pc (injection with phosphite) are to be regarded as preventatives in susceptible soils, and not used as a 'cure' for trees in decline.

Therefore:

**Is the implementation of the Pc protocols (as required) effective: is it simply a 'feel good' task; or (worse) does it provide an excuse for the authorities to take no further action?**

**Is the use of phosphite being applied strategically (e.g. to create a buffer zone)?**

# PHYTOPHTHORA CINNAMOMI (Pc)

## *Conclusions...*

### **My concerns:**

1. That the hygiene protocols as implemented will do nothing to address the root causes of tree death, and may well provide an excuse for non-action on the urban stormwater runoff problem
2. That having identified presence of Pc in a number of bushland reserves, further research and investigations into other causes of tree death will be suspended or ignored altogether

### **My recommendations:**

1. That investigations into 'soil health' be undertaken over a range of sites and that this experimental work be designed to reflect the outcomes of previous research, with all results to be quantifiable and statistically relevant