Journal of the Royal Society of Western Australia, 87:15–18, 2004

The occurrence and impact of *Phytophthora cinnamomi* in the central-western Avon Wheatbelt bioregion of Western Australia

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(Manuscipt received April 2003; accepted March 2004)

Abstract

Dieback, the expression of the disease caused by *Phytophthora cinnamomi* Rands, has been little studied in the lower rainfall areas of the South-West botanical province of Western Australia. Our survey of access routes within the Department of Conservation and Land Management's Narrogin operational district (in the central-western Avon Wheatbelt bioregion) identified four areas with dieback infestations from 21 state forest blocks (forming Dryandra Woodland), 11 nature reserves and one private property block. All infestations were restricted to water-gaining sites lower in the landscape or those that had been subject to high disturbance. Fifty soil and root tissue samples were taken, with 5 returning positive for *Phytophthora cinnamomi*. Eleven plant species were observed to be dead or dying in association with the infestation sites. *Banksia* spp and other deep-rooted species are recommended for soil and root tissue sampling in this region due to their deeper root systems being more likely to support the survival of *P. cinnamomi* in the drier months. To avoid the spread of *P. cinnamomi,* it is recommended that under moist soil conditions vehicles should be clean on entry to nature reserves and State Forest blocks, road maintenance works should not move soil from gullies, and that vehicle access tracks across boggy crossings should be avoided or built to provide a hard, all weather running surface.

Key words: *Phytophthora cinnamomi* dieback disease, Narrogin, Avon Wheatbelt, management.

Introduction

A soil borne pathogen, *Phytophthora cinnamomi* Rands is a significant threat to the native vegetation of Western Australia, with infestation resulting in the deaths of susceptible plant species and altering the ecology of plant communities (Shearer 1994). Now widespread in the higher rainfall areas of the South-West of Western Australia, *P. cinnamomi* is having a major impact on the ecology of the jarrah forest (*Eucalyptus marginata* Donn ex. Smith) (Shearer & Tippett 1989) and other vegetation communities of the South-West botanical province (Shearer 1994).

While there are a number of studies have examined dieback (the expression of the disease caused by *P. cinnamomi*) in the jarrah forest (Shea *et al.* 1983; Shearer & Tippett 1989; Shearer & Dillon 1995), little work has been done on the impact and distribution of the disease in the lower rainfall areas of the South West botanical province. Shearer & Tippett (1989) considered that rainfall distribution is partly responsible for the decreasing incidence of *P. cinnamomi* with distance east from the Darling Scarp (decreasing in rainfall with distance east).

This paper discusses the results of a broad scale survey of the distribution of dieback in the central-

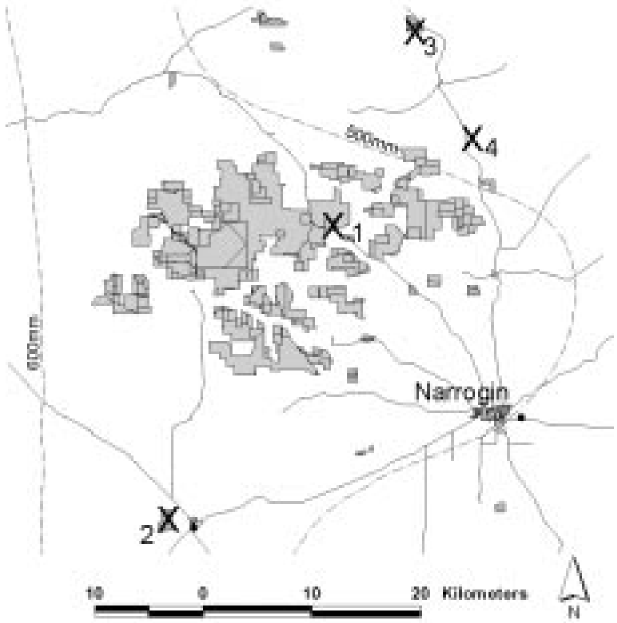

Figure 1. Location of the study area and infestations located in the central-western Avon-Wheatbelt bioregion of Western Australia. Shaded areas are State Forest or Nature Reserves; the dashed line is the maximum rainfall isohyet for Western Australia; crosses with numbers refer to site numbers from Table 1.

western Avon Wheatbelt bioregion covering the Department of Conservation and Land Management's (CALM) Narrogin operational district, approximately east of the 600 mm rainfall isohyet on the Darling Plateau (Fig 1). The area contains a number of nature reserves and the system of State Forest blocks that make up the Dryandra State Forest This work was undertaken to identify *P. cinnamomi* disease infestations and limit the risk of disease spread within the district. The impact of the disease and the species affected is also discussed.

Materials and Methods

Linear survey method

Due to the large size of the study area the 'linear survey' method (Anon 2001) was used to detect the disease symptoms caused by *Phytophthora cinnamomi* infestations. This involved slowly driving (less than 25 kmh^{-1}) or walking all accessible tracks within the forest block or nature reserve being considered, including boundary tracks along private property. Areas were mapped according their 'interpretability' for 25 m either side of the track. This technique is based on the premis that as an introduced pathogen, occurrence will generally be related to past disturbance or access routes. 'Interpretable' areas are those that have susceptible species in sufficient numbers to indicate whether the presence of *P. cinnamomi* can be adequately assessed (Anon 2001). 'Uninterpretable' areas are those where susceptible species are absent or too few in number to determine to the presence or absence of the disease. The boundaries of categories were marked using a handheld global positioning system unit (Garmin II plus). Sites with likely disease symptoms were examined on foot and a soil and root sample taken from dead or dying plants to confirm the presence of *P. cinnamomi*.

Soil and root samples

Fifty soil and root samples were taken from dead or dying susceptible plants, to a minimum depth of 30 cm (sterilised surface root samples were not taken). Samples were taken during April 2000 to May 2002. Axes and shovels were used to remove sections of root material and collect soil. All equipment used to collect the samples was sterilised before and after sampling with Methylated Spirits (95% v / v ethanol).

Sample baiting followed Marks & Kassaby (1974) where *Eucalytpus sieberi* F Muell cotyledons were used to determine whether the soil and root tissue samples were infested with *P. cinnamomi*. All samples were processed by the Vegetation Health service at CALM.

Infestation assessment

The impact at the *P. cinnamomi* infestations was assessed by determining the percentage of susceptible species that were dead or dying (see Anon 2001 for a list of susceptible species). Low impact refers to sites with few deaths; medium impact refers to scattered or <30% susceptible species deaths; high impact refers to sites with most susceptible species deaths (follows Shearer *et al*. 1997). At the Lol Gray infestation (Table 1, site 1) this was quantified using 10 x 10 m quadrats.

Voucher specimens were collected from dead and dying susceptible plant species at the Lol Gray infestation site. All specimens were submitted to the Western Australian Herbarium for incorporation into the collection.

Results

Infestations

Out of the 21 Dryandra Woodland blocks, 11 nature reserves and one private property, four dieback infestations were located (Fig. 1). All infestations were located on water-gaining sites (*i.e.* along a water course, drain or near a dam) or where there had been high disturbance in areas that were also low in the landscape. The infestation at Lol Gray State Forest in Dryandra Woodland was the largest at 16.4 ha (including a 10 m buffer). Three of the four infestations had low disease impact, while the Lol Gray State Forest, had low to high impact sites.

Susceptible species

Eleven susceptible plant species were recorded as dead or dying in association with the dieback infestations (Table 2). Other possible causes of death may include drought, roadside compaction of roots, or a combination of factors. These causes cannot be ruled out as a contributing factor in the deaths of species listed in Table 2. All are from plant families previously recorded as having species susceptible to dieback disease (Shearer & Dillon 1995) although six species are new to the *Phytophthora cinnamomi* dieback disease indicator species list (Anon 2001).

Table 1

Topograhical situation, soils / geology and disease impact for *Phytopthora cinnamomi* infestation locations.

Location	Topographical situation	Soils/ geology	Impact*
1. Lol Gray State Forest (Dryandra Woodland)	Lower slope beside drainage line and dam	Over granite	Low to High
2. Culbin Nature Reserve	Flat	Grey sand	Low
3. Hotham River Nature Reserve (8291)	Lower slope beside river	Grey sand	Low
4. Hotham River (private property)	Lower slope beside river	Grey sand	Low

* Low impact refers to sites with few deaths; medium impact refers to scattered or <30% susceptible species deaths; high impact refers to sites with most susceptible species deaths (follows Shearer *et al.* 1997).

Table 2

Susceptible species observed dead or dying in association with *Phytophthora cinnamomi* infestations in the Narrogin district.

Species	Family	Voucher No.	Site Impact +	% *
Allocasuarina ?huegeliana	Casuarinaceae	-	High	100%
Banksia cuneata #	Proteaceae	-	-	-
Banksia prionotes #	Proteaceae	-	Low to medium	-
Dampiera lindleyi	Goodeniaceae	LWS 1-9	Low	11%
Gastrolobium calycinum	Papilionaceae	LWS 1-8	Low to high	25- 90%
Hakea incrassata	Proteaceae	LWS 1-6	High	25%
Persoonia quinquenervis	Proteaceae	LWS 1-7	High	14%
Petrophile serruiae	Proteaceae	LWS 1-2	High	100%
Synaphea aff. *petiolaris*	Proteaceae	LWS 1-1	High	83%
Xanthorrhoea drummondii #	Xanthorrhoeaceae	LWS 1-3	Low to high	50%
Xanthorrhoea preissii	Xanthorrhoeaceae	-	Low	-

+ Low impact refers to sites with few deaths; medium impact refers to scattered or <30% susceptible species deaths; high impact refers to sites with most susceptible species deaths (follows Shearer *et al.* 1997). # returned a positive sample for *Phytophthora cinnamomi* when soil and root tissue samples were taken from around the base of plants at suspected infestations. Nomenclature follows Paczkowska & Chapman (2000). * within 10 m x 10 m quadrats.

% refers to dead and dying plants

Samples

P. cinnamomi was recovered from five of the 50 soil and root tissue samples taken from dead or dying plants across the study area,. The infestation at Hotham River (Table 1, site 4) had previously been identified from samples taken along the Pingelly to Narrogin highway (Shearer 1994).

Discussion

Shearer (1990, 1994) found that *Phytophthora cinnamomi* dieback disease impact is low in inland woodlands and shrub lands due to the low rainfall. Three of the four infestations located in our study area supported this finding. However we found that the level of impact in low rainfall areas can also be high, as observed at the Lol Gray infestation. At this site, a contributing factor may the granite outcropping (Table 1). Granite outcrops promote moisture runoff after rainfall or fog events (York Main 1997) and possibly there is some under-surface moisture accumulation; moisture is a key factor in the biology of the disease (Shearer & Tippett 1989). This effect may be comparable to the effect of concreted duri-crust layers of the jarrah (*Eucalyptus marginata* Donn ex Sm.) forest where zoospores are transmitted laterally over the layer (Shea *et al*. 1983).

No infestations were observed away from low land and/or water-gaining or highly disturbed sites (Table 1). In this bioregion it is unlikely that there is sufficient moisture throughout the year to sustain an upland *P. cinnamomi* infestation. Kuhlman (1964) found that *P. cinnamomi* was unable to survive in dry soils. When screening for *P. cinnamomi* we therefore recommend taking soil and root tissue samples from deep-rooted plants such as *Banksia* spp. Moisture in roots and soil is likely to be higher deeper in the soil profile.

Management recommendations

1. In winter and spring or under moist soil conditions (where clumps of soil may attach that may carry propagules) vehicles should be cleaned down on entry into reserves and State Forest blocks to remove soil and root material underneath.
2. Road maintenance activities should avoid relocating soil from gullies and water-gaining sites.
3. Vehicle access tracks that cross gullies or areas of muddy sticky soils should be constructed to allow natural drainage. Track running surfaces should remain hard and not conductive to soil adhering to vehicles.

Acknowledgements: Thanks to Greg Durell (CALM Narrogin), Janet Webster, Nola D'Souza (CALM Vegetation Health Service) and Martin Rayner (CALM Bunbury). Funding for this work was supplied by the Western Australian Salinity Strategy: Crown Reserve Program.

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