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Emerging Pathogens in the Revegetation Industry:

Phytophthora species

Canker

Myrtle rust

Colin Crane

Aims

Brief description of the major diseases that have helped shaped the Western Australian flora

Look at the genus Phytophthora and emerging species

Emerging canker disease pathogens

Overview of the Myrtle rust invasion of Australia

Disease -

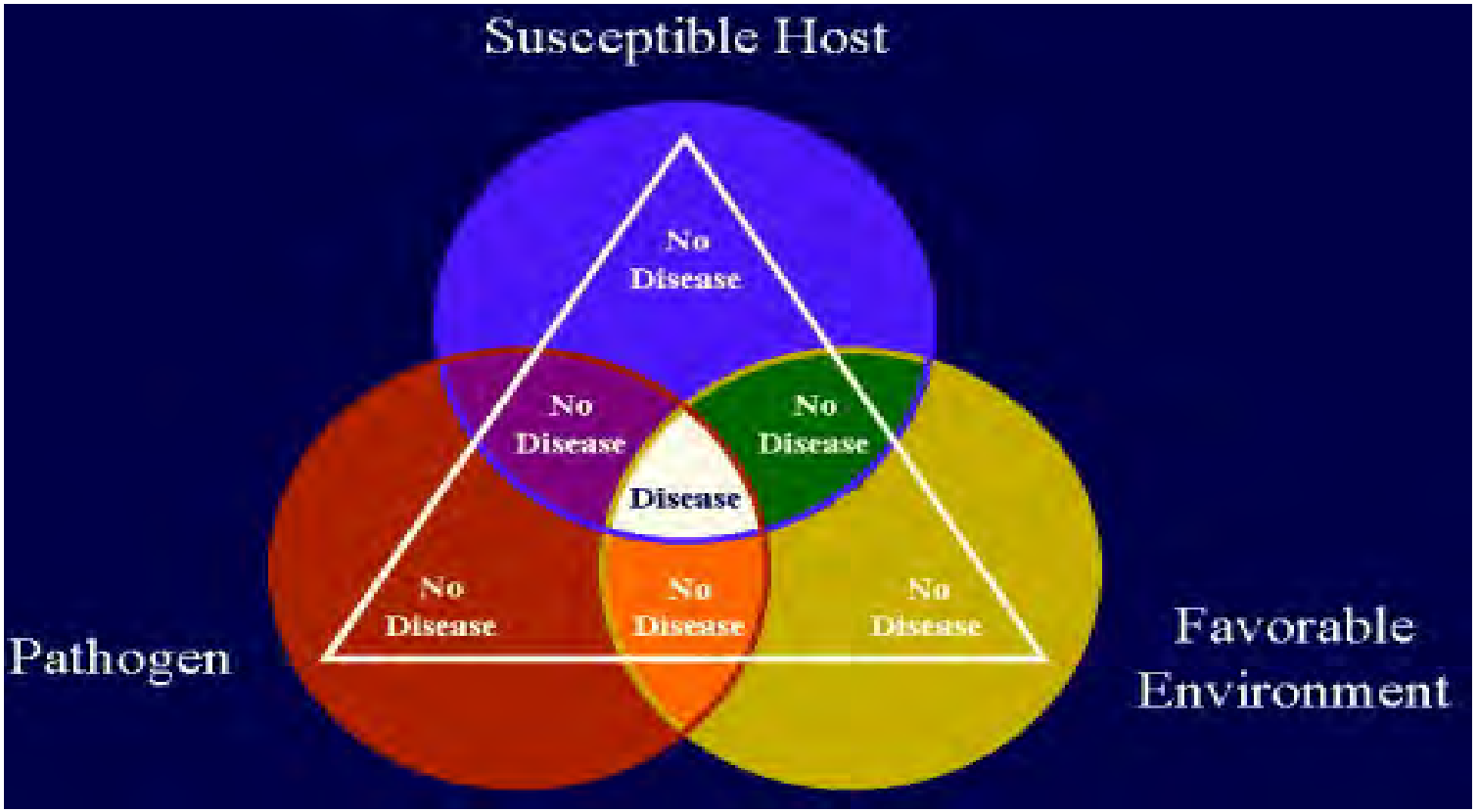
Result of an infectious organism (pathogen) that can multiply, spread to nearby plants, interact with the environment and host plant to produce plant injury with characteristic symptoms.

For biotic plant disease to occur:

The host must be susceptible

A pathogen must be present

The environment must be favourable



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Journal of the Royal Society of Western Australia, 77: 113-122, 1994

The major plant pathogens occurring in native ecosystems of south-western Australia

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Abstract

Objective assessment of the relative importance of pathogens on conservation and production values in native plant communities of south-western Australia is impeded by the lack of systematic disease surveys. The occurrence of diseases and pathogens on Western Australian native plants was compiled from published information, other reports and personal databases. Pathogens were databased according to name, host name and family, disease group and Botanical Province, giving a total of 936 entries that did not include reports of pathogens on hosts in nurseries. Ninety-one per cent of the pathogen reports were from the South-West Botanical Province and 2% from each of the Eremaean and Northern Botanical Provinces. Bacterial diseases, galls, downy and black mildews, ergot and leaf moulds were infrequently reported on native plants. Pathogens were infrequently reported on species within the families: Aizoaceae, Amaranthaceae, Amaryllidaceae, Annonaceae, Anthericaceae, Apocynaceae, Arecaceae, Asphodelaceae, Cupressaceae, Cyperaceae, Dennstaedtiaceae, Geraniaceae, Juncaceae, Lamiaceae, Linaceae, Loganiaceae, Olacaceae, Onagraceae, Phormiaceae, Pittosporaceae, Podocarpaceae, Polygonaceae, Portulacaceae, Rubiaceae,

Major pathogens are fungi – 3 main groups

Diseases caused by species of *Phytophthora*

Diseases caused by canker fungi

Diseases caused by *Armillaria luteobubalina and other basidiomycetes*

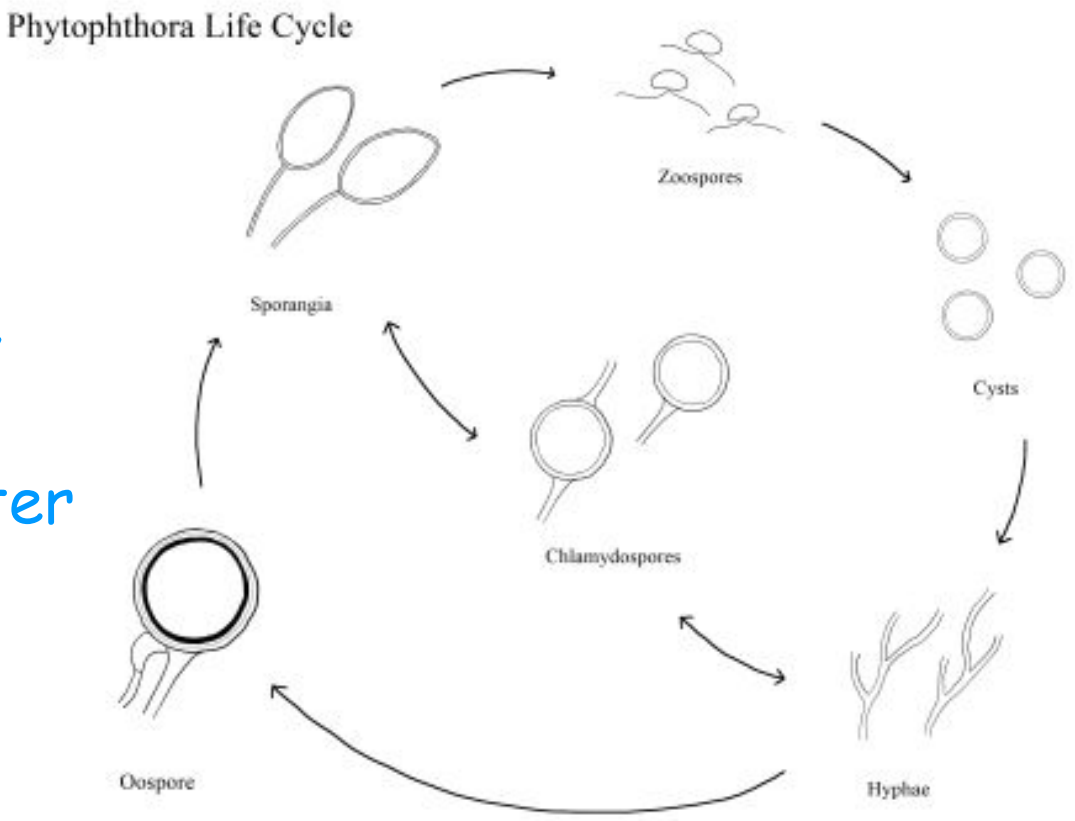
Phytophthora

soil borne

infection & spread by

movement of soil, water

& roots



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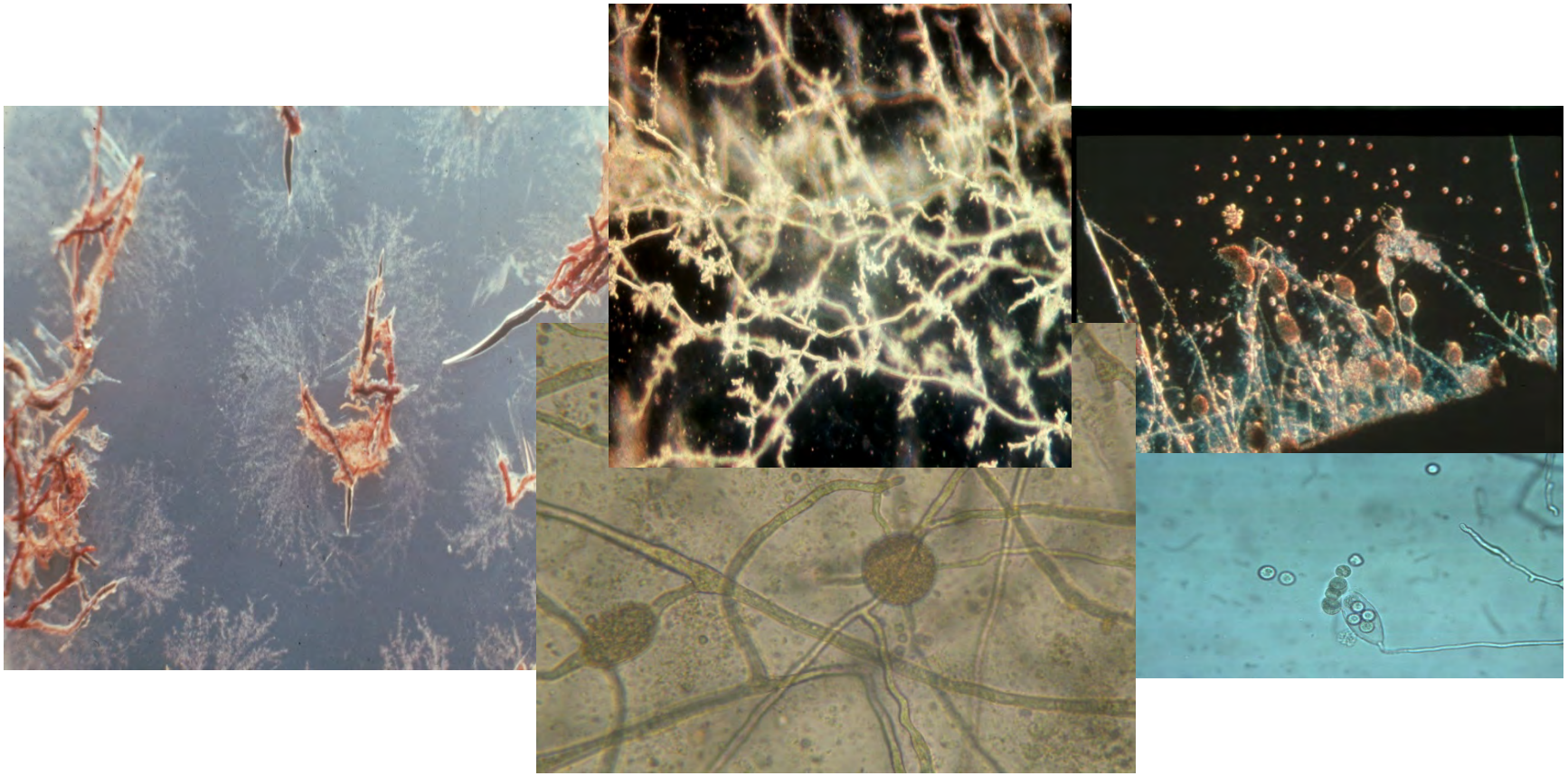
Phytophthora



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Phytophthora

Pc - *Banksia occidentalis* Cape Arid National Park

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Phytophthora

Pc - West of Eneabba

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Phytophthora spp.

What are cankers?

An artificial grouping of organisms that kill plant cambium tissue

Mainly caused by fungi but also bacteria, mycoplasmas and viruses

Symptoms include dead leaves, twigs and branches

Sometimes kill whole plants and change entire communities

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Cankers
kill cambial tissue

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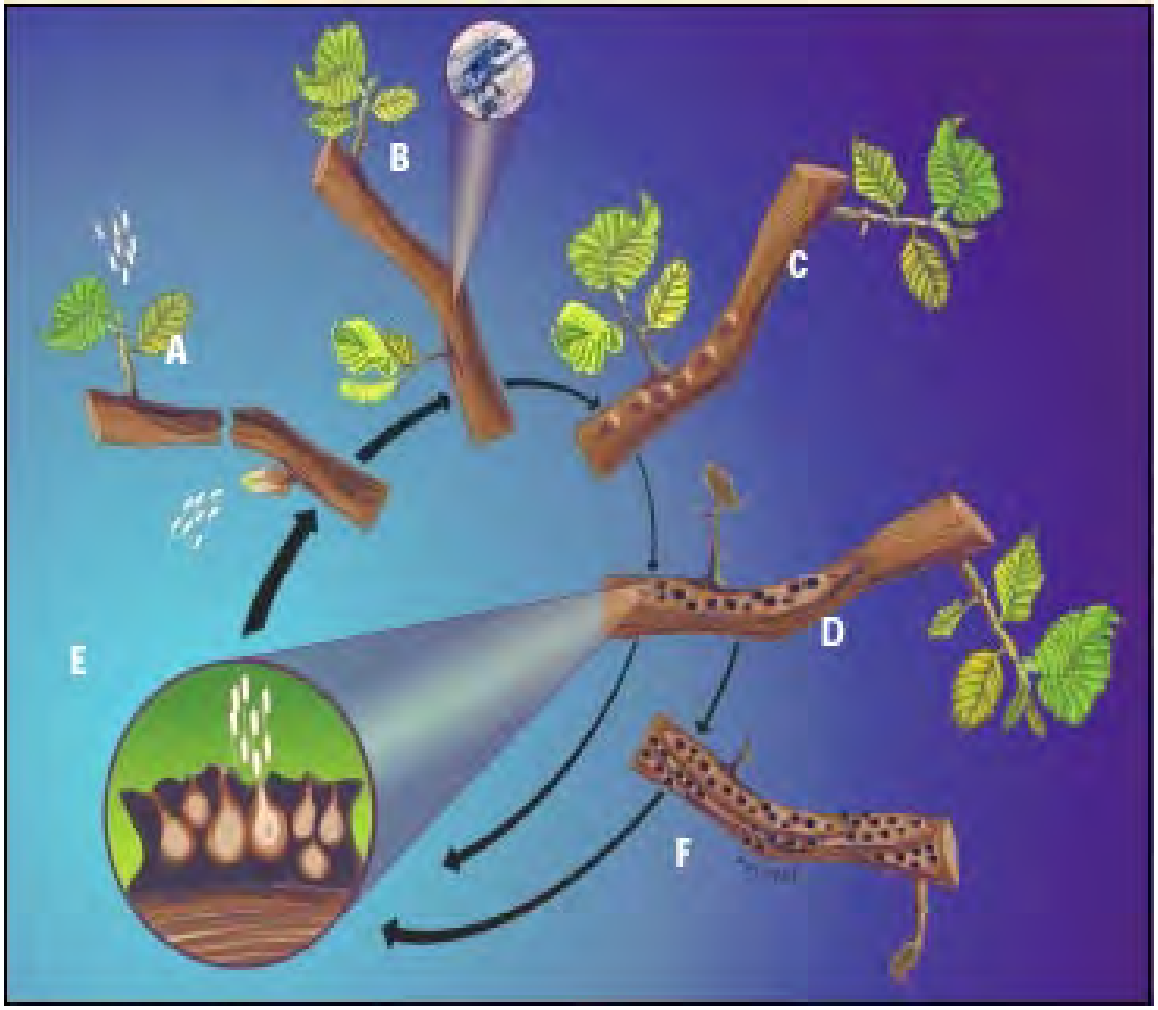
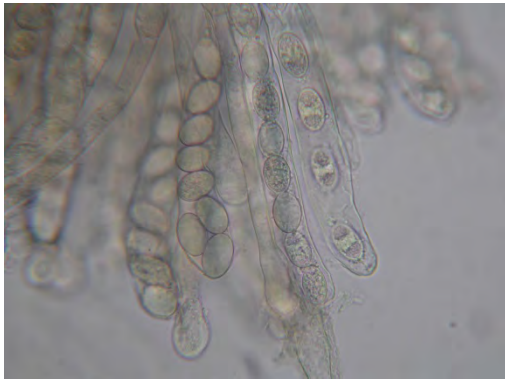
Cankers

Cankers microscopically exposed



Majority are ascomycete fungi
Air borne
Infection & spread by wind and water splash



Canker diseases of South Western Floristic Region

Marri canker – Quambalaria spp.

Cankers of Proteaceae – *Neofusicoccum* spp., *Luteocirrhus* sp. & *Cryptodiaporthe* sp.

Cankers of Eucalypts – *Neofusicoccum* spp. many others

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Canker diseases of South Western Floristic Region

Marri canker – Quambalaria spp.

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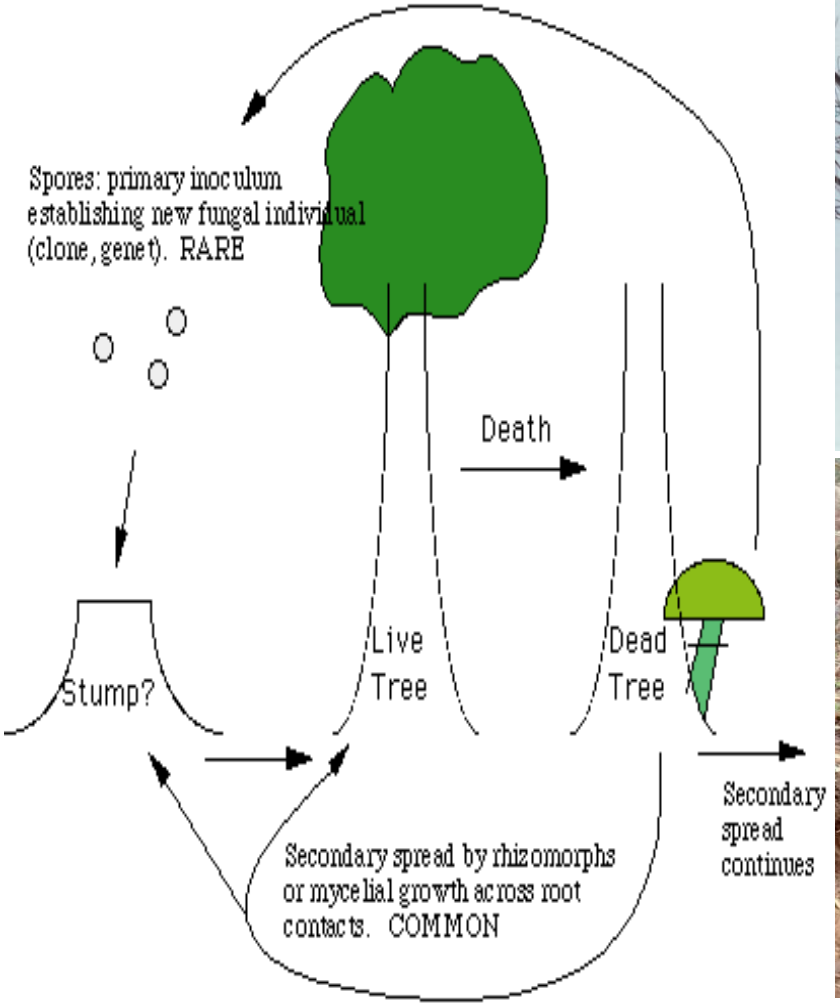
Armillaria luteobubalina

Infection & spread: air, roots



Armillaria luteobubalina (native)

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Other basidiomycetes

eg. *Omphalotus nidiformis*

causing disease in *Banksia speciosa* stand

Emerging Pathogens?

Because we have only just become aware of the pathogen

Because they are exotic introductions

Because the environment is changing altering impact

Because of a genetic shift in the host or pathogen

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Persoonia 25, 2010: 50–60
www.persoonia.org

OPINION ARTICLE

doi:10.3767/003158510X548668

A case for re-inventory of Australia's plant pathogens

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Key words

disease associated fungi
disease threats
molecular phylogeny
quarantine
taxonomy

Abstract Australia has efficient and visible plant quarantine measures, which through various border controls and survey activities attempt to prevent the entry of unwanted pests and diseases. The ability to successfully perform this task relies heavily on determining what pathogens are present and established in Australia as well as those pathogens that are exotic and threatening. There are detailed checklists and databases of fungal plant pathogens in Australia, compiled, in part, from surveys over many years sponsored by Federal and State programmes. These checklists and databases are mostly specimen-based, which enables validation of records with reference herbarium specimens and sometimes associated cultures. Most of the identifications have been based on morphological examination. The use of molecular methods, particularly the analysis of DNA sequence data, has recently shown that several well-known and important plant pathogenic species are actually complexes of cryptic species. We provide examples of this in the important plant pathogenic genera *Botryosphaeria* and its anamorphs, *Colletotrichum*, *Fusarium*, *Phomopsis* / *Diaporthe* and *Mycosphaerella* and its anamorphs. The discovery of these cryptic species indicates that many of the fungal names in checklists need scrutiny. It is difficult, and often impossible, to extract DNA for sequence analysis from herbarium specimens in order to validate identifications that may now be considered suspect. This validation can only be done if specimens are recollected, re-isolated and subjected to DNA analysis. Where possible, herbarium specimens as well as living cultures are needed to support records. Accurate knowledge of the plant pathogens within Australia's borders is an essential prerequisite for the effective discharge of plant quarantine activities that will prevent or delay the arrival of unwanted plant pathogens.

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Phytophthora DATABASE

Species List

Provisional species

There are 116 formally described species.

save	116	species	Species name	The number of isolates
1	200			
	3		Chk	
☐			*Phytophthora alni subsp. alni*	19
☐			*Phytophthora alni subsp. multiformis*	1
☐			*Phytophthora alni subsp. uniformis*	1

WWW.PHYTOPHTHORADB.ORG

There are 21 provisional species.

Chk	Species name	The number of isolates
☐	*Phytophthora* sp. *"brasiliensis"*	7
☐	*Phytophthora* sp. *"canalensis"*	1
☐	*Phytophthora* sp. *"cuyabensis"*	5
☐	*Phytophthora* sp. *"erwinii"*	1
☐	*Phytophthora* sp. *"hungarica"*	1
☐	*Phytophthora* sp. *"kelmania"*	

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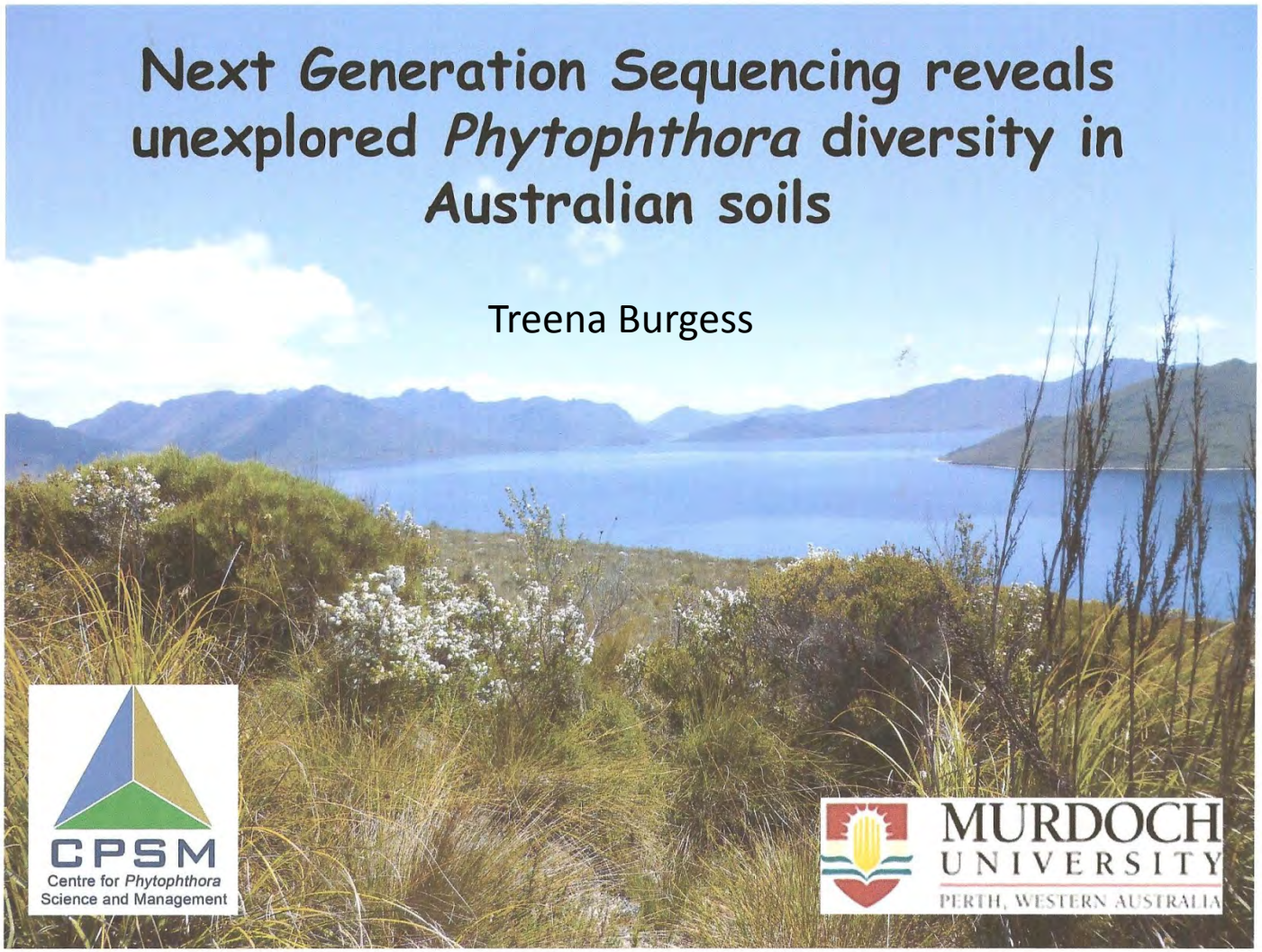
Next Generation Sequencing reveals unexplored *Phytophthora* diversity in Australian soils

Treena Burgess



Phytophthora
most common species

NSW	VIC	TAS	WA
multivora	*multivora*	*multivora*	*multivora*
arenaria	*arenaria*	*arenaria*	*arenaria*
cinnamomi	*cinnamomi*	*cinnamomi*	*cinnamomi*
taxon acerina	taxon acerina	taxon acerina	*nicotianeae*
cryptogea	*cryptogea*	*nicotianeae*	aff. ohioensis
elongata	aff. ohioensis	aff. ohioensis	*elongata*
thermophila	*amnicola*	*cryptogea*	taxon acerina
aff. ohioensis	*elongata*	*thermophila*	*cryptogea*
taxon stagnum	*thermophila*	*fallax*	*thermophila*
inundata	taxon stagnum	*amnicola*	taxon niederhauseri

Phytophthora taxa detection in different States

	NSW	VIC	TAS	WA
number of samples	91	46	148	88
number of taxa	32	21	29	38
taxa per site	0-14 (av. 5.1)	0-14 (av. 8.2)	0-10 (av. 3.6)	0-14 (av. 6.4)
number of geographic regions	9	3	9	9
average number of taxa per region	14	14.7	10.8	17.6
number of unique taxa (to State)	3	1	3	8
number novel taxa	2	0	5	7
number unreported taxa (for Australia)	11	4	10	16

- Profiles from roots and soil differ, but perhaps not as much as we expected; this will be explored in more detail
- there are some species associations with rainfall and temperature and this will be further examined with PCA analysis
- there are new species, but need to be very careful with 454 data to ensure that these are not chimeras; need to bait soil and obtain isolates (if possible)
- there may be unculturable species
- *P. europea* found in Tasmania and NSW, but only in altitudes of over 1000m
- *P. fallax* found in all regions so far examined; *P. captiosa* at a single site in Western Woodlands of WA (no *P. kernoviae* or *P. pluvialis*)
- many known pathogens such as *P. cinnamomi* and *P. multivora* isolated from sites with no disease expression
- *P.* aff. ohioensis first isolated in WA in 2010, but it is one of the most widespread species, probably missed previously because it is slow growing
- drawback in ITS1 region is that some species cannot be separated, drawback of DNA extraction is that organism could be dead

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Phytophthora spp. cultured in WA by Vegetation Health Service at August 2014 (41000 + samples)

CAUSAL ORGANISM(s):

P.amnicola
P. aspargi
P. arenaria
P'. bilorbang
P. boehmeriae
P. cinnamomi (introduced)
P. constricta
P. cryptogea
P. elongata
P. fluvialis
P. gibbosa
P. gregata
P. inundata
P. sp. kelmania
P. lacustris
P. litoralis
P. multivora
P. megasperma
P. nicotianae
P. niederhauserii
P. palmivora
P. rosacearum
P. taxon PgChlamydo
P. taxon personii
P. thermophila

+ at least 7 other species awaiting description

Total 32

Some *Phytophthora spp* emerging?

Because we have only just become aware of the pathogens

Because they are exotic introductions?

Because the environment is changing altering impact?

Emerging Cankers?

Marri canker found in *Corymbia* spp. of Southwest W.A.

Cankers of Proteaceae

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Cankers

Marri canker

BULLETIN NO.3

Centre of Excellence for
Climate Change, Woodland & Forest Health

RESEARCH FINDINGS 2012

www.foresthealth.com.au

TRUDY PAAP • JEN MCCOMB • BRYAN SHEARER • TREENA BURGESS • GILES HARDY

The fungal pathogen Quambalaria coyrecup has been identified as the causal agent of marri canker disease and is thought to be an endemic (native) pathogen. The reasons for this recent disease epidemic are undetermined, however the Centre has recently been awarded a three year ARC linkage grant to explore the underlying causes of marri decline in the south west and help formulate management solutions.

Identifying marri canker disease

Introduction

A severe canker disease has been contributing to decline in marri (*Corymbia calophylla*) for some years now. Cankers are a symptom caused by the death of areas of bark and the cortex tissue below that, and are caused by the plant pathogen *Quambalaria coyrecup*. The canker is present on trunks, branches and twigs of trees of all ages.

Canker disease occurs on marri across the natural range of this tree in south west WA. It also affects amenity-planted red flowering gum (*C. ficifolia*). Once canker symptoms are evident, trees do not appear to be able to recover, and given the large number of infected trees, the future health of marri in south west WA is of serious concern.

Identifying the symptoms

The canker disease can easily be recognised by the following identifying symptoms:

The bark surrounding the affected area cracks and is eventually shed. Large amounts of kino (gum) are produced, staining the limb or trunk dark red.

Large target-like lesions are formed as a result of a progressive 'tug-of-war'. The tree produces a defence response that 'walls off' the diseased region, but with time the fungus manages to penetrate this barrier and reinvade.

The pathogen Quambalaria coyrecup is sometimes observed sporulating on the diseased area, visible as a powdery white mass. This contains many millions of spores that can be spread by rain splash, wind, insects and pruning.

Once the disease has progressed to the point of girdling the host, it has effectively ring barked the tree, resulting in the death of the affected limb or the entire tree if the trunk has been girdled. Observe the 'target like' scarring around the trunk.

A SERIES OF BULLETINS OUTLINING KEY RESEARCH FINDINGS ASSOCIATED WITH WOODLAND HEALTH IN SOUTH-WEST WESTERN AUSTRALIA

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Quambalaria sp. in *Corymbia ficifolia*

Cankers

Quambalaria spp. found in *Corymbia* spp. of Southwest W.A.

Q. coyrecup – marri canker

Q. pitereka – leaf and shoot blight
In WA since 1993 & widespread by 2005, causing leaf and shoot blight

Q. cyanescens - always found in association with *Q. pitereka* or *Q. coyrecup*, or from asymptomatic tissue

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Canker

C. melanocraespeda in *Banksia coccinea*

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Canker *C. melanocraespeda* in *Banksia coccinea*

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Canker *L. shearii* in *Banksia verticillata*

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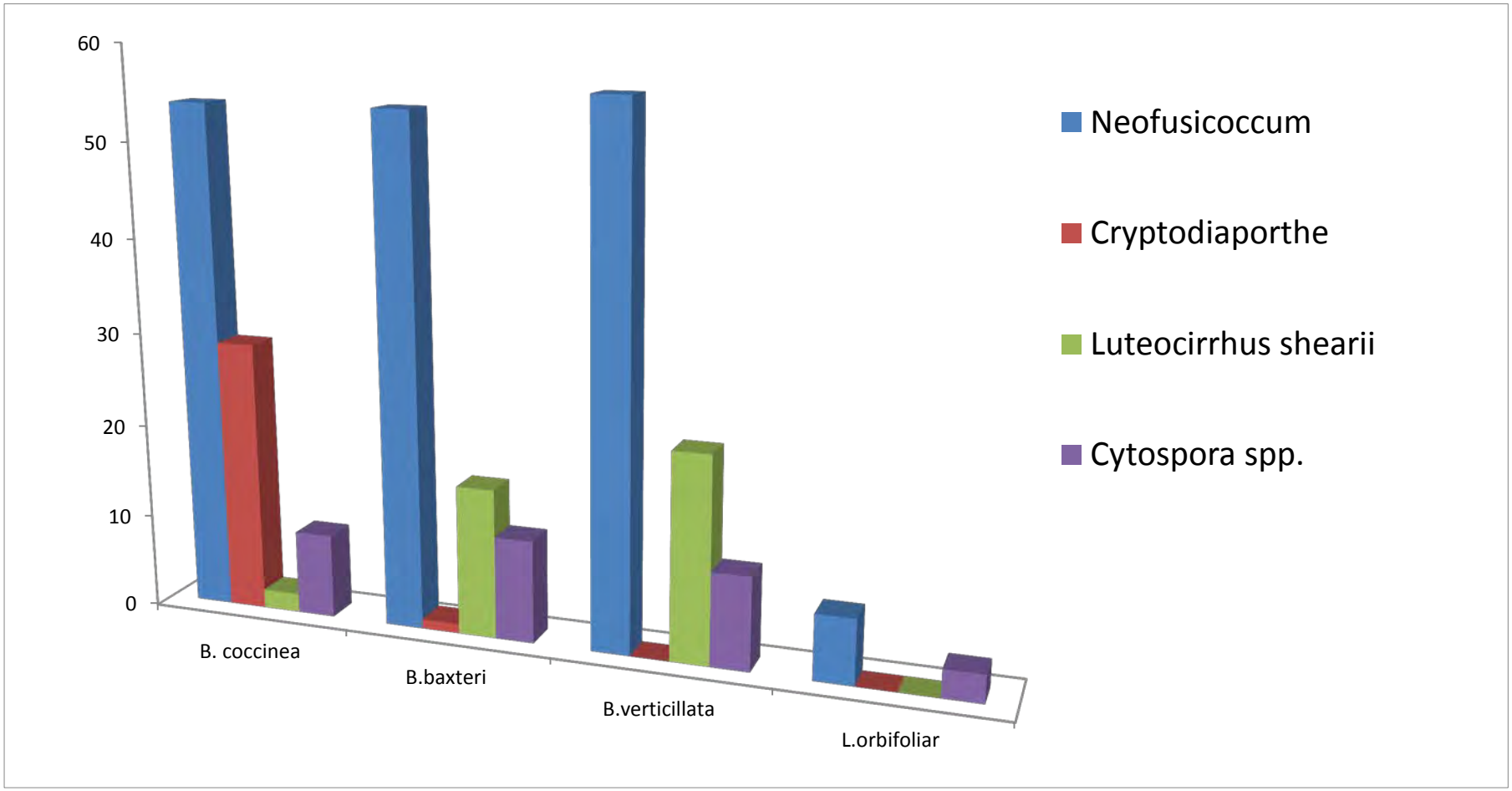
Canker pathogens of Proteaceae - Isolation frequency from cankered twigs



540 individual cankers

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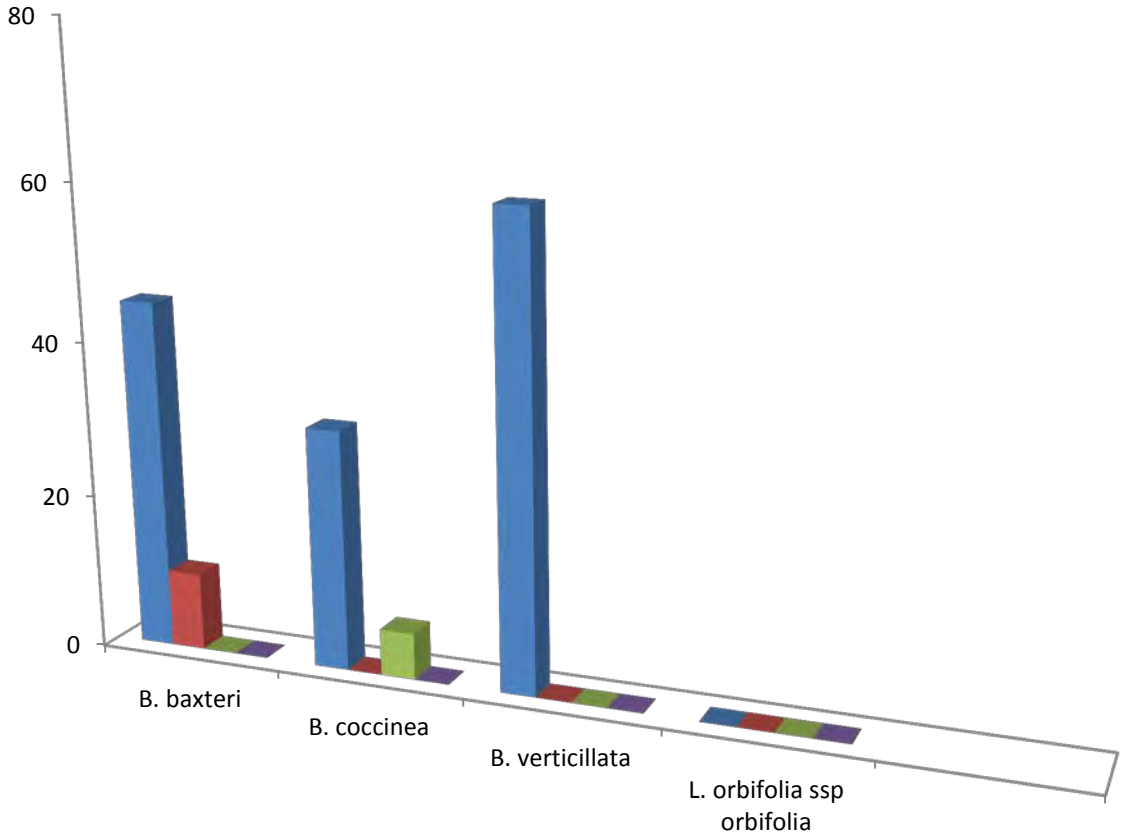
Canker pathogens - isolation frequency from healthy asymptomatic plants/tissue



46 individual twigs

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Canker

26

Influence of climate on canker disease in the Proteaceae of the Southwest Australian Floristic Region

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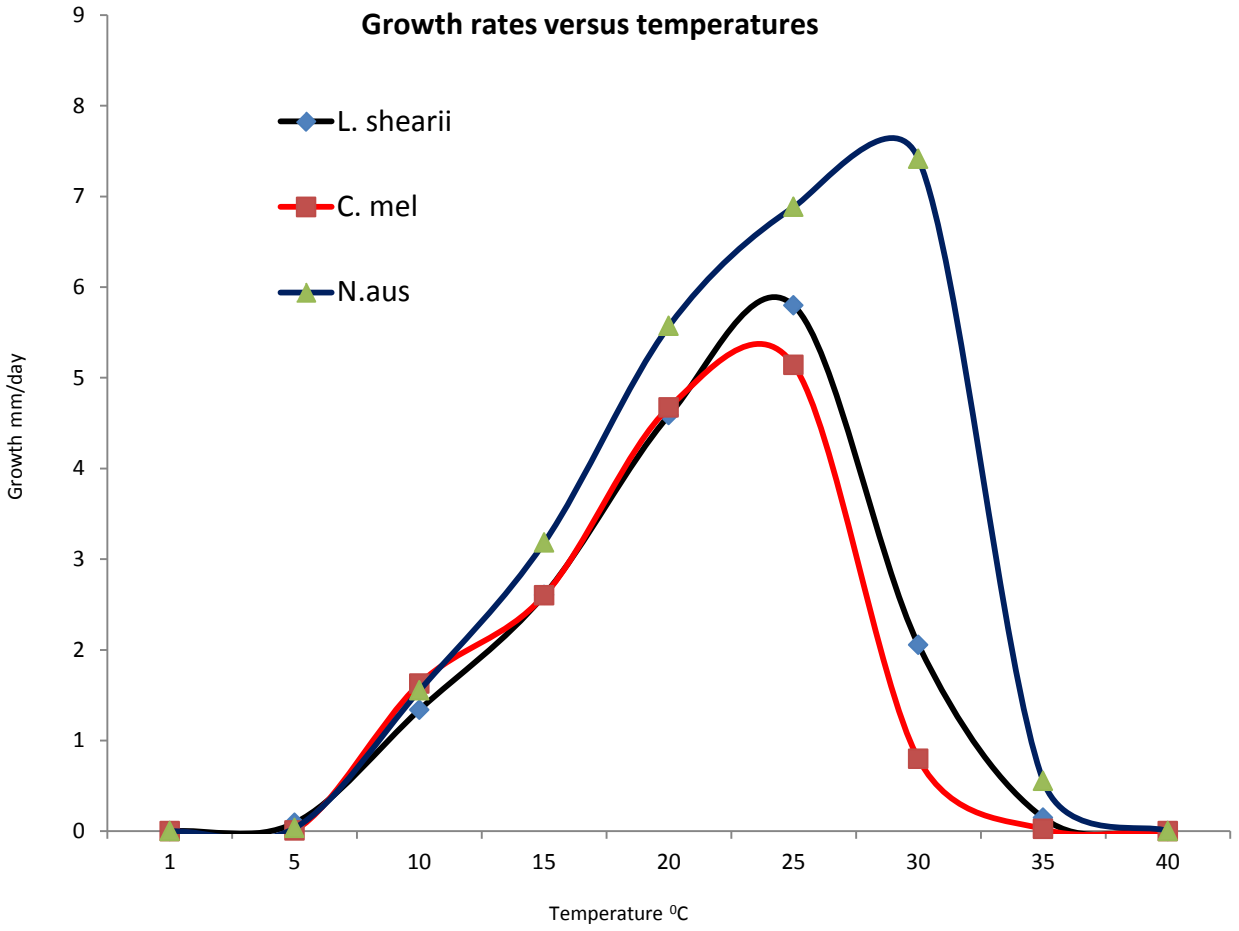
The incidence and severity of plant canker diseases caused or associated with fungi and other endophytes has been steadily increasing worldwide. Climate change is seen as the driving force in the apparent emerging pathogenicity of these normally minor diseases. The contribution of canker to stem and branch death in the Southwest Australian Floristic Region (SWAFR) is poorly documented and understood. *Banksia verticillata* and *Lambertia orbifolia*, both *Threatened* and endemic to the SWAFR, are currently being severely impacted by canker disease. Transects were established in populations of *B. baxteri*, *B. coccinea*, *B. verticillata* and *L. orbifolia* populations to quantify and monitor canker severity and impact, with 1,620 individuals assessed across 32 sites. Climate as interpolated rainfall, temperature, humidity, and actual temperature and humidity data for sites covering the northern and southern rainfall extremities were used for comparison against canker impact scores in an attempt to develop predictive ability in climate change scenarios. The most frequently isolated pathogenic canker fungi were in the *Botryosphaeria* complex, a putative *Zythiostroma*, *Cryptodiaporthe* and *Cytospora* spp. respectively. All except *Cytospora* spp. have been isolated at a low level from healthy asymptomatic tissue suggesting that they have some degree of benign endophytic role and that the environment is shifting the host-pathogen relationship to a more aggressive one. Co-occurrence of several of the pathogens in single canker lesions demonstrates a synergism in canker disease expression that will impact the distribution of some proteaceous species in the SWAFR. Systemic fungicides were also investigated as control options for the four main canker fungi as part of an integrated pest management approach.

Canker score / climate variables correlations



Some canker spp emerging?

Because we have only just become aware of the pathogens

Because they are exotic introductions?

Because the environment is changing altering impact

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Myrtle rust

Acacia gall rust - *Uromycladium tepperianum* species complex

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Myrtle rust

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Myrtle rust

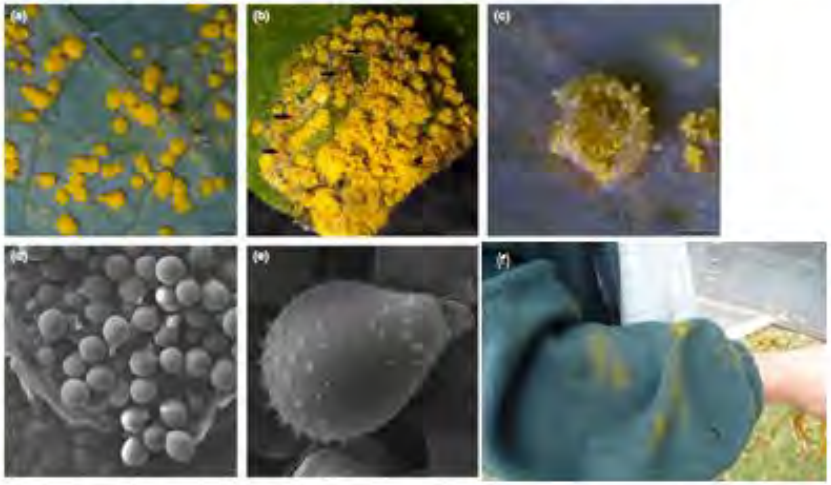
Custodian: Plant Diseases Program Coordinator
Approved by: Manager Environmental Health Branch - FEMD
Last updated: 16 July 2014

Department of
Parks and Wildlife

What is Myrtle rust?

- It is a disease of plants caused by a **fungus** called ***Puccinia psidii***, which originated in South America
- You may sometimes hear it referred to as 'Eucalyptus Rust' or 'Guava Rust' but in Australia it is commonly referred to as **Myrtle rust**

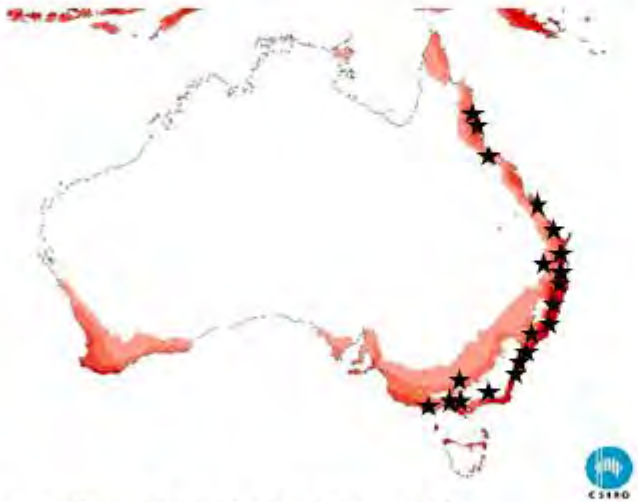
Myrtle rust on young leaves and shoot
Photo credit: Louise Morin, CSIRO



Myrtle rust at increasingly higher magnifications
(a-c) spore masses on leaves (scale bar is 0.5 mm)
(d) individual spores (scale bar 0.02 mm)
(e) single spore (scale bar 0.005 mm)
(f) spores look a bit like pollen on this jumper!!
Photos credit: (a) to (e) Geoff Pegg, DAFF Qld; (f) Department of Primary Industries, Vic

Where does Myrtle rust occur in Australia?

- **It is not in WA**...and we don't want it either!
- It was first detected in NSW in 2010 and has spread rapidly along the east coast since then



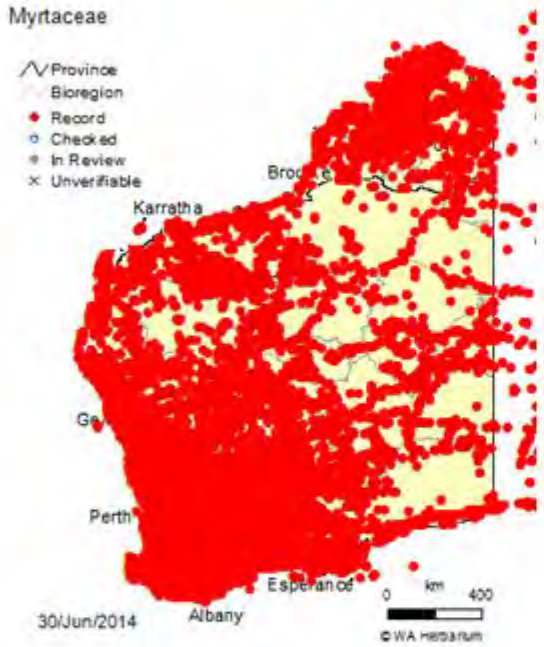
Areas where Myrtle rust occurs in Australia ★

Image credit: Darren Kriticos CSIRO

The red dots represent Myrtle rust – notice how quickly it spread in 18 months...over 1,700 km!!

Image credit: Geoff Pegg, DAFF Qld

What plants does Myrtle rust affect?



The red dots on this map show the distribution of myrtaceous plants in WA

Image credit: Florabase

- It affects plants from the **Myrtaceae Family**

- There are over 1,500 native Myrtaceae species in WA – **which could make Myrtle rust as big a scourge as Phytophthora Dieback if it were to arrive and become established in the State!**

What WA plants could be affected?

Scientific name	Common name	Susceptibility	
		Field	Lab
Agonis flexuosa	WA Peppermint	ES	
Beaufortia schaueri	Pink Bottlebrush		ES
Beaufortia sparsa	Swamp Bottlebrush		ES
Chamelaucium uncinatum	Geraldton Wax	ES	
Darwinia citriodora	Lemon-scented Darwinia		ES
Calothamnus quadrifidus	One-sided Bottlebrush	S	S
Corymbia ficifolia	Red-flowering Gum		S
Eremaea asterocarpa		S	
Eremaea pauciflora		S	
Eucalyptus cladocalyx	Sugar Gum		S
Eucalyptus diversicolor	Karri		S
Eucalyptus gomphocephala	Tuart		S
Eucalyptus marginata	Jarrah		S
Eucalyptus occidentalis	Flat-topped Yate		S
Eucalyptus wandoo	Wandoo		S
Eugenia reinwardtiana		S	
Hypocalymma angustifolium	White Myrtle	S	
Kunzea baxteri	Baxter's Kunzea		S
Leptospermum rotundifolium	Round Leaf Tea-tree	S	S
Melaleuca leucadendra	Broad leaved Paperbark	S	S
Melaleuca linariifolia	Flax Leaf Paperbark	S	S
Melaleuca nervosa	Paperbark	S	
Melaleuca viridiflora	Broad Leaved Tea Tree	S	
Pericalymma ellipticum	Swamp Teatree		S
Regelia ciliata			S
Regelia velutina	Barrens Regelia		S
Syzygium angophoroides	Watergum	S	
Syzygium eucalyptoides		S	
Thryptomene saxicola	Rock Thryptomene	S	
Verticordia chrysantha	Yellow Featherflower	S	

ES = extremely susceptible
S = susceptible

Thanks to the work of researchers in eastern Australia we have information on the susceptibility to Myrtle rust of a **handful** of the WA myrtaceous species.

Photos (a) and (b) credit: Geoff Pegg, DAFF Qld; (c) internet

How could Myrtle rust enter WA?

The potential for Myrtle rust entering WA is considered **high** and there are many potential pathways.

Myrtle rust spores can be spread by wind and animals but the introduction of the pathogen to WA is **more likely to result from human-mediated spread** such as:

- Bringing infected nursery stock into WA (which is why Myrtle rust has been declared a quarantine pest for WA and in May 2010 DAFWA prohibited, under the BAM Act 2007, the import of all Myrtaceae plants and parts of plants to WA)
- Vehicles, freight containers, equipment, clothing etc. contaminated with Myrtle rust spores coming into WA

Consequently, **the major risk entry points are airports, shipping ports, plant nurseries and arterial roads from eastern Australia**

National Parks and Reserves that attract a lot of eastern states tourists will also be at risk

Photo credit: Department of Primary Industries, Vic

Potential environmental impacts of Myrtle rust in WA?

Photos credit: Geoff Pegg, DAFFQld

The impact of Myrtle rust on the eastern seaboard is in its early stages but indicates that the pathogen is affecting:

- plant succession
- regeneration of seedlings
- flower production
- fruit production and quality
- the growth rate of trees and their structure
- death of adult and young plants through repeated attack on the young foliage
- failure of buds
- prevalence of insect attack

Consequently, if Myrtle rust enters WA we could expect significant detrimental changes to our flora with flow-on effects to our fauna.

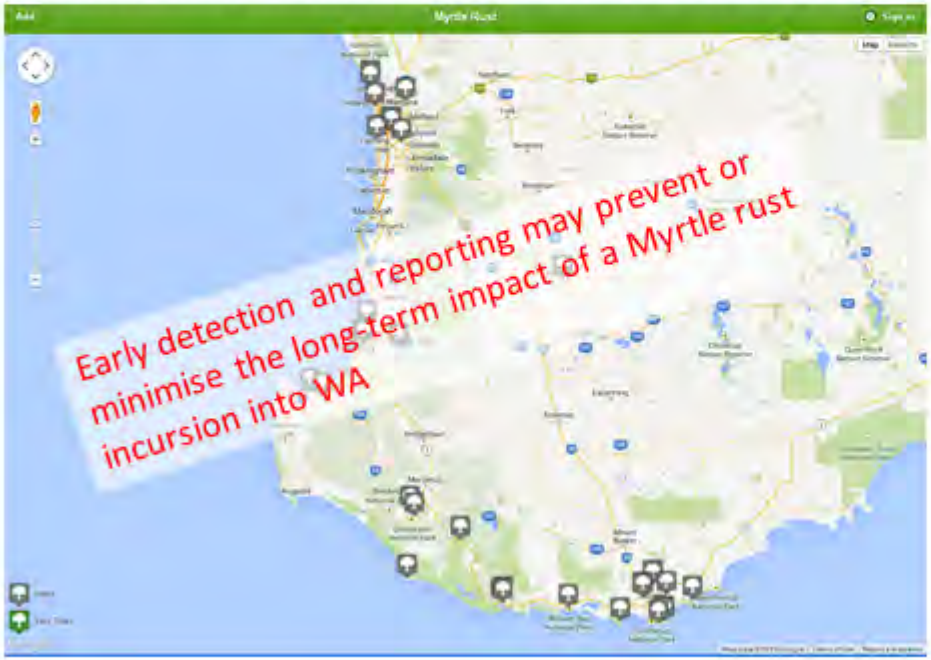
What is Parks & Wildlife doing about Myrtle rust?

- Working with DAFWA and other agencies to develop a State Contingency Plan
- Webpage on Parks and Wildlife internet site http://www.dpaw.wa.gov.au/management/pests-diseases/206-myrtle-rust
- Development of a departmental Preparedness Plan, and Standard Operating Procedures (more about these later)
- Awareness raising
- Distribution of Myrtle Rust Emergency Response Kits

Kit No.	Region	Location	Contact
1	Kimberley	Kununurra	Corinn Everitt
2	Kimberley	Broome	Corinn Everitt
3	Midwest	Geraldton	Anthony Desmond
4	Swan	Perth Hills	Bob Huston
5	Swan	Kensington	Emer O'Gara
6	South Coast	Albany	Greg Freebury
7	South Coast	Esperance	Stephen Butler
8	South West	Bunbury	Peter Blankendaal
9	Warren	Manjimup	Brad Barton

What can you do?

1. Keep an eye out for Myrtle rust – **spring is a prime time** for the yellow spores
2. Know what you are looking for and what to do if you see it
3. Promote this presentation to your staff and colleagues



4. Participate in the surveillance program by registering a myrtaceous plant near your home/office on the DAFWA Myrtle rust 'Adopt-a-Tree' site http://agspsrap31.agric.wa.gov.au/myrtlerust/

If you have problems registering please let Emer O'Gara know on emer.ogara@dpaw.wa.gov.au

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What to do if you see Myrtle rust?

1. **Do not** take a sample or touch it because the spores can be easily spread
2. **Do** take photos of the symptoms and the plant, and precise details about the location
3. **Do** contact the Exotic Plant Pest Hotline on Freecall 1800 084 881
4. **Do** contact the relevant Parks and Wildlife District Manager
5. **Do** contact the Parks and Wildlife Environmental Health Branch:

Plant Diseases Program Coordinator
Emer O'Gara
emer.ogara@dpaw.wa.gov.au
0429 885 240

Environmental Health Branch Manager
Bob Hagan
bob.hagan@dpaw.wa.gov.au
0427 776 110

Early detection and reporting may prevent or minimise the long-term impact of a Myrtle rust incursion into WA

Custodian: Plant Diseases Program Coordinator
Approved by: Manager Environmental Health Branch - FEMD
Last updated: 16 July 2014

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Department of **Parks and Wildlife**

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Royal Botanic Gardens Sydney : Bob Mackinson

Hosts of others

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