



SCIENCE AND
EDUCATION **FOR**
SUSTAINABLE
LIFE

Strategies and measures to prevent occurrence of forest damage and reduce its spread

Case study *Phytophthora*

Carmen Romeralo, SLU
4th Oct 2021

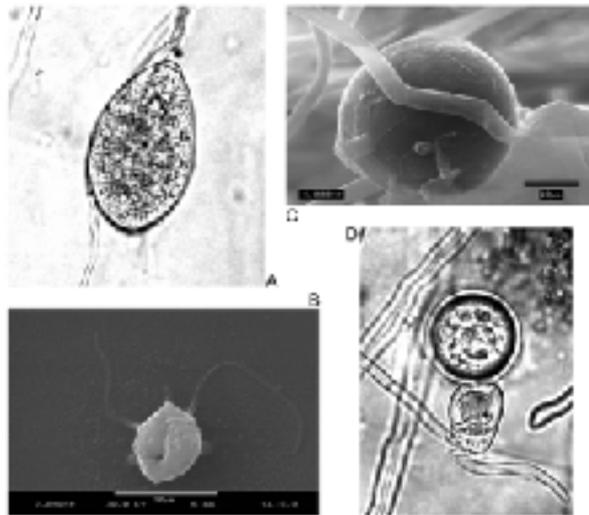
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1. Introduction of genus *Phytophthora*
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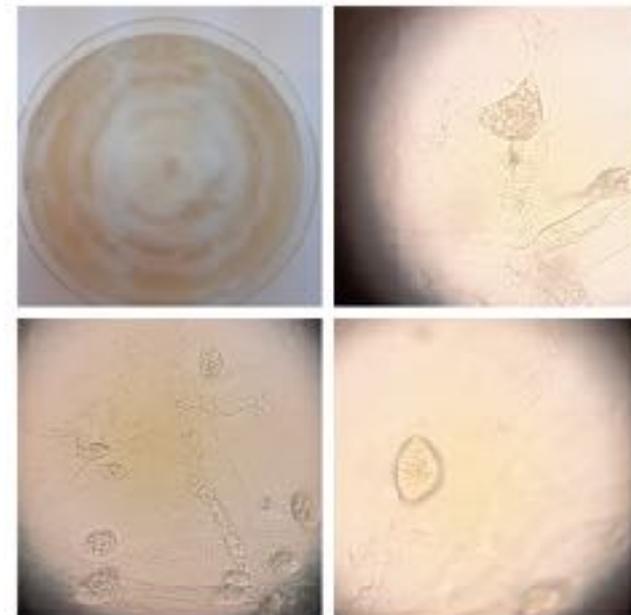
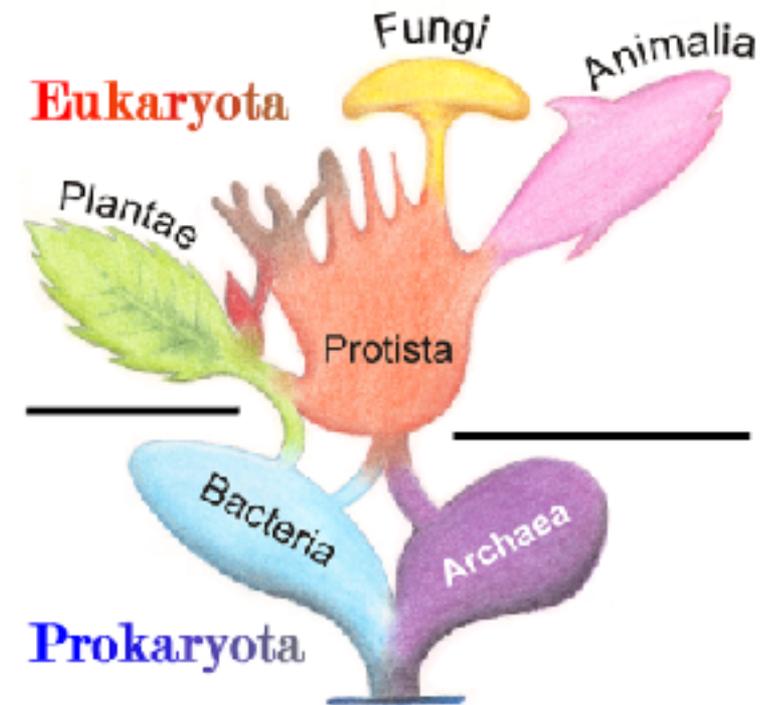
Phytophthora

Oomycetes: Fungus-like organisms

	Fungi	Oomycetes
Cell walls	Chitin	Cellulose
Vegetative stage (non reproductive)	Haploid	Diploid



Asexual (A: sporangia, B: zoospores, C: chlamydospores) and sexual (D: oospores) reproductive structures of *Phytophthora infestans*



Phytophthora

PHYTOPHTHORA (FROM GREEK ΦΥΤΟΝ (PHYTÓN), "PLANT" AND ΦΘΟΡÁ (PHTHORÁ), "DESTRUCTION"; "THE PLANT-DESTROYER")

Wikipedia

Impacts on human history by causing agriculturally and ecologically important plant diseases (Erwin & Ribeiro 1996)



Phytophthora infestans



Great famine: Irish Potato Famine

Phytophthora

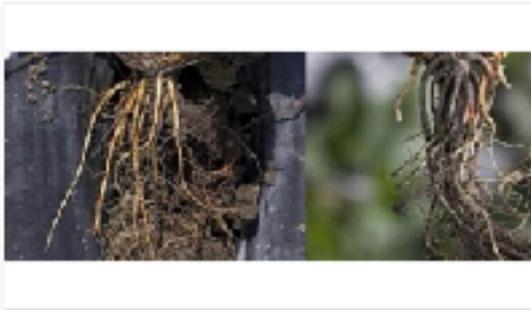
Phytophthora **infects the roots and basal stem tissue** preventing the uptake of water and nutrients by the plant, causing **dieback** (characterized by progressive death of twigs, branches, shoots, or roots).



Phytophthora

More than 150 species nowadays

P. cinnamomi, *P. nicotianae*, and *P. sojae*



In Australia, *Phytophthora*-species have destroyed whole biotopes, earning the name “biological bulldozer”



Australian Government
Department of Agriculture,
Water and the Environment

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Biodiversity



Invasive species



Diseases, fungi and parasites



Beak and feather disease affecting
endangered psittacine species

Feral animals in Australia



Insects and other invertebrates



Threat abatement projects

Weeds in Australia

Publications and resources

Phytophthora dieback

A healthy natural environment is important for our plants, animals and communities. *Phytophthora cinnamomi* poses a significant threat to the Australian environment. This plant pathogen can spread easily, causing disease, death and potential extinction in susceptible plants, and loss of habitat for animals. The disease, *Phytophthora dieback*, is often difficult to detect and can cause permanent damage to ecosystems and landscapes before it is identified. *Phytophthora cinnamomi* can remain dormant for long periods during dry weather and is impossible in most situations to eradicate from infested areas, so it is critical to prevent further spread.

Any activity that moves soil, water or plant material can spread *Phytophthora* – this includes recreational activities such as bushwalking, off-road vehicle use and gardening, as well as other activities such as road building, land management, timber harvesting and mining. To minimise spread of the disease from one site to another, it is important to ensure that footwear, tools and vehicles are always clean on arrival and departure, to source pathogen-free material and plant stock and dispose of garden waste carefully.

Key threatening process

'Dieback caused by the root-rot fungus *Phytophthora cinnamomi*' is listed as a key threatening processes under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. Since its listing, further research has determined that *Phytophthora cinnamomi* is a water mould and not a fungus.

[Dieback caused by the root-rot fungus \(*Phytophthora cinnamomi*\)](#)

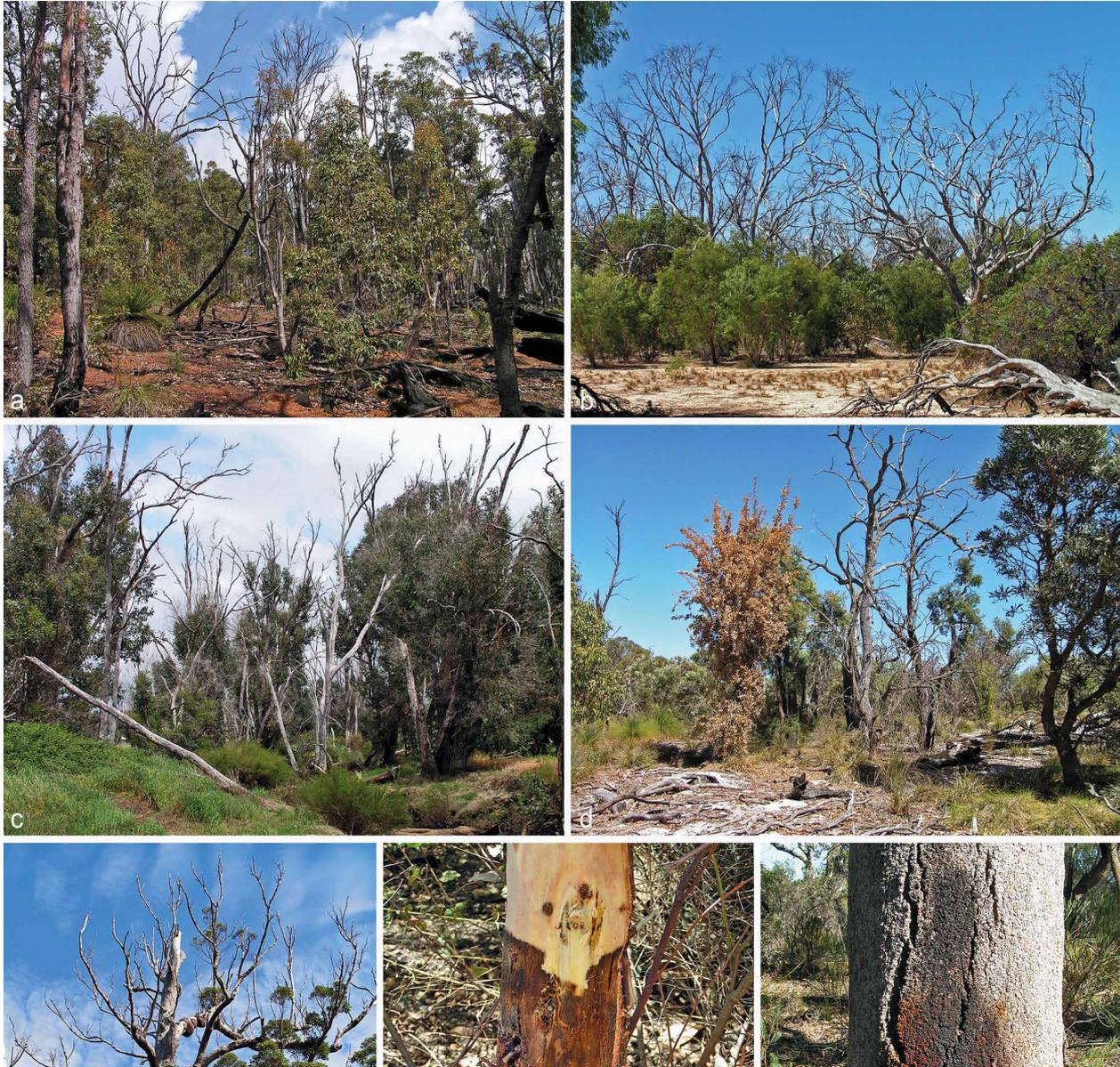
Threat abatement plan



Canker and decline diseases caused by soil- and airborne *Phytophthora* species in forests and woodlands

T. Jung^{1,2}, A. Pérez-Sierra³, A. Durán⁴, M. Horta Jung^{1,2}, Y. Balci⁵, B. Scanu⁶

Australia: *Eucalyptus* spp.



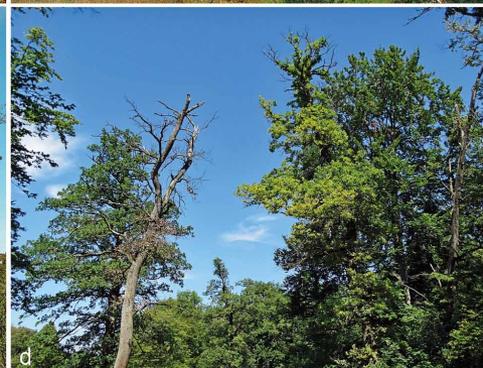
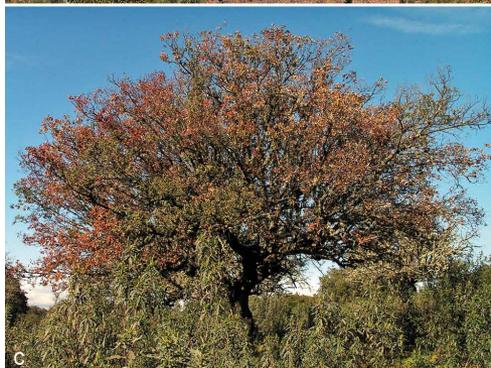
Phytophthora ramorum in California



(a) Tanoaks (*Notholithocarpus densiflorus*) in a mixed coastal forest with *Sequoia sempervirens* in California; b. necrotic lesions on of California bay laurel (*Umbellularia californica*); c. necrotic lesions on tanoak; d. bleeding bark lesions on a tanoak; e. tanoak stem

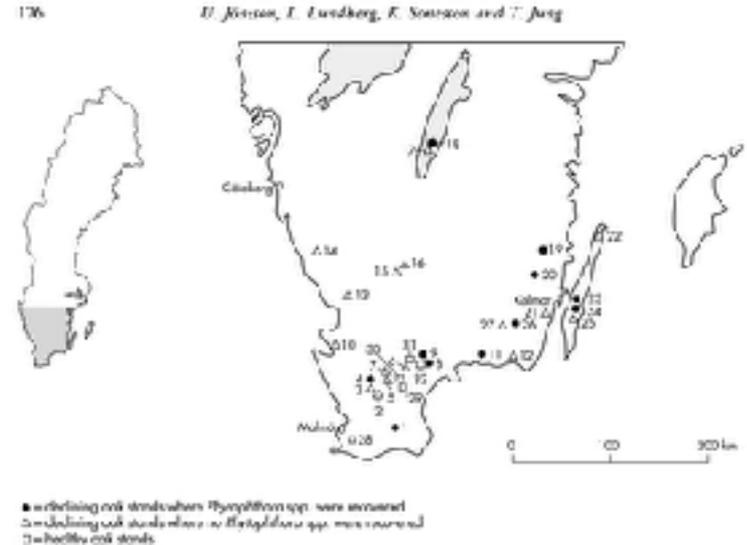
Phytophthora cinnamomi Involved in the Decline of Holm Oak (*Quercus ilex*) Stands in Southern Italy

Salvatore Frisullo, Giuseppe Lima, Gastano Magnano di San Lio, Ippolito Camelo,
Luigi Molisano, Ivana Puglisi, Antonella Pane, Giovanni Enrico Agosteo,
Leonardo Prudente, Santa Olga Cacciola



First records of soilborne *Phytophthora* species in Swedish oak forests

By U. JÖNSSON¹, L. LUNDBERG¹, K. SONESSON¹ and T. JUNG²



Phytophthora quercina, *P. cactorum* and *P. cambivora*

DISEASE NOTES



First Report of *Phytophthora gonapodyides* Causing Stem Canker on European Beech (*Fagus sylvatica*) in Southern Sweden

M. Cleary, M. Ghosemkhani, M. Blomquist, and J. Witzell

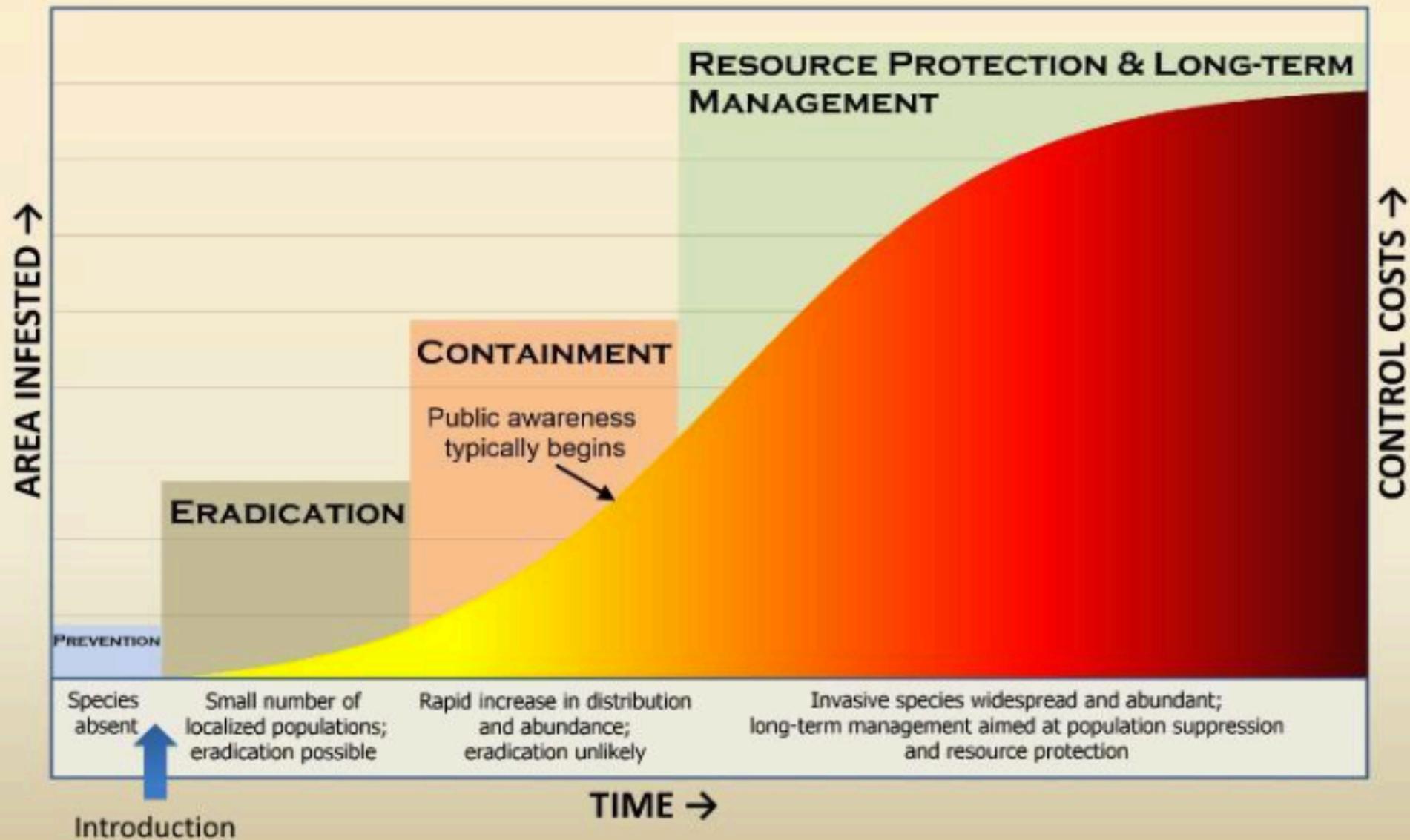
Affiliations 

Published Online: 8 Aug 2016 | <https://doi.org/10.1094/PDIS-04-16-0468-PDN>



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Treatments

Actions	Definition	Practice
Avoidance	Avoid the contact between the pathogen and the host.	<p>Planting in areas where the disease is not present or the environment does not favor disease development.</p> <p>Selection of planting sites at some distance from infested plantations.</p> <p>Avoid planting susceptible species.</p> <p>Timing management activities to avoid having susceptible trees or tissues during disease infection periods.</p> <p>Reduce the source of inoculum: pruning, host elimination.</p>
Exclusion	Keep out a disease from an area.	<p>Quarantine, inspection and certification of commercial plants.</p> <p>Use of pathogen-free material when restoring a new area.</p>
Eradication	Total removal of the disease from a site.	<p>Cutting and removing all infected trees.</p> <p>Only in nurseries with chemicals or biological products.</p>

Actions	Definition	Practice
Protection	<p>Application of a substance or technique to protect a plant.</p> <p>Prevent the infection.</p>	<p>Applications of fungicides.</p> <p>Mycorrhizae and fertilizers.</p> <p>Thinning, pruning lower branches.</p>
Resistance	<p>A resistant phenotype reduces the growth, reproduction and/or activity of the pathogen.</p>	<p>Found genetic resistance in a population.</p> <p>Selective breeding: select resistant species/individuals/provenances.</p> <p>Improve the resistance of the host: induced resistance</p>
Therapy	<p>Cure the plants after they have become diseased.</p>	<p>Treat with chemicals/biological products or heat.</p> <p>Remove diseased branches/pruning</p>

Integrated Pest Management

What is IPM?

Integrated Pest Management is a science-based approach that combines a variety of techniques. By studying their life cycles and how pests interact with the environment, IPM professionals can manage pests with the most current methods to improve management, lower costs, and reduce risks to people and the environment.

IPM tools include:

- Alter surroundings
- Add beneficial insects/organisms
- Grow plants that resist pests
- Disrupt development of pest
- Prevention of pest problem developing
- Disrupt insect behaviors
- Use pesticides

1 IDENTIFY/MONITOR

Determine the causal agent and its abundance (contact your local extension agent for help).

2 EVALUATE

The results from monitoring will help to answer the questions: Is the pest causing damage? Do we need to act? As pest numbers increase toward the economic threshold further treatments may be necessary.

3 PREVENT

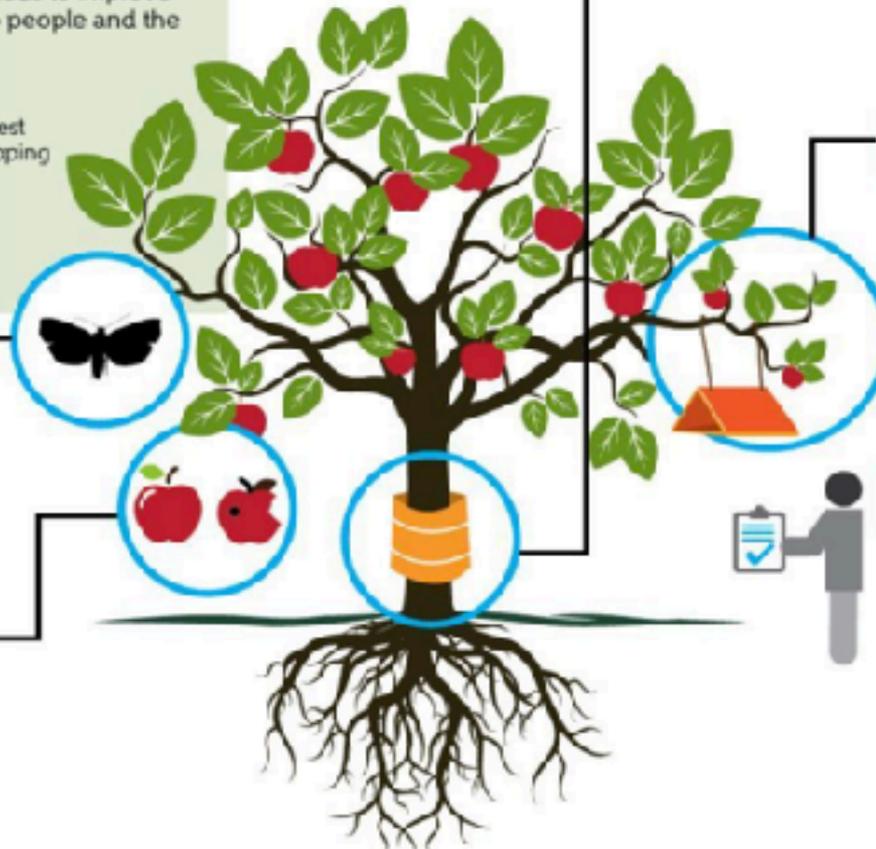
Some pest problems can be prevented by using resistant plants, planting early, rotating crops, using barriers against climbing pests, sanitation, and sealing cracks in buildings.

4 ACTION

IPM uses multiple tools to reduce pests below an economically damaging level. A careful selection of preventive and curative treatments will reduce reliance on any one tactic and increase likelihood of success.

5 MONITOR

Continue to monitor the pest population. If it remains low or decreases, further treatments may not be necessary, but if it increases and exceeds the action threshold, another IPM tool should be used.



Management strategies for Phytophthora diseases

- **Protection:** Fungicides- Agricultural Plantations.
- **Protection:** Phosphite treatments.
- **Resistance:** find resistant individuals/microbiome.
- **Avoidance:** Prevention & Containment Biosecurity: Stop the spread
- **Postponing** activities in the forest in wet conditions.

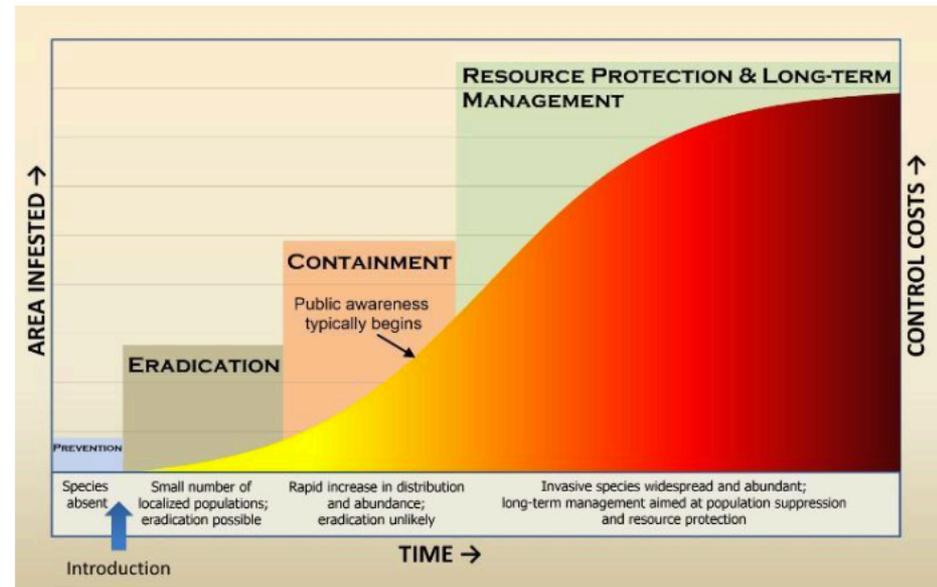


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What can be done to control phytophthora?

There is no cure for Phytophthora once it has infested an area. Phytophthora can spread in ground water and from plant to plant by root contact. It spreads quickly with the help of 'artificial' factors, like human disturbance. The best way to control Phytophthora is to prevent transfer of infested soil or plant material.

- Avoid driving, riding or walking in areas when soils are wet and sticky
- Stay on designated roads and tracks. Vehicles, bikes and people moving off roads into infested areas may pick up infested soil and transfer it to uninfested areas
- Brush soil off vehicles, bikes, boots and camping gear before entering an uninfested area and after leaving an infested area – don't wait until you get home to clean them
- Obey road signs. Roads and tracks may be closed, sometimes permanently, to help stop the spread of Phytophthora
- Use wash down or hygiene stations when provided
- Ensure that any plants you purchase for your garden or landscape are free of Phytophthora

MINIMIZING THE SPREAD!!

Bushwalking guidelines to prevent *Phytophthora cinnamomi*

FACT SHEET 2017

Phytophthora cinnamomi (pronounced fy-TOFF-thora). Also known as PC or root-rot fungus is killing our native plants and threatens the survival of animals depending on plants for food and shelter. This introduced fungus can be found in plant roots, soil and water. Bushwalkers can spread *Phytophthora* by allowing moist soil and plant material to stick to footwear.

Help stop the spread by complying with these guidelines:



Vegetation affected by *Phytophthora cinnamomi*.

- » clean your boots before you leave home
- » park your car in designated car parks only
- » keep to designated roads and walking trails at all times
- » use hygiene stations where provided
- » clean your boots when you finish your walk. Don't take boots or shoes home to clean.



Natural Resources
Kangaroo Island



National Parks
South Australia

How to keep your footwear clean:

Bushwalkers are encouraged to carry a hygiene kit in their backpacks to keep footwear clean.

A 'hygiene kit' should contain:

- » hard brush to clean footwear
- » spray bottle of disinfectant
 - › methylated spirits (undiluted) or
 - › household bleach (diluted 1 part of bleach with 4 parts of water).



Hard brush for cleaning.

Cleaning procedure:

1. if a hygiene station isn't located on your walk, select a hard, well drained site for boot cleaning
2. remove all soil and plant material from one boot at a time using the brush
3. disinfect the entire sole using the spray bottle before placing the boot on the ground
4. allow the sole of the boot to dry for approximately one minute
5. step forward to avoid re-contaminating your footwear
6. repeat steps two to six for the other boot
7. finish by disinfecting the brush.



Hygiene station.

Phytophthora Hygiene Station

Please Clean Your Footwear



Phytophthora root-rot fungus is killing our native plants.

Phytophthora threatens many native plant and animal habitats in this area.

Your footwear can bring in or pick up infested soil and spread *Phytophthora*.

Help stop the spread by cleaning your footwear using this hygiene station:

1. Clean the soles and sides of your footwear thoroughly using the boot scrapers and brushes.
2. Please step forward once you have completed cleaning your footwear to prevent re-contamination.
3. You may now leave the hygiene station.

Thank you for your cooperation

For more information contact your local Department for Environment and Heritage Office.

Phytophthora Infested Area

Restricted Access Only



Phytophthora root fungus is killing our native plants.

This fungus threatens many native plants and animal habitats in South Australia.

Vehicles and walkers can pick up infested soil and spread *Phytophthora*.



Help stop the spread. Please stay on formed tracks and clean your footwear before and after you walk in this area.

Once infested the damage to natural ecosystems is forever.

For more information contact
National Parks and Wildlife SA (08) 8552 3677



PROHIBITED AREA

RESTRICTED ACCESS *PHYTOPHTHORA* ZONE



Phytophthora is present in this area.

This introduced organism:

- Kills many native [indigenous] plants
- threatens wildlife dependent on these plants for food and shelter
- threatens [often kills] a range of home garden and commercial horticultural plants.

***Phytophthora* water mould:** lives within the soil subsurface. Infestations are permanent.

Pedestrians, vehicles, bicycles and horses can spread this disease over large distances by transferring infected soils into new areas. This applies particularly to damp soil.

UNAUTHORISED ACCESS PROHIBITED BEYOND THIS POINT



HELP STOP THE SPREAD

For further information please contact the City of Playford Parks and Recreation office, Phone 8254 0404

Failure to comply with this notice will incur fines under provisions of the local Government Act 1999

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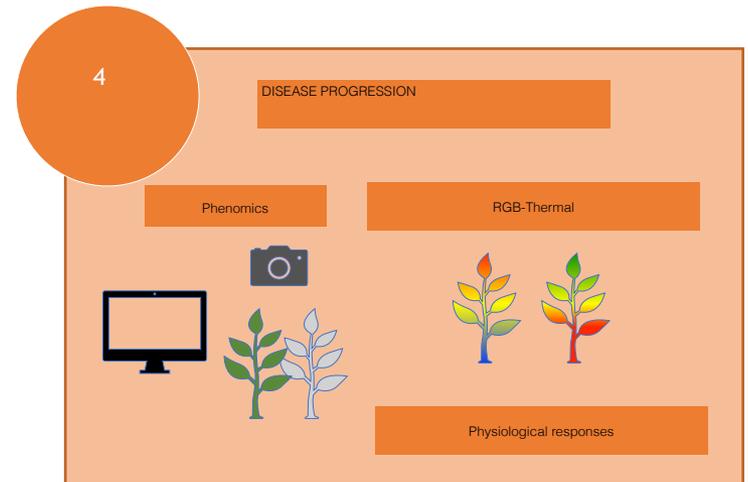
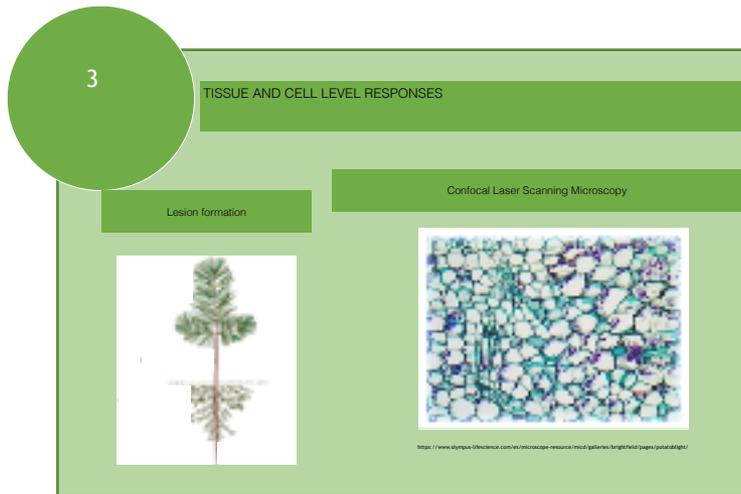
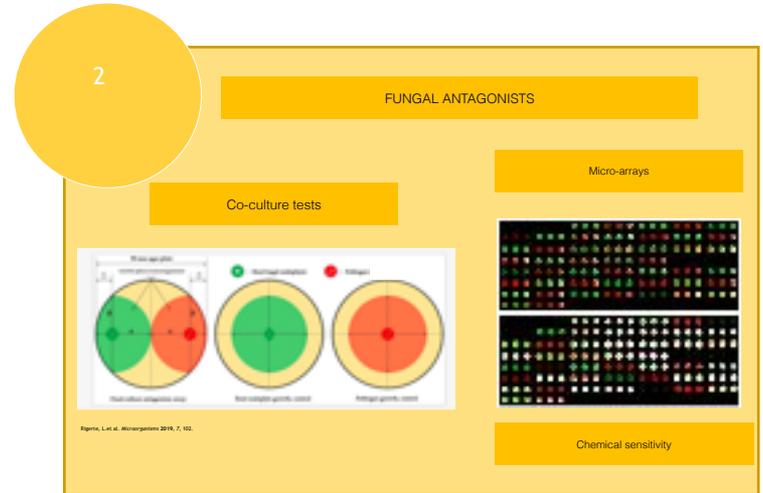
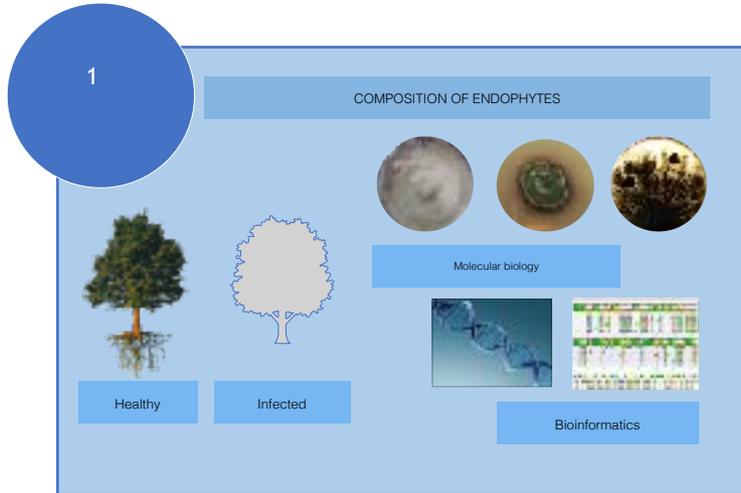
1. Introduction of genus *Phytophthora*
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- 4. RESISTREE project**

Identification of **Phytophthora resistant beech** trees by composition of endophyte communities, lesion formation and phenomics approaches

Carmen Romeralo & Johanna Witzell

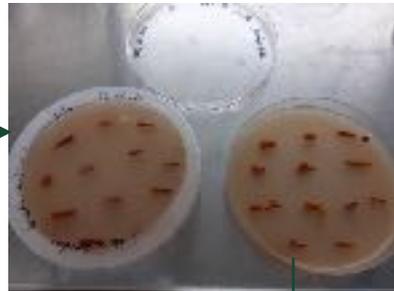
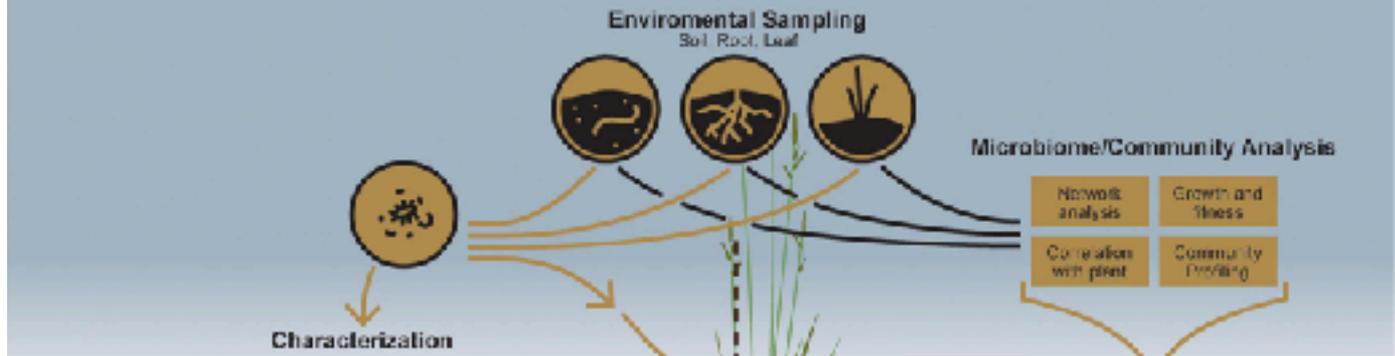


GOALS AND TASKS



Reductionist Approach

Holistic Approach



FUNGAL COMMUNITIES ILLUMINA-ITS



Co-culture

tests

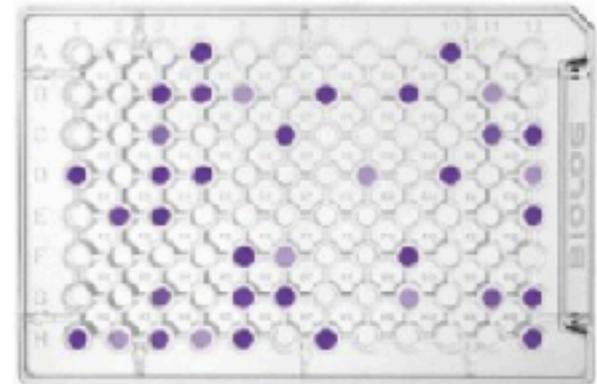


Antagonisms observed

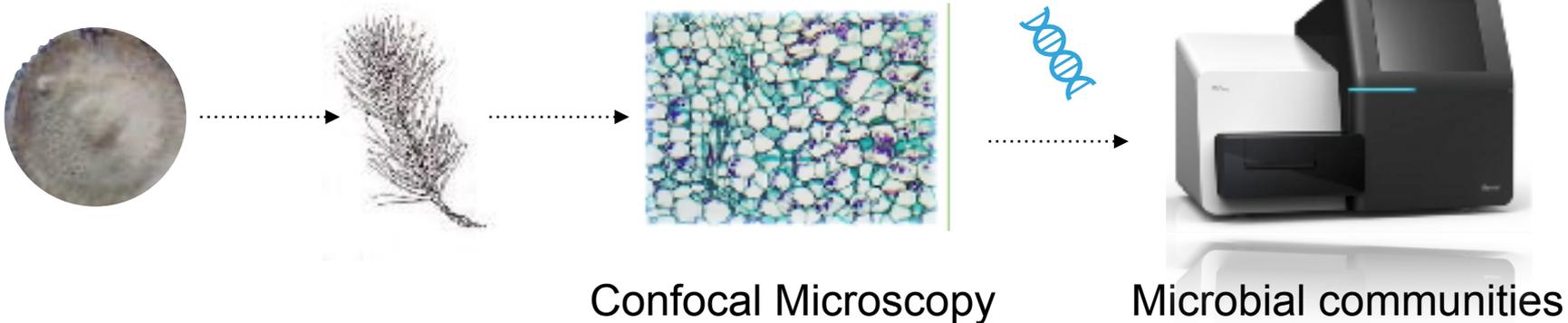
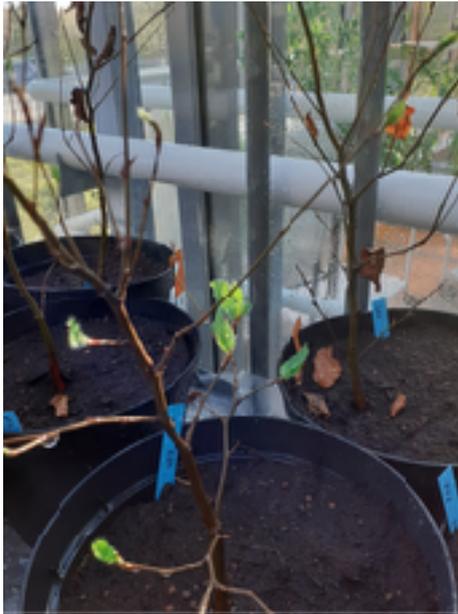


Eco-Plates

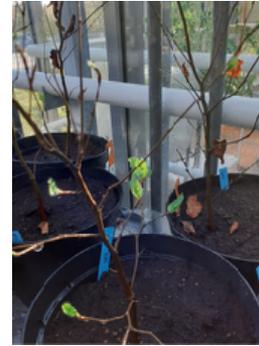
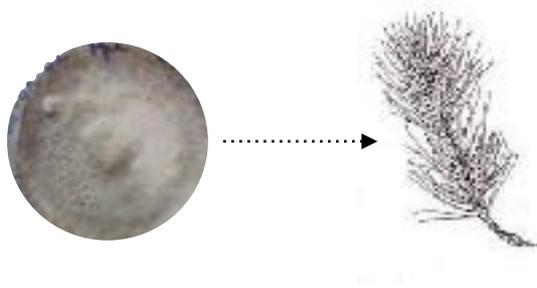
- Measure the metabolism of 31 carbon sources per assay
- Each assay panel tests in triplicate
- Simple colorimetric readout
- Readable with any microplate reader



To characterize tissue and cell level responses in beech infected by *Phytophthora* and related endophytes

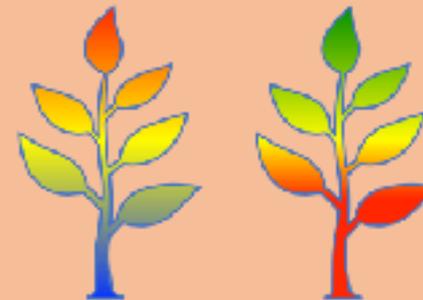
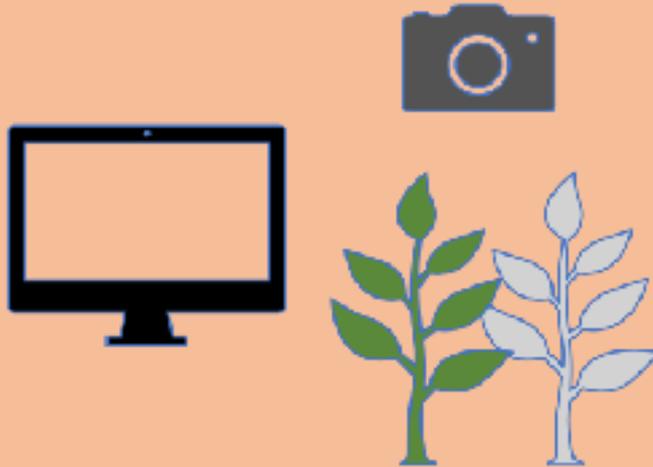


Monitor disease progression and host responses by the use of phenotyping

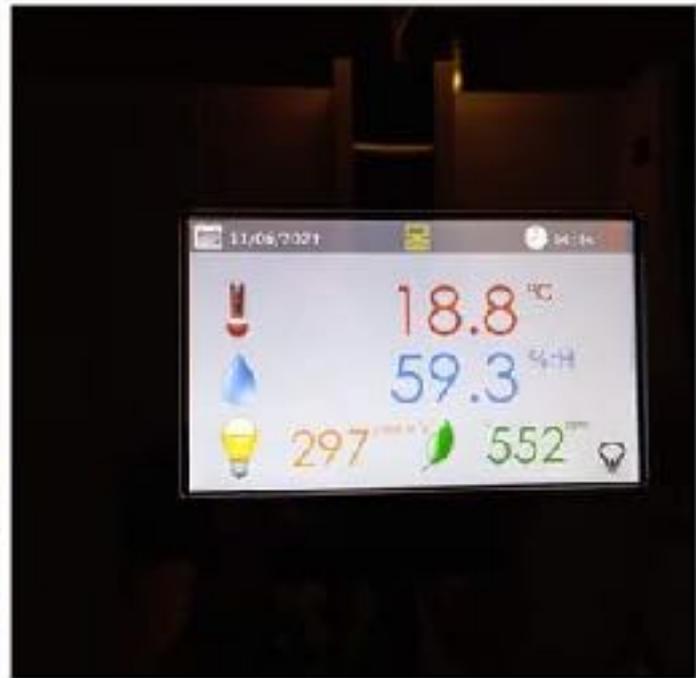


Phenomics

RGB-Thermal



Physiological responses



New Zealand: <https://www.youtube.com/watch?v=8uz8ocAYUKA> (2 min)

<https://www.youtube.com/watch?v=7cJlOqvuG7g> (3 min) (Kids Film)

Australia: <https://www.youtube.com/watch?v=TYHK71YwjnI> (2min)

<https://www.youtube.com/watch?v=StP-KEGg6-0> (12 min)

Thanks for your attention!

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SUSTAINABLE
LIFE