Science for Saving Species

Research findings factsheet

Project 1.4.3

Threatened Species Recovery Hub

National Environmental Science Programme

Imminent extinction of Australian Myrtaceae trees and shrubs by myrtle rust

In brief

Myrtle rust is a plant pandemic caused by the fungus *Austropuccinia psidii*. It impacts certain species in the iconic Myrtaceae plant family which includes eucalypts and tea-trees. This study predicts myrtle rust will cause a plant extinction event of unprecedented magnitude.

We conducted extensive field surveys of Australian rainforest to determine which locations, habitats and species have been impacted by the fungus since its detection in this country in 2010, surveying 145 Myrtaceae tree species, from 1900 plant populations across 935 rainforest sites. All field survey information has been entered into a myrtle rust database to evaluate the spread of the disease over time and across the landscape. The results predict the imminent extinction of 16 rainforest tree species in the wild within a generation, with another 20 species also at risk of extinction.

Myrtle rust retards plant growth and prevents reproduction on severely affected plants. We have been monitoring populations of the native guava (*Rhodomyrtus psidioides*) and found a severe decline in population number and health: this species is now nearly extinct in the wild as a result of myrtle rust. Protecting populations in the wild with targeted use of fungicide, translocation into new locations and breeding of rust-resistant individuals will be important conservation strategies for the Myrtaceae plant family.

Myrtle rust spores on leaves.
Image: Julian Radford-Smith

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Background

The Australian continent has a distinctive and diverse flora that has had a relatively short, but intense exposure to agricultural and industrial civilisation. Despite this, the flora has largely managed to survive. The national list of threatened species is dominated by plant species, yet so far only 12 of Australia's known 22,865 plant species are likely to be extinct.

Myrtle rust is caused by the fungus *Austropuccinia psidii* and impacts some species in the large Myrtaceae plant family. Myrtle rust is a novel pathogen, that probably originated in South America. It has spread rapidly across the globe and was first detected in New South Wales in 2010. Myrtle rust rapidly colonised the humid areas of the east coast, reaching the northern tropics by 2012 and doubling its host range.

In continents that have not co-evolved with the pathogen, Myrtaceae are considered "naïve hosts" and show little to no resistance to the disease. Myrtle rust symptoms have now been detected on 358 native Australian species, and severe infection could lead to plant extinctions and a range of ecological impacts.

The rust infects newly expanding leaves and shoots, causing branchlet dieback. New shoots are particularly susceptible to infection. Because the tree fails to produce new leaves, the long-term impact of severe infection is death of major branches, and eventually death of above-ground parts of the tree. Myrtle rust readily infects flowers and fruit, rendering plants infertile. Future regeneration is often limited, as even if some viable seeds remain, seedlings are also highly susceptible to infection.

Main aims

We aimed to identify which tree species in the Myrtaceae plant family in the rainforests of eastern Australia were at risk of extinction due to infection by myrtle rust.

We also wanted to collect detailed field survey information, such as the species infected and their habitats and locations. The myrtle rust database that is the foundation of this project could be used to evaluate the spread of the disease over time and across the landscape.

We examined native guava (*Rhodomyrtus psidioides*) as a case study of possible extinction from myrtle rust infection. Native guava is a small tree that occurs in subtropical environments on the east coast of Australia on the margins of rainforest.

LEFT: Dieback on a northern malletwood (Rhodamnia spongiosa) *infected with myrtle rust. Image: Julian Radford-Smith*

What we did

We surveyed 1900 plant populations from the Myrtaceae family across 935 rainforest sites in eastern Australia to determine the impact of myrtle rust. We measured the extent of dieback on branchlets and branches and carried out an assessment of the potential fertility of infected plants. Independent scores for major branch and trunk mortality and minor branchlet death were recorded for multiple populations and individuals for each species. We averaged the scores to provide a myrtle rust damage score for each species.

We categorised reproductive capacity by looking at the amount of flower and fruit present, and the extent of fungal infection. We interviewed seed collectors and nursery workers to confirm whether infected fruit did not produce viable seed. The susceptibility of seedlings to infection was recorded from existing sources and nursery workers actively involved in growing Myrtaceae species.

Trees with woody parts that were mostly dead were scored above 5.1 and labelled Category X species. Trees with damage scores between 3.2 and 5.1 were labelled Category Y species. Category X species had consistently high myrtle rust damage scores across multiple populations, with no known observations of mature fruit with viable seed since 2015. Category X species will become extinct in one generation as they are effectively unable to grow or reproduce in any population. Category Y species we identified as those with persistent myrtle rust infection, but having some individuals and populations exhibiting sufficient resistance that they may survive beyond a single generation.

In 2014 and 2018, we located 66 populations of native guava throughout its known geographic range and assessed the myrtle rust damage on the trees as described above. We also monitored the change in population size over time.

*A grey teak (*Backhousia hughesii*) tree that died following myrtle rust infection*
Image: Julian Radford-Smith

Key findings

We identified 16 species of Myrtaceae that were sufficiently affected by myrtle rust to indicate imminent extinction within a generation (Category X species) (Table 1). These species all had extensive branch damage, infected flowers and fruit and no seedling regeneration. The full list of species and their locations are shown in Figure 1. Most of these species came from just three plant genera, and represented a large portion of the known species for these groups. The three genera were *Gossia* (four of 20 species), *Lenwebbia* (three of four species) and *Rhodamnia* (seven of 21 species). These at risk species occur from southern New South Wales through to northern Queensland.

Some of these species were extremely common and were once dominant within forests recovering from disturbance. They include *Gossia hillii, Gossia punctata, Gossia lewisensis, Lenwebbia* sp. Blackall Range, *Rhodamnia maideniana, Rhodamnia rubescens* and *Rhodomyrtus psidioides. Lenwebbia* sp. Main Range was the dominant shrub on the edge of rocky cliff-lines associated with the highest altitude peaks in the subtropics. Many of these species can be associated with rainforest margins that are occasionally burnt. They can resprout after burning, but this fresh new growth is particularly susceptible to myrtle rust. Drought can have a similar impact as fire, and thus the impacts of prior fire and drought can amplify the effects of the myrtle rust disease on these species.

We identified 20 species as having persistent infection, varying from moderate to variable (Category Y).

Key findings (continued)

These species are listed in Table 2 and are likely to exhibit future population declines from myrtle rust disease; however, they need further monitoring and assessment before the magnitude of the impact can be predicted.

A positive finding was that many other genera were not at risk of extinction from myrtle rust. This included the 56 species within the *Syzygium* genus.

In 2014, we found that 50% of native guava plants from 18 populations had been killed within three years of myrtle rust establishing. In 2018, 23% of surveyed populations were either extinct or could not be located, and another 61% had been reduced to root suckers following the death of the tree canopy.

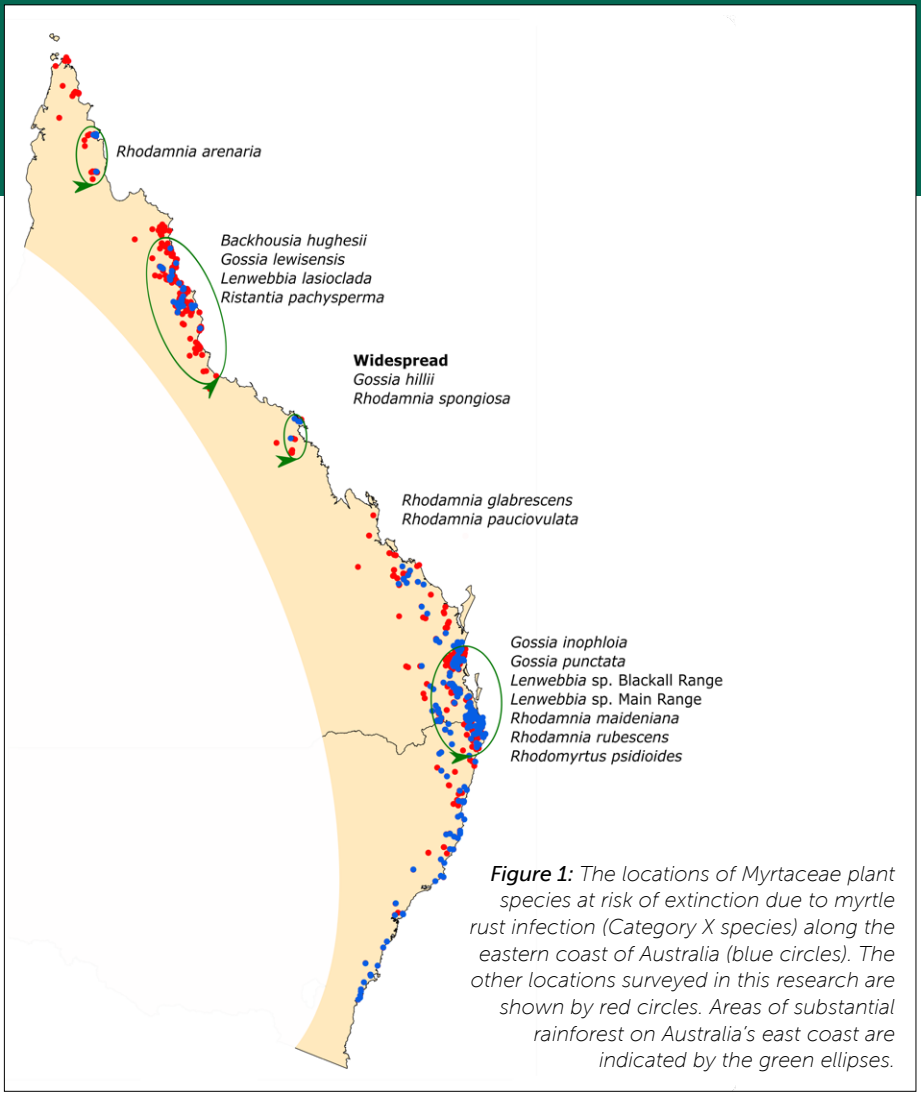

Figure 1: *The locations of Myrtaceae plant species at risk of extinction due to myrtle rust infection (Category X species) along the eastern coast of Australia (blue circles). The other locations surveyed in this research are shown by red circles. Areas of substantial rainforest on Australia's east coast are indicated by the green ellipses.*

Table 1. *Plant species in the Myrtaceae family we identified as being at risk of extinction due to myrtle rust infection (Category X species).*

Common name	Scientific name	Damage score	Original latitudinal range	Reproductive capacity
Native guava	*Rhodomyrtus psidioides*	*7.5 (55)*	-33.5° to -25.7°	Very low
Main Range myrtle	*Lenwebbia sp. Main Range*	7.4 (4)	-28.3° to -27.9°	Very low
Northern malletwood	*Rhodamnia spongiosa*	6.6 (27)	-24.6° to -11.7°	Very low
Small-leaved malletwood	*Rhodamnia pauciovulata*	6.3 (17)	-26.8° to -20.1°	Very low
Brush turpentine	*Rhodamnia rubescens*	6.3 (79)	-35.7° to -26°	Low
Velvet myrtle	*Lenwebbia lasioclada*	6.3 (5)	-17.8° to -16.4°	Data Deficient
Smooth malletwood	*Rhodamnia glabrescens*	6 (16)	-24.6° to -20.2°	Moderate
Blackall Range myrtle	*Lenwebbia sp. Blackall Range*	5.9 (8)	-26.8° to -26.4°	Low
Scaly myrtle	*Gossia hillii*	5.9 (50)	-30.2° to -16.2°	Low
Mount Lewis myrtle	*Gossia lewisensis*	5.8 (12)	-16.6° to -16.1°	Data Deficient
Smooth scrub turpentine	*Rhodamnia maideniana*	5.7 (13)	-28.9° to -28°	Moderate
Grey teak	*Backhousia hughesii*	5.7 (4)	-17.3° to -15.9°	Low
Sour hardwood	*Ristantia pachysperma*	5.6 (7)	-17.5° to -16.1°	Data Deficient
Thready barked myrtle	*Gossia inophloia*	5.3 (11)	-27.3° to -26.2°	Low
Cape York malletwood	*Rhodamnia arenaria*	5.1 (3)	-13.9° to -12.7°	Data Deficient
Dotted myrtle	*Gossia punctata*	5 (19)	-29° to -25.8°	Low

Key findings (continued)

These root suckers are highly susceptible to infection. All populations of native guava showed evidence of myrtle rust infection, and only two populations (3%) had less than 10% of their branches infected. Flowers are highly susceptible to infection, and we have not found any mature fruit since the disease established.

Rainfall, temperature and elevation were not related to infection levels in native guava, indicating that myrtle rust could impact the full natural range of native guava. The native guava is on a steep trajectory towards extinction. Only one population survived with less than 10% of its branches killed by myrtle rust infection.

However, even this population did not produce any viable seed. More than 100 species of insectivorous pollinators have been associated with native guava. The invasion by myrtle rust is likely to disrupt these key plant–insect relationships.

Table 2. *Plant species in the Myrtaceae family we identified as persistent myrtle rust infection (Category Y species)*

Common name	Scientific name	Damage score	Original latitudinal range	Reproductive capacity
Glastonbury Myrtle	*Rhodamnia* sp. Glastonbury	5.1	-26.8 to -25.2	Moderate
Rusty Rhodomyrtus	*Rhodomyrtus pervagata*	5.1	-19° to -15.7°	Moderate
Rib-fruited malletwood	*Rhodamnia dumicola*	4.9	-28.1° to -24.3°	Moderate
Narrow-leaved malletwood	*Rhodamnia angustifolia*	4.9	-24.2°	Low
Malanda ironwood	*Gossia myrsinocarpa*	4.8	-20.8° to -13.4°	Data deficient
Shepherd's ironwood	*Gossia shepherdii*	4.7	-19.2° to -15.7°	Data deficient
Crater ironwood	*Rhodomyrtus canescens*	4.6	-17.7° to -16.2°	Moderate
Silky myrtle	*Decaspermum humile*	4.5	-33.3° to -10.7°	Moderate
McIlwraith's myrtle	*Gossia macilwraithensis*	4.2	-16° to -13.5°	Data deficient
Angle-stemmed myrtle	*Gossia gonoclada*	4.1	-27.8° to -27.5°	Moderate
Velvet myrtle	*Lenwebbia prominens*	4.0	-28.6° to -28°	Moderate
Bamaga ironwood	*Gossia bamagensis*	3.9	-15.2° to -10.7°	Data deficient
Iron malletwood	*Rhodamnia sessiliflora*	3.7	-19.2° to -15.7°	Low
Beach cherry	*Eugenia reinwardtiana*	3.7	-25.4° to -10.5°	Moderate
Whyanbeel Myrtle	*Mitrantia bilocularis*	3.5	-16.3°	Data deficient
Daintree Myrtle	*Rhodomyrtus effusa*	3.5	-16.5° to -15.8°	Moderate
Grey myrtle	*Gossia grayi*	3.5	-18.2° to -12.9°	Data deficient
Silver malletwood	*Rhodamnia argentea*	3.4	-32.2° to -20.8°	Moderate
Scrub ironwood	*Gossia acmenoides*	3.2	-34.5° to -21°	Moderate
White malletwood	*Rhodamnia whiteana*	3.2	-28.5° to -27.8°	Moderate

Implications and recommendations

The diversity of tree species within the Myrtaceae family is threatened by myrtle rust infection. Some of the species at risk of extinction are common and widespread, suggesting that other ecosystem impacts from the loss of these species may develop.

When large common trees in the rainforests are heavily infected by myrtle rust, they produce an abundance of spores. This means that nearby plants were exposed to the rust. As large host trees die, spore loads might decline and surviving individuals could be spared from infection.

Native guava is a pioneer species in naturally disturbed environments and was formerly a common tree in these habitats. The exotic species lantana (*Lantana camara*) can also act as a pioneer species in these environments. When native guava trees are completely lost from these communities it could increase lantana cover. During drought, lantana provides a source of fuel for fires between the understorey vegetation and the tree canopies, which can make normally fire-retardant dry rainforests more flammable. Invasive species and fire management plans could need revising for communities dominated by myrtle rust–infected Myrtaceae.

Resistance to the rust may emerge in the species at imminent risk of extinction (Category X species). Some natural resistance to the rust might already be seen in the 20 species identified whose populations have been severely impacted by the rust (Category Y species), especially where the populations exhibit a range of impacts. We need to search for wild populations and individuals that show resistance to the rust. This task could potentially be assisted by field workers and rangers who regularly work in Myrtaceae habitats.

Individuals and populations exhibiting the greatest resistance to the pathogen should be screened for resistant genotypes. Nurseries can play a role in identifying and growing resistant genotypes. Susceptible species produce uninfected seed in environments where myrtle rust is present but not widespread, and these seeds could be used for propagation.

Targeted application of fungicides to populations in the wild could prevent extinction in species already heavily impacted by myrtle rust. A long-term strategy to avoid extinction of species susceptible to myrtle rust could involve moving populations or planting cultivated plants in locations where the environment is not suitable for myrtle rust. In subtropical areas, species such as native guava would need to be planted in locations with less than 900mm mean annual rainfall to be outside the climatic range of the disease. In such low-rainfall climates, the plants are likely to need additional watering to survive.

Cited material

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Further Information

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