Environmental impacts of myrtle rust

fact sheet

A new pathogen that could fundamentally alter Australia's ecology has slipped through our borders. Myrtle rust could infect a large proportion of Australia's more than 2000 plants in family Myrtaceae (eucalypts, melaleucas, tea trees etc), altering the composition and function of forest, woodland, heath and wetland ecosystems. This incursion is about as bad as it can get for biosecurity in Australia – a new disease attacking our dominant plants.

What is myrtle rust?

Myrtle rust (*Uredo rangelii*) is a fungus that causes disease in plants in family Myrtaceae. It was described only recently, and has been recorded in Argentina and Jamaica (Simpson et al. 2006). It is not known how it entered Australia.

Myrtle rust is a member of the eucalyptus/guava rust complex, and some experts consider it to be the same species as *Puccinia psidii*, known as guava[1] or eucalyptus rust, which is thought to be native to Central and South America (Glen et al. 2007; Ramsfield et al. 2010). Eucalyptus rust has spread to the Caribbean, Florida, Hawaii, California and Japan (Tommerup et al. 2003; Mellano 2006; Glen et al. 2007; Kawanishi et al. 2009; Loope 2010)

Myrtle rust was not distinguishable from eucalyptus rust in a DNA sequence comparison and returns a positive result in the diagnostic test for eucalyptus rust (Carnegie et al. 2010). Its taxonomy requires clarification.

For the purposes of describing potential impacts of myrtle rust, we will treat myrtle and eucalyptus rust as the same species.

Pathology

South American plants are little affected by eucalyptus rust, presumably because they have evolved resistance. However, pathogens are often far more virulent on naive hosts (Glen et al. 2007). Eucalyptus rust has caused severe disease in plants introduced to Central and South America (eg. plantations of non-native guava and Australian eucalypts) and in areas invaded by the rust in the past few decades. The allspice industry in Jamaica was devastated in the 1930s, weedy Australian paperbarks are severely damaged in Florida, and two native species and a weed are badly affected in Hawaii (Tommerup et al. 2003; Loope 2010). Many Australian plants are likely to be highly susceptible. Most Australian Myrtaceae are naïve to any rust disease: there are just two Myrtaceae rusts known in Australia, one found on two *Xanthostemon* species and another on one *Kunzea* species (Simpson et al. 2006).

Eucalyptus rust damages young, developing tissue, infecting juvenile leaves, shoots, floral buds and/or fruit, depending on the host (Tommerup et al. 2003; Zuaza et al. 2010b). Infection can cause defoliation, twig mortality and abortion of flowers and fruits (Rayachhetry et al. 2001, citing Smith 1935). The rust affects different tissue on different species: it is most severe on fruits and floral buds of guava but affects only juvenile leaves and shoots of eucalypts. The disease is particularly severe on seedlings, saplings and coppices. However, as most susceptibility testing on Australian species has occurred only on seedlings, impacts on older plants are mostly unknown (Plant Health Australia 2009).

Infections inhibit growth and reproduction and result in a stunted or bushy habit. Eucalypts in South America are generally not susceptible once they are taller than 3-4 m, probably due to a different microclimate and fewer spores at greater height (Zuaza et al. 2010b). Other Myrtaceae are vulnerable at all ages, for example rose apple (*Syzygium jambos*), broad-leaved paperbarks (*Melaleuca quinquinervia*), allspice (*Pimenta officinalis)* and guava (*Psidium guajava*) (Plant Health Australia 2009; Loope 2010). Eucalypts may be vulnerable when they sprout new growth after fire; Coutinhou (1998) notes that eucalyptus rust can be fatal when it infects coppice growth of highly susceptible species.

Disease severity is highly variable, depending on the rust biotype and host susceptibility. Susceptibility testing in eucalypts and melaleucas has found that even within the same species there can be large differences between plants from different places and between seedlots (Zuaza et al. 2010a).

In severe infections, rusts occasionally kill trees (Tommerup et al. 2003). One of the most severely affected species – rose apple (*Syzygium jambos*) – is suffering landscape-scale dieback in Hawaii, where it is abundant and weedy. Loope (2010) describes the infection process as follows:

> Healthy, reddish green immature leaves on new twigs become deformed, yellow-red, and covered with masses of yellow urediniospores following infection. As the disease progresses, infected leaves are blackened and defoliate, with no functional leaves formed. Stem tips and branches are killed and the canopy becomes progressively smaller. Repeated mortality of juvenile leaves was observed to kill 8 to 12 m tall trees in the Haiku area of Maui. Wind dispersal of

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[1] Named because it was first detected on guava (*Psidium guajava*) in Brazil in the 1880s. However, for Australia eucalypt rust is a much more applicable name so we will call it that here.

spores resulted in heavy infection of even small groups of *S. jambos* isolated by 1 km or more and billions of spores covered the ground under diseased trees.

The conditions most favourable for eucalyptus rust germination are high humidity, temperatures of 15-25°C for 5-7 days and leaf wetness. Infection is inhibited by temperatures outside the range of 10-30°C (Zauza et al. 2010b). Epidemics in eucalypt plantations in Brazil have occurred during periods of leaf wetness (Booth et al. 2000, citing Carvalho et al. 1994).

Hosts

To date (February 2011), myrtle rust has been found infecting about 40 species in 20 genera in Australia (both native and exotic Myrtaceae, including eucalypts, melaleucas, syzygiums, rhodamnias, eugenia)[2]. Susceptibility testing is being done on other species.

The better known eucalyptus rust is unusual among plant pathogens in having a very broad host range. It is known to infect 20 genera and 71 species, with hosts from the following Australian genera: *Angophora*, *Callistemon* (now often placed in *Melaleuca*), *Corymbia*, *Eucalyptus*, *Kunzea*, *Melaleuca*, *Syncarpia*, *Syzygium* (Simpson et al. 2006).

Only about 4% of Australian Myrtaceae (83 species) have been tested for their potential to host eucalyptus rust, and most are susceptible (Zauza et al. 2010a), although not all individuals in most samples become infected. If the same proportion of susceptibility

[2] See http://www.dpi.qld.gov.au/4790_19789.htm

***Rhodamnia rubescens* (leaves, stems and fruit, left), *Melaleuca quinquinervia* (top right) and *Agonis flexuosa* cv Afterdark infected with myrtle rust.**

Photos: NSW Department of Industry & Innovation

Myrtle rust infections cause grey to brown leaf spots on leaves and buds that develop into yellow pustules with masses of spores. Infected tissues may shrivel and die. See Simpson et al. (2006) and Plant Health Australia (2009) for description.

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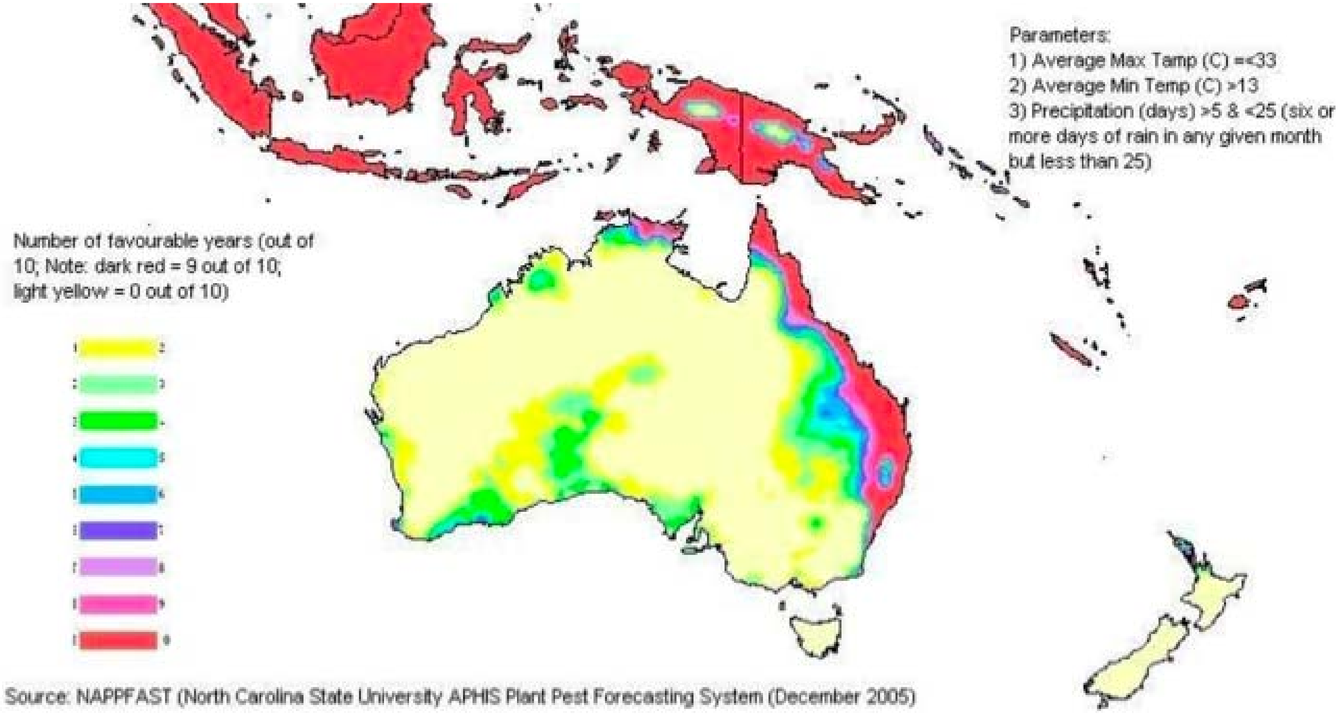
applies generally, close to 2000 species in Australia are potential hosts (although not all will be in the vulnerable climatic zone).

In its native Brazil, eucalyptus rust infects only 28 of more than 1000 potential native host species, but this is probably due to evolved resistance. The rust also infects 43 exotic Myrtaceae species in Brazil, 36 of which are Australian (Simpson et al. 2006), and in Hawaii five of eight native Myrtaceae have been infected (Loope 2010).

Spread in Australia and potential distribution

Myrtle rust was first detected in Australia in April 2010 at a cut flower growing facility on the central NSW coast. By late August it had been found at six sites, and by late October at 48 sites including in two bushland areas. It is now considered “widespread” in coastal NSW from Shoalhaven to the northern NSW border.[3] Myrtle rust was first detected in southeast Queensland in late December; by late February it had been found in more than 30 sites (from the Sunshine Coast to the Gold Coast to Kingaroy and Cairns), including a forested park.[4] Biosecurity officers think the rust may have been present in Australia for at least two years before it was detected[5].

Once a rust has spread into bushland it is impossible to eradicate. Rusts produce huge numbers of microscopic spores that spread on the wind, and are



Risk map for spread of eucalyptus rust from Plant Health Australia (2009)

transported by animals (eg. bees, flying-foxes, birds), humans and on goods. Eucalyptus rust reportedly spread over 5000 km^2 of Jamaica within a year (Glen et al. 2007, citing Smith 1935). After being detected in Hawaii in April 2005 it had spread to all but one island by the end of the year (Killgore and Heu 2005).

With thick walls that resist desiccation and pigments that reduce UV damage (Ramsfield et al. 2010), eucalyptus rust spores can remain viable for at least 90 days in favourable conditions (15°C and 35–55% relative humidity) and for 10 days at 35 or 40°C (Glen et al. 2007 citing unpublished data of Lana et al.). Spores on timber, plastic wrapping and the outside surface of a container survived a 2-month sea journey from Brazil to Australia (Grgurinovic 2006).

Preliminary bioclimatic modelling for eucalyptus rust predicts that areas at high risk of establishment (presumably also of myrtle rust) include most of the eastern seaboard and the eastern fall of the Great Dividing Range, and coastal areas in the Top End of the Northern Territory. Areas of lower risk extend onto the western slopes of the Divide (Booth et al. 2000;

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[3] See http://www.dpi.nsw.gov.au/biosecurity/plant/myrtle-rust/update.

[4] See http://www.dpi.qld.gov.au/4790_17185.htm.

[5] See http://www.daff.gov.au/aqis/quarantine/pests-diseases/myrtle-rust/myrtle-rust-qa.

Glen et al. 2007). Habitat likely to be suitable for the rust only in especially wet years extends the lower-risk area well west of the Divide in northern New South Wales and southern Queensland, and into Victoria, South Australia and Western Australia (Plant Health Australia 2009). See map on previous page.

Potential ecological impacts

There is insufficient information to predict the ecological impacts of myrtle rust in Australia. Eucalyptus rust disease is highly variable depending on rust strain, susceptibility of host species, and environmental factors. That eucalyptus rust has caused severe damage to plants elsewhere, and that Myrtaceae plants dominate many Australian ecosystems and are naïve to the pathogen, suggest the impacts could be severe.[6] There are no control options (fungicides) in bushland.

Eucalyptus rust has been regarded as a serious threat to biodiversity (and some industries) by scientists and Australian governments:

> [Eucalyptus rust is] "one of the most serious threats to Australian production forests and natural ecosystems" (Commonwealth of Australia 2006).

> *Puccinia psidii* causes a devastating foliar disease that poses a threat to biodiversity in Australia and the Eucalyptus forest industry worldwide. It has the potential to cause major damage … to natural ecosystems that include plants in the Family Myrtaceae (Grgurinovic et al. 2006).

> The potential for these fungi to result in epidemic disease situations in the areas of origin of Eucalyptus spp., and perhaps other myrtaceous genera, seems real, and could be a serious threat to global biodiversity. Such a situation would be equivalent to other introduced epidemic tree diseases, such as Dutch elm disease …, chestnut blight…, pine wilt …, and white pine blister rust (Coutinho et al. 1998).

The NSW Scientific Committee (2010) has already made a preliminary determination to list myrtle and eucalyptus rusts as key threatening processes. They note that the area of highest risk in NSW – the coastal zone from Illawarra to the Queensland border – includes a large proportion of the state's conservation reserve system, many Myrtaceae-dominated ecological communities, and most of NSW's World Heritage-listed rainforest.

Myrtaceae is Australia's dominant plant family, accounting for about 10% of native plant species, with 88 genera and about 2253 species (NSW Scientific Committee 2010, citing CHAH Australian Plant Census, unpublished data). Many are endemic or almost endemic to regions within the high-risk zone for eucalyptus rust. They are ecologically important, frequently the dominant floristic and/or structural element, providing habitat and resources for many other species (NSW Scientific Committee 2010).

The direct impacts on some species could be severe. Myrtaceae includes more than 140 federally threatened species (Glen et al. 2007), including endangered species from the genera *Decaspermum, Gossia, Kardoma, Melaleuca, Micromyrtus, Rhodamnia, Xanthostemon.*

Rusts are not known to have caused extinctions of Myrtaceae, and Glen et al. (2007) think extinctions are unlikely except of critically endangered species, but 'genetic diversity in highly susceptible species could be greatly reduced'. However, the incursion into Australia represents a vastly increased scale of interactions between the disease and new potential hosts. Australia has orders of magnitude more Myrtaceae species than any other country recently exposed to the disease. In Hawaii, eucalyptus rust has infected five of eight native Myrtaceae species, severely damaging two of them, including the endangered *Eugenia koolauensis*, whose recovery has been set back 'substantially' (Loope 2010). The rust's impacts on rose apple (*Syzygium jambos*), one of 15 non-native species infected in Hawaii (native to Asia), are also cause for caution. It is 'severely affected at a landscape scale, with widespread crown dieback and many instances of complete tree death' (Loope 2010) (see pictures next page).

Although mature trees usually survive rust infection, seedling deaths and aborted flowering or fruiting can reduce regeneration and lead to species decline (Glen et al. 2007; Loope 2010). In Florida, paperbarks of all ages are infected, and in Hawaii rose apple trees up to 12 m high are killed (Rayachhetry et al. 1997; Loope 2010). Destruction of new growth on trees can cause crown dieback and death can occur after repeated destruction of new growth, when food reserves become depleted (Loope 2010).

In Australia, infection of keystone species including eucalypts *(Angophora, Corymbia, Eucalyptus*), melaleucas and syzygiums could have widespread impacts on other species and compromise ecosystem function.

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[6] Glen et al. (2007) note that the "effects of new diseases on naïve hosts are far more unpredictable than they are on hosts that have a long association with the pathogen."

Eucalyptus rust has caused the loss of almost entire plantings of young eucalypts in Brazil (Glen et al. 2007) and reduced timber yield by as much as 40% (Commonwealth of Australia 2006). Heavy infection of shoots stunts growth and causes multi-branching (Tommerup et al. 2003). Highly susceptible individuals (typically 10–20% of a stand) are 'grossly malformed and may be killed'. Infection rates of 20–30% of the canopies of young trees or coppice regeneration have been reported for Brazilian plantations (Tommerup et al. 2003). The only feasible control method in plantations is selection and breeding for resistance (Plant Health Australia 2009).

The vulnerability of coppice shoots to infection, and death of highly susceptible species, is of concern as it could prevent recovery of eucalypts after fire or insect damage (Commonwealth of Australia 2006; Grgurinovic et al. 2006; Simpson et al. 2006).

Eucalyptus rust severely damages the Australian broad-leaved paperbark *Melaleuca quinquenervia* in Florida, with the damage described by Rayachhetry et al. (2001) as follows:

> *P. psidii* isolates infected expanding foliage as well as succulent twigs of *M. quinquenervia*. … Severe infection (>50% leaf coverage) caused extreme leaf distortion that ultimately resulted in defoliation. Even with light infection (<10% leaf coverage), leaves near growing branch tips quickly lost turgor, desiccated, and then turned gray to black. Severe infection of the succulent stems caused the tips to lose turgor and to die. Severely infected twigs with live bark developed bark-limited lesions that often developed into localized swellings. These twigs were usually completely defoliated and became brittle, breaking easily at the point of swelling. Infected *M. quinquenervia* reproductive

Syzygium jambos **infected by eucalyptus rust on Maui, Hawaii.**

Photos: Forest and Kim Starr

structures (flowers and immature fruits) were often encountered in the field and at nurseries.

Severe infections reduce flower and fruit production (Rayamajhi et al. 2010). The damage is severe enough that eucalyptus rust is considered a potential biological control agent in Florida (Rayachhetry et al. 2001; Rayamajhi et al. 2010). In experiments on coppicing melaleucas, the rust killed more than 40% of coppicing stems and more than 60% of coppicing stumps after 3 years (Rayamajhi et al. 2010).

Decline of dominant eucalypt and melaleuca species due to reduced regeneration would result in loss or degradation of habitat for many fauna species. Nectar shortages due to land clearing are already a problem for many birds and bats that could be exacerbated by myrtle rust. Herbivores such as koalas and many insects would be affected by reduced regeneration and loss of young leaves. Birds and microbats could be affected by fewer insects because new foliage is often critical for hatching caterpillars and other insect young. Myrtaceae also include important fruiting trees. Syzygium species in tropical rainforests of northern Queensland are important food sources for birds, flying-foxes and other mammals (Tommerup et al. 2003).

Canopy decline could result in erosion, reduced water quality (Commonwealth of Australia 2006) and weed invasion. The capacity of Australia to sequester carbon by planting eucalypts could be jeopardised, putting at risk carbon reduction goals. In addition, reduced timber yields in forests due to myrtle rust (see next section) could increase logging pressure in unaffected forests.

Other potential impacts

Industries based on Myrtaceae could be seriously affected: the apiculture, nursery and cut flower, plantation pulp wood and plantation timber, oil mallee, tourism, wildflower and native forest timber industries (The Institute of Foresters of Australia 2010).

The Commonwealth of Australia (2006) provides estimates of potential direct impacts of eucalyptus rust on timber production. From 2.5-3.75 million m^3 of timber could be lost in the medium to longer term from native forest harvests, which is 10-15% of the annual log volume, worth $145-219 million. Further losses worth an estimated $25-38 million could occur in plantations.

In contrast to biodiversity conservation, industries using susceptible Myrtaceae species have the option of selecting species or varieties resistant to myrtle rust. Substantial research effort has gone to developing resistant strains of eucalyptus for South American plantations (Loope 2010).

Government actions

A contingency plan for eucalyptus rust was developed by the Federal Government after the rust was detected in Hawaii (Commonwealth of Australia 2006) and then by the Nursery and Garden Industry (Plant Health Australia 2009) as the basis for an Emergency Plant Pest Response Deed. When myrtle rust was detected in April 2010, however, the plan was not implemented, as the Federal Government's National Management Group initially decided that it was not technically feasible to eradicate the rust[7]. That decision was criticised by various groups – including the Australasian Plant Pathology Society[8] and the forestry industry – and the Management Group revised its decision a few months later. An eradication attempt with cost-sharing was initiated in July 2010.[9] However, when the rust was found in bushland it became clear that eradication was no longer feasible, and this goal was abandoned by the National Management Group in December 2010.[10]

Each state has developed its own entry requirements for myrtle rust risk material. NSW has established two management zones with different reporting and management guidelines. There may be spot eradications in the zone considered relatively free of the rust but elsewhere people are advised to 'consider managing the disease according to their situation and the circumstances of infection.'[11] Queensland is conducting surveillance and developing a strategy designed to slow the rate of spread of the disease.[12] Western Australia, Tasmania, South Australia, Northern Territory and Queensland have interstate import restrictions/conditions on Myrtaceae plants and plant parts or known myrtle rust hosts to reduce the

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[7] See http://www.daff.gov.au/about/media-centre/dept-releases/2010/myrtle-rust_uredo_rangelii_detection.

[8] See http://www.australasianplantpathologysociety.org.au/Press_Releases/.

[9] See http://www.daff.gov.au/aqis/quarantine/pests-diseases/myrtle-rust/myrtle_rust_national_management_group.

[10] See http://www.daff.gov.au/aqis/quarantine/pests-diseases/myrtle-rust/update_on_response_to_myrtle_rust.

[11] See http://www.dpi.nsw.gov.au/biosecurity/plant/myrtle-rust/zones.

[12] Biosecurity Queensland briefing, Feb 2011.

risk of introduction[13] (some were slow to implement these restrictions). The Nursery Industry has developed its own management plan.[14]

Research is underway to clarify the taxonomy of myrtle rust and to test the susceptibility of various Myrtaceae species to the rust.

To date (February 2011), environment NGOs have not been involved in Federal Government processes to respond to myrtle rust, in contrast to industry groups, which are represented on the Myrtle Rust National Management Group. The National Management Group consists of the CEOs of national and state/territory agencies for primary industries or agriculture, industry peak bodies and Plant Health Australia. The recent independent review of Australian biosecurity arrangements recognised the need for a stronger environmental focus in biosecurity (Beale et al. 2008).

Biosecurity issues

The myrtle rust incursion into Australia exemplifies the great risks associated with international movement and trade of exotic plants and plant products. Most serious plant diseases 'are related to pathogens that originate from another host in different geographical areas' (Rayachhetry et al. 2001, citing Hokkanen 1985). The introduction of exotic Myrtaceae into South America (where there are vast eucalypt plantations) facilitated the host jump of eucalyptus rust from guava to eucalypts (first recorded in 1912). It is cited as a prime example 'illustrating the potential danger for host jumps following anthropocentric movement of potential hosts' (Loope 2010). These threats are typically underestimated by quarantine authorities 'largely due to a lack of understanding of the taxonomy and ecology of the fungi involved' (Loope et al. 2008). There are similar risks of dangerous wattle diseases reaching Australia via host jumping onto wattles planted on other continents.

It is not known how myrtle rust entered Australia but it is now vital to keep out further strains of myrtle or eucalyptus rust because a different strain could infect different species, have different virulence and combine with the existing strain. Loope (2010)'s analysis of the risks of new strains entering Hawaii is relevant to Australia. Currently there is one strain in Hawaii that only mildly infects ohia, the dominant forest tree. If another strain reached Hawaii, the consequences could be dire, 'with each new genotype arriving having an unknown likelihood of increasing damage to ohia, possibilities for mutation and (or) genetic mixing, even with asexual strains'. Based on what is known about the much-studied, crop-damaging species of the genus *Puccinia* – at least 67 races of a wheat rust (*Puccinia striiformis* f. sp. *tritici*) have been identified since 2000 – there is reason to believe there are at least dozens, 'likely hundreds' of genotypes in the core range of eucalyptus rust, with potential for dispersal. Plant Health Australia (2009) suggested that a review of quarantine procedures may be necessary to reduce the risk of additional biotypes should eucalyptus rust establish in Australia. We strongly endorse the need for a review (see next section).

Australia does not permit imports of Myrtaceae plants and plant material from countries known to host eucalypt rust but there are many pathways by which rusts can be spread (eg. on people's clothes and non-Myrtaceae plants) that are difficult or impossible to regulate. Pathways include (Grgurinovic et al. 2006):

- movement of host plants, germ plasm and plant products (seeds, pollen, micropropagation material, tissue culture, cuttings, live plants, lumber, wood chips);
- unregulated movement of plant material;
- movement of people; and
- long distance dispersal in air currents.

Grgurinovic (2006) for example highlighted the risk of contamination of shipping containers carrying timber or any other commodity if the port is close to areas with eucalyptus rust. In 2004 viable spores were detected on sawn eucalyptus imports from Brazil (after a 2-month sea journey), on the timber, plastic wrapping and external surface of the shipping container. In response, AQIS suspended trade in eucalyptus timber from countries with eucalyptus rust. Spores 'are likely to be present in the air throughout the year in Brazil and are very evident around eucalypt plantations', so there is considerable potential for contamination of timber and other export commodities.

That myrtle rust may have been in Australia for more than two years before being detected highlights the risks of importing any Myrtaceae material even from countries not known to have the disease. If the rust entered south-east Asia, where there are eucalypt

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[13] WA: http://www.agric.wa.gov.au/PC_94035.html?s=1016440660; Tas: www.dpiw.tas.gov.au › Home › Quarantine; SA: http://www.pir.sa.gov.au/biosecuritysa/planthealth/legislation/?a=134710; Vic: http://www.new.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/shrubs-and-trees/myrtle-rust; NT: www.nt.gov.au/ntg/gazette/2010/s46.pdf; Qld: http://www.dpi.qld.gov.au/4790_17185.htm

[14] See www.ngiq.asn.au/documents/**MyrtleRust**ManagementPlanFinal2011.pdf.

plantations and some native Myrtaceae, air currents could move the rust to northern Australia (Grgurinovic 2006). There is the converse risk that Australia could have exported the disease to new countries.

From an environmental perspective, there should be a highly precautionary approach taken to risks of future imports of eucalyptus and myrtle rust. There should be a review of current measures to see whether tighter quarantine restrictions are warranted. However, importing industries may oppose tighter restrictions, as may exporting industries out of concern that Australian exports will be restricted by other countries.

The incursion also highlights internal biosecurity risks. Some states and territories were slow to implement interstate restrictions on imports of Myrtaceae. Spread of disease into bushland is facilitated by the siting of many commercial plant operations next to bushland. Requiring buffer zones under planning laws could reduce risks of pathogen spread into bushland.

What should be done

Following are recommendations for responding to the environmental threats of myrtle/eucalyptus rust incursion.

Aim to keep further strains out of Australia: High priority should be given to keeping further biotypes of eucalyptus or myrtle rust out of Australia; new strains could considerably exacerbate the disease and the number of species affected.

Review biosecurity arrangements: Conduct an independent review to consider how national and state/territory biosecurity regimes could be improved to reduce the risk of further incursions and detection/eradication of the rust should further incursions occur.

Conduct research to assess ecological impacts: Develop a comprehensive ecological research program to assess the likely ecological impacts of the disease and management options. A scientific panel should be established to advise on the research program and management options.

Involve environmental NGOs and agencies in response management: Ensure that environment NGOs are accorded equality with industry groups in all government processes to respond to the disease and biosecurity arrangements. Environmental agencies should be involved in all relevant government decision-making.

Develop cost-sharing arrangements for priority actions in the national interest: Develop a national response to myrtle rust that involves cost-sharing for high-priority actions that are primarily in the public interest.

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