Global effort to build rust shield

PHOTO: BRAD COLLIS

In response to growing concern about the damaging effects of a South American fungus on eucalypts, Australian pathologists worked with ACIAR in a bid to protect Asian–Pacific plantations and Australia's native flora from the threat of an incursion

BY GIO BRAIDOTTI

In the aftermath of an Australian bushfire, one can observe scores of slender seedlings rushing to repopulate the scorched land. Many of these fast-growing plants—be they eucalypts, bottlebrushes or tea trees—tend to belong to the myrtle family, Myrtaceae, whose 155 genera include many species that are native, endemic and iconic to the southern hemisphere.

An infectious pathogen able to parasitise new growth after a bushfire, even if it leaves old growth unscathed, presents a troubling biosecurity threat, with the potential for serious consequences—and a fungus with precisely that capability has been found to exist. Fortunately it is, for now, half a world away, which is giving scientists some breathing space in which to prepare a countermeasure for when—rather than if—the fungus reaches Australia and the Asia–Pacific.

Commonly known as guava rust, the infectious fungus *Puccinia psidii* is indigenous to South America and was only known to infect native South American plants. However, by the early 1900s industrialisation had created the need for fuel in the form of fast-growing tree species. Railway companies imported Australian *Eucalyptus* species especially suited to that task.

According to Australian plant pathologist Dr Ken Old, who has 25 years' experience at CSIRO Forestry and Forest Products, the first published report of *P. psidii* infecting eucalypts occurred as early as 1929 in Brazil.

"Normally any one particular rust species infects a narrow range of hosts, usually only one genus of plants," Dr Old says. "But *P. psidii* is a strange rust because its host range is wide. A review done in the 1990s found it infected at least nine genera of Myrtaceae. With exposure, many more may prove susceptible."

Reports of rust-affected eucalypts persisted for decades, but the first notable epidemic—on *Eucalyptus grandis* seedlings sourced from South Africa and cultivated for Brazil's rapidly developing pulp and paper industry—did not occur until 1973. At that point, the pathogen gained a second common name—eucalypt rust—and a vastly expanded potential geographical range.

The airborne fungus has been on the move. In the 1930s it became established in Jamaica, where it infected the pimenta tree and severely disrupted the allspice industry. In 1979, it found its way to Florida, where it caused several outbreaks during the 1980s. In 2005, the pathogen really alarmed Australian pathologists when it crossed the Pacific and turned up in Hawaii. However, international researchers had by this time been collaborating closely.

Dr Old says pathologists and quarantine authorities in Australia have been aware for a long time that the rust is a potentially dangerous pathogen, but nobody really had any opportunity to do sustained research on the needs of Australia and its Asian–Pacific partners: "We needed much more information about the range of susceptible species, the parts of Australia threatened by outbreaks, and we needed a quick and accurate method for identifying the fungus in case of an outbreak."

In response, Dr Old approached John Fryer, then forestry coordinator for ACIAR, with a funding request for a three-year research project. It was approved in 2000. Of particular importance to the ACIAR project has been the involvement of Professor Acelino Couto Alfenas, of the Department of Phytopathology at the Federal University of Vicosa, Brazil, and Dr Michael J. Wingfield, Mondi Professor of Forest Pathology at the University of Pretoria, South Africa.

At the outset, half of the nine myrtaceous genera known to be rust-susceptible were native to South America. But that profile was unlikely to reflect the rust's true host range, since Australia hosts about 75 myrtaceous genera, compared with 45 for Central and South America. To obtain a better snapshot of *P. psidii* susceptibility, the ACIAR project made it possible to test not only a wide range of *Eucalyptus* species but also many more Australian native genera, including species of *Melaleuca*, *Leptospermum*, *Syncarpia* (turpentine), *Lophostomon* (brush box) and *Kunzea*.

Screening the seedlings was a major operation. Seed had to be selected or collected for a large cross-section of genera before being carefully transported to Brazil, where enough seedlings could be raised to infect and screen at Professor Alfenas's facilities. The testing was so extensive that even difficult-to-germinate, fruit-bearing rainforest species such as lillipilli were included.

"The facilities in Brazil made the whole thing possible," Dr Old says. "They include moist chambers where seedlings are incubated in the dark to maximise infection, before being moved to a glasshouse that offers temperature control to grow and then assess the inoculated plants for resistance or susceptibility. When we became involved, we assisted in setting up additional facilities to handle inoculated seedlings."

Overall, the testing found that Australian plants display a varied response to the rust pathogen, from highly resistant to highly susceptible.

"We found that some of the melaleucas are very susceptible to this rust," Dr Old says. "We tested *Melaleuca alternifolia*, the species used by the tea-tree industry along the coast in northern NSW and Queensland. We also tested a number of seed sources for *Melaleuca cajputi*, the tea tree commonly used in South-East Asia for its wood and its medicinal oil. Both these proved to be susceptible, which in itself poses a substantial threat."

Since eucalypts are usually transported as seed that can contain potentially contaminated plant material, efforts were also undertaken to test seed and pollen. Using samples from different Brazilian seed suppliers, the multinational team found that seeds and pollen can indeed carry spores of the rust disease.

That finding is likely to prove crucial for quarantine authorities, and also for the ability to run diagnostics to spot the pathogen. To help with that, the CSIRO research group developed a DNA-based tool using polymerase chain reaction (PCR) technology that requires only minute amounts of fungal samples to detect the rust.

As to what might happen should *P. psidii* breach Australia's mounting defences, Dr Old says it is difficult to predict the consequences. He adds that climatic conditions are likely to play a major role, and points to work done by team member Dr Trevor Booth to map the range the fungus is likely to have in Australia.

"Trevor looked at the climate at South American sites that are prone to rust epidemics," he explains. "Fortunately there are computer programs that allow you to compare the climatic profile of rust-prone areas with the climate anywhere else in the world."

When the climate-matching technique was applied to Australia and considered alongside information about susceptible flora, a map emerged of the most at-risk sites. The area encompasses the coastal region starting around Sydney and running up to Cape York Peninsula.

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"One comforting thing about this pathogen is that it mainly infects juvenile leaves, so crowns in established forests are unlikely to be infected," Dr Old says. "That limits the possibility for epidemics."

Despite the remaining uncertainties and the need for more research, the ACIAR project has already proved its strategic importance. In 2004, a particularly observant officer of the Australian Quarantine and Inspection Service noted spore-like material on wood imported from Brazil. Aware of the *P. psidii* threat, the service sent samples to the CSIRO laboratory in Western Australia, where it was confirmed that the rust had made its way to an Australian port. Additional tests also established that some of the spores were still viable.

Having proved its strategic worth, information derived from the ACIAR project has been made available to neighbouring Asian–Pacific countries to help the region defend against eucalypt rust incursions. Benefits have also accrued to Australia, South Africa and Brazil, whose eucalypt plantations alone are worth an estimated A$1.85 billion. In Australia, the data acquired from the ACIAR project is providing a basis for ongoing CSIRO research efforts as well as contingency plans to deal with the aftermath of an incursion. ■

PARTNER COUNTRIES: Brazil, South Africa

PROJECT: Assess the risk posed by a South American fungal pathogen to Australian and South African forests and native vegetation

DESCRIPTION: The project aims to assess risks from an incursion by eucalypt rust and develop the tools needed to protect Australasian and Asian–Pacific plantation eucalypts and native forests from outbreaks of the disease