Protecting our borders

A Scion Impact Statement 2008

The early detection of the fungal agent causing pine pitch canker saved the New Zealand forest industry from potentially substantial costs.

In November 2003, the New Zealand Ministry of Agriculture and Forestry suspended all shipments of Douglas fir cuttings from the USA and ordered the destruction of a recent consignment that had arrived in New Zealand. Scion's research into rapid identification of *Fusarium circinatum,* the fungal agent causing pine pitch canker had led to the detection of this potentially devastating disease. With a potential impact of about $500 million on New Zealand's production forestry estate early detection and eradication of such diseases is critical to sustaining New Zealand's third largest industry.

Scion's contribution did not stop there; results from their diagnostic tests prompted further quarantine restrictions. The Ministry of Agriculture and Forestry further tightened the procedures for importing plant material from the U.S. No area in the U.S. would be regarded as disease-free and therefore all *Pinus* or Douglas-fir seed from the U.S. would need to be imported into high security quarantine facilities in New Zealand. Finally, the importation of all *Pinus* or Douglas-fir nursery stock from any country would be prohibited [1]. The results from Scion's tests also led to the re-classification of areas in the U.S. where the material originated to be identified as areas where the disease was present. It also led to a number of questions, such as how widespread *F. circinatum* was in the USA and what other plant species were acting as asymptomatic hosts.

Los Angeles Times latimes.com

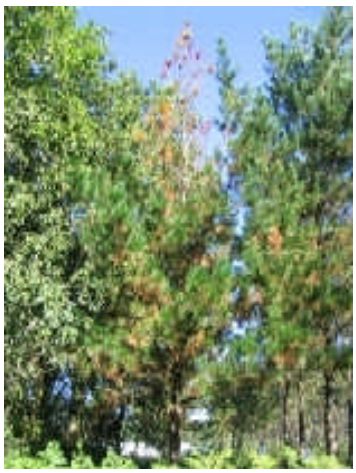
CALIFORNIA

Disease Afflicting Coastal Trees is Found in Sierra

By Bettina Boxall, Times Staff Writer

First discovered in California in 1986, the pitch canker has damaged native stands of Monterey pine as well as ornamental plantings from Mendocino to San Luis Obispo counties. The disease produces oozing cankers and causes branches to die back eventually killing trees.

The Sierra detection, announced Wednesday by the Forest Service, was made last year when a Douglas fir cutting from the Badger Hill seed orchard aroused suspicion in New Zealand, where it had been shipped.....



A mature *Pinus radiata* tree dying from multiple pitch canker infections.

These biosecurity measures are vital to the protection of New Zealand's production forestry assets, which are worth about $17 billion and contribute to around $3.5 billion of exports each year. Along with being New Zealand's third largest exporter, forestry is also a substantial contributor to employment and environmental outcomes such as land and soil protection and carbon sequestration.

Over 90% of those forestry assets are radiata

[1] Ormsby, M. 2004: Report on the Interception of *Fusarium circinatum* (Pitch Canker) on imported seedlings of Douglas-fir (*Pseudotsuga menziesii)* 11 February 2004. MAF Biosecurity Authority, unpublished report

pine. While the dominance of radiata pine is both a New Zealand strength – since handling single species reduces processing complexity - it also represents a very significant weakness in that all our biosecurity "eggs" are in one basket.

Fusarium circinatum, the fungal agent causing pine pitch canker, is one of New Zealand's most unwanted exotic forest pests[2] with potentially large economic consequences to the forest industry and the country as a whole if it became established. Radiata pine is highly susceptible and trials have indicated that 98% to 99.7% of New Zealand's stock is susceptible[3]. Other species such as Douglas-fir can act as hosts, but often show few symptoms. The fungus is also capable of spreading through nurseries very rapidly, with devastating losses[4]. Currently there is no effective treatment for the disease in mature trees. The fungus is present in a variety of locations world wide, and since the early 1990s has been recorded in South Africa, Chile, and Spain, but is still absent from New Zealand, thanks to quarantine measures underpinned by Scion capabilities.

Early detection of a newly introduced pest greatly increases the probability of its eradication. The cornerstone of early detection is an accurate and fast identification method. Initially, identification of *F. circinatum* involved incubating suspicious material and examining any fungi that grew. This testing process was lengthy and results were considered unreliable, as it was difficult to distinguish between this and a range of other closely related *Fusarium* species. Also tissues with no external symptoms have been found to be contaminated. It was therefore important that tests were developed that could quickly and accurately identify presence of *F. circinatum* on any imported material that could host the fungus.

Scion developed a molecular identification technique to identify *F. circinatum* from isolates of the fungus in culture. Initially this involved a molecular test on DNA extracted from fungal material that had been grown and cultivated in the laboratory. This test was developed in 1999-2000 and involved two researchers for some of their time at a total cost of about $30,000, funded through a FRST programme.

The roots and stem of a young *Pinus radiata* tree outplanted from a nursery that died from infection by *Fusarium circinatum*.

MAF, in its function of protecting New Zealand's forest industry, recognised the importance of ensuring the safe importation of new genetic material by having at its disposal tests that could reliably identify the presence of harmful fungi. During 2003-04, MAF funded research to develop this molecular technique further so that the presence of *F. circinatum* could be identified directly from contaminated plant tissue, at a cost of $43,650. This research involved two researchers. During 2004-05 MAF also funded development of a test that could detect the fungus in soil.

[2] Ganley, R. 2007: Pitch Canker: Risk of establishment in New Zealand based on a global perspective. New Zealand Journal of Forestry, Volume 52, Number 2. August 2007.
[3] Hodge, G.R. and W.S. Dvorak. 2000: Differential responses of Central American and Mexican pine species and *Pinus radiata* to infection by the pitch canker fungus. New Forests 19:241-258.
[4] Viljoen, A., M.J. Wingfield and WFO. Marasas

This work was funded at a cost of $38,330 and undertaken by three researchers. Soil was considered important because it is a common contaminant on containers and species of *Fusarium* were the most commonly isolated fungi[5].

The molecular identification technique proved its worth in 2003, when Douglas-fir stock was imported into New Zealand from the Sierra Nevada region of California - a region thought to be free of *F. circinatum*. To conform to the import standard, samples of tissue were regularly taken from imported material held in quarantine and tested for the presence of the fungus. In early November 2003, *F. circinatum* was identified by Scion in their capacity as a MAF approved diagnostic service provider, using the molecular technique developed by Scion scientists. The initial identification was later confirmed by Professor Tom Gordon, UCLA Davis, California.

This led to the destruction of the shipment and the subsequent review of *F. circinatum* in the USA.

It is worth reflecting on what could have happened if the infected material had not been intercepted, or was incorrectly diagnosed (noting that a second laboratory in New Zealand that received the Douglas-fir samples did not detect *F. circinatum*). As the stock was destined for a nursery, the result may have been infection of the receiving nursery, causing its closure and loss of production. An individual nursery producing three million plants would lose $0.5 million to $0.85 million worth of products each year, affecting the planting of 4000 ha. There would be the cost of treatment to ensure the disease was eradicated. There would also be ongoing costs in the years following the outbreak. It would take a couple of years for other nurseries to compensate for the loss of production, and there would be costs of monitoring to ensure eradication had been achieved.

The impact of the disease, if it had spread beyond the nursery and into plantation forests, is uncertain. The cost of eradication is estimated to be $15,500 per hectare for the timber lost[6]. Hence, an eradication attempt over 1000 hectares would cost $15.5 million[7]. In one study, $250 million in net present value terms was quoted as the cost to New Zealand if the disease were to take hold. Assuming that the disease could spread at the rate of 100 km per year, it would take about 20 years for infection to cover most forest areas, and once established there will be 2% increase in mortality, a 25% reduction in growth rate and a 50% increase in stem deformation. A more recent study estimated the potential cost to New Zealand of pitch canker as $565 million (2003-2040, 10% discount rate), compared with a $0.01 million cost of eradication[8]. Whatever estimate is used, it is clear the research that led to the development of a molecular detection technique provided an extremely large benefit to New Zealand's forest sector and economy for a relatively small cost.

[5] Gadgil, P.; Dick, M.; Simpson, J.; Bejakovich, D.; Ross, M.; Bain, J.; Wylie, R.; Horgan, G.2002: Management Plan for Response to an Incursion of Pine Pitch Canker for Australia and New Zealand, Forest Research, Rotorua, New Zealand. 121p.

[6] Dick, M; Horgan, G.P.; Bain, J. 2003: Pine Pitch Canker – The Threat to New Zealand. Forest Research, Rotorua, New Zealand.

[7] Gadgil, P.D., Bulman, L.S.; Glassey, K.L. 2003. Quarantine risk associated with air cargo containers. New Zealand Journal of Forestry Science 32: 28-47.

[8] Dr James Turner, Resource Economist, Scion, Rotorua, pers.comm