Healthy trees, healthy future
Enabling technologies to combat *Phytophthora* diseases

News

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Introducing the kauri killer, *Phytophthora agathadicida*

Kauri (*Agathis australis*) trees are slow growing venerable giants of northern forests. These iconic trees are special to all New Zealanders, particularly Māori who individually named each of the most revered trees.

In recent times, kauri dieback disease – caused by a fungus-like organism (oomycete) with the interim name *Phytophthora* 'taxon Agathis' (PTA) – has caused significant harm; there are currently no effective methods of managing the disease. Given the very slow regeneration time of kauri, the kauri dieback pathogen is of major concern.

Recently, Weir et al. 2015 published a taxonomic paper describing the kauri dieback pathogen as a new species: *Phytophthora agathidicida* (the 'Agathis-killing *Phytophthora*'). Isolates were obtained from kauri trees and soils, and closely related taxa and isolates were obtained from researchers and culture collections around the world. Eight genes were sequenced from each isolate, and a robust phylogenetic tree constructed (Figure 1).

Morphological measurements were taken of sexual and asexual spores (Figure 2), cultures, growth rate on four media and temperature optimum. These data were used to formally describe *P. agathidicida* as a new species, and clarify the taxonomy and nomenclature of related species, including describing another new species *P. cocois*, a pathogen of coconut trees.

The formal name is important for clear scientific communication between biosecurity agencies, commercial operators, researchers and the public. Gene sequencing, which was done as part of the species description, shows very low genetic variation in *P. agathidicida* (reflecting a 'founder population'), supporting the hypothesis it is an exotic incursion rather than a native species.

This new understanding of its genetic relationship to similar species will be useful to the Kauri Dieback Programme and others seeking to understand and control this devastating disease.

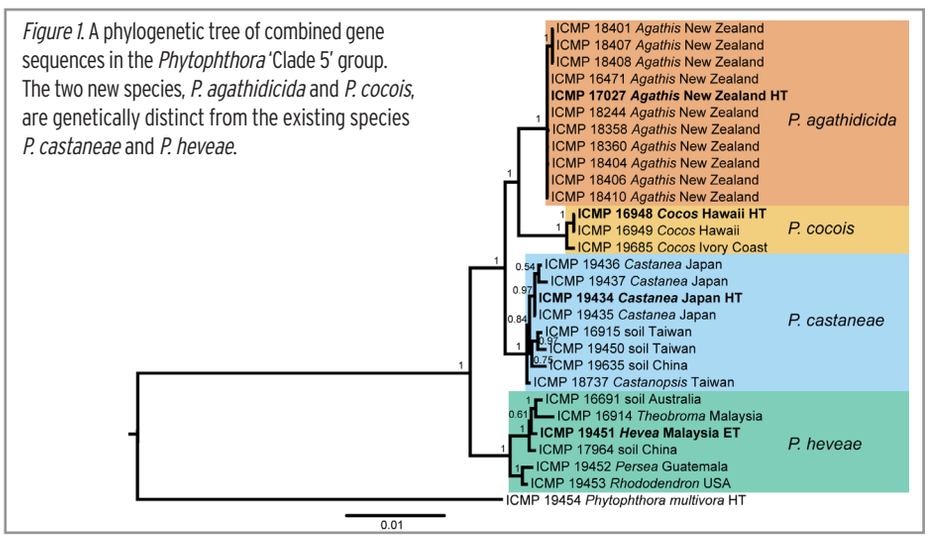
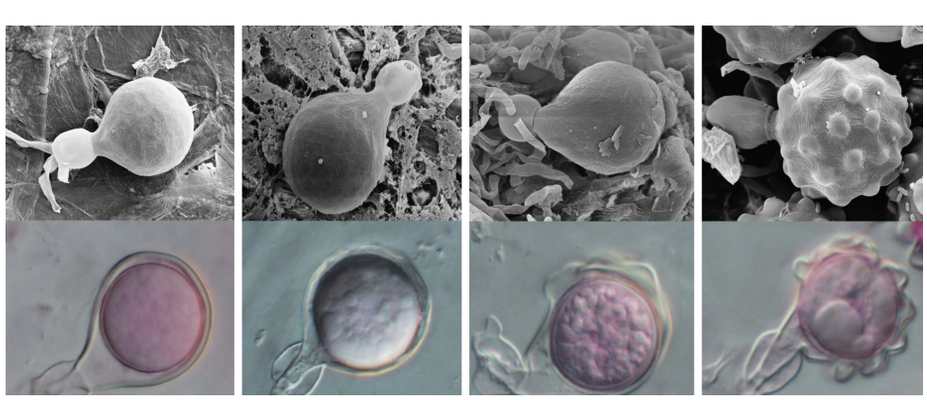


Figure 1. A phylogenetic tree of combined gene sequences in the *Phytophthora* 'Clade 5' group. The two new species, *P. agathidicida* and *P. cocois*, are genetically distinct from the existing species *P. castaneae* and *P. heveae*.



P. heveae *P. agathadicida* *P. cocois* *P. castaneae*

Figure 2. The most reliable morphological character within Clade 5 is shape and surface texture of the oogonium (sexual spore) illustrated here. The spore surface ranges from completely smooth in *P. heveae*, to coarsely bullate in *P. castaneae*.

Forest Genetics for Productivity Conference: the next generation

14-18 March 2016
Rotorua Energy Events Centre, Rotorua.

Scion is proud to host this International Union of Forest Research Organization's (IUFRO) conference. The five day event will focus on breeding productive and resilient forests; finding synergies in genotype, environment and silviculture; and genomics and phenomics. The conference is expected to attract around 200 delegates from all over the world.

Confirmed keynote speakers are Professor Brian Cullis (Australia), Professor Dario Grattapaglia (Brazil), Dr Antoine Kremer (France), Professor Dr Ulrich Schurr (Germany), Dr Jerry Tuskan (USA) and John McEwan (New Zealand). A 3-day post-conference tour to the South Island is offered by the conference organisers, encompassing forest productivity with a special added taste of New Zealand.

For further information, and to register, visit: www.fgpc2016.nz/fgp16

Building international linkages and meaningful collaboration

Vincent Bus (right) from Plant & Food Research, discussing apple root stock production with Professor Everett Hansen.

The HTHF scientists are conscious of keeping in regular contact with the research activity of collaborators and associated researchers, and to develop research linkages, networks and feed-back mechanisms across the programme. Now, 18 months into the research, it was our pleasure to welcome Professor Everett Hansen from Oregon State University, in May.

Everett reviewed and provided feedback on the HTHF programme and associated *Phytophthora* research. Key focus points of the visit were to observe red needle cast in radiata pine and Douglas-fir, discussions on *Phytophthora* resistance breeding, and integrated disease management in each of the tree plant systems being studied in the HTHF programme. Everett was well positioned to comment given his observations and many years of experience in Oregon working on a variety of different *Phytophthora* species, including the first isolation and subsequent identification of *P. pluvialis*.

Ironically, the late onset of winter rains this year meant that there was no red needle cast to be seen during Everett's visit, but remnants of last year's defoliation stimulated discussions in contrast to emerging observations of *P. pluvialis*-associated defoliation in Douglas-fir in Oregon. Everett commented that we've done excellent work developing methods for controlled inoculations for resistance challenge tests and tree genotype screening. The programme presents abundant opportunities for important discovery.

This visit seeds what we hope will be an ongoing interaction with Oregon State University, especially given mutual interest in the role of *P. pluvialis* in foliar forestry diseases.

In August, we hosted Professor Nik Grunwald who specialises in *Phytophthora* genomics and population genomics, with a reciprocal visit to Oregon State University currently underway by Dr Nari Williams. Our Ph.D. students, Simren Brar and Mireia Gomez, will each visit Oregon State University for components of their candidature in 2016 and 2017, respectively.

What does resistance look like? Delving into the infection process over time

A central dogma of plant pathogen research is the disease triangle, in that infection and disease are assessed with consideration of the pathogen, host and environment in which infection occurs. Or, the disease pyramid considering impacts and responses over time.

Key to our investigations of what *Phytophthora* species are doing on plants, is the question of what resistance will look like and whether it will be durable in the life span of the tree. For instance, is resistance a slower rate of growth by the *Phytophthora* on host tissue; the production of inhibitors by the host; or a delay or interruption of the pathogen's reproduction which limits the establishment of a disease epidemic. Understanding which of these mechanisms is at play is central to identifying durable resistance and markers which enable broad resistance.

Results emerging from the observation of *Phytophthora pluvialis* on the surface of one resistant and one susceptible genotype of radiata pine have shown that while *P. pluvialis* may be present in inoculated pine needles, the behaviour of the pathogen is quite distinct. Sporangia, the structures from which the infective motile zoospores are released, are produced in abundance on the needles of the susceptible genotype but are very rare on the resistant genotype.

The metabolic and genetic signatures associated with the infection profiles of the susceptible and resistant genotypes, are in the process of being analysed. Preliminary results are promising and show a distinctive biological response to infection, which is of direct relation to the epidemiology of the pathogen (Figure 3).

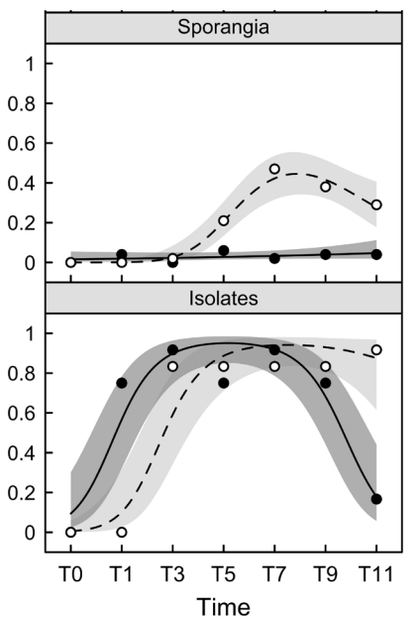


Figure 3. Profile of *Phytophthora* activity in one susceptible (●) and one resistant (○) genotype of *P. radiata*, showing the proportion of segments with sporangia (Panel A) and rates of re-isolation (Panel B) present/absent from the point of inoculation (T0) up to 11 days post inoculation (T11).

To learn more about the HTHF programme

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Visit our website and subscribe to our quarterly newsletter
www.healthytrees.co.nz

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