

Molecular Genetic Studies Highlight Potential Threat of Guava Rust (AKA 'Ōhi'a Rust, in Hawai'i) to Myrtaceae

*This is a summary of the seminar, "Molecular genetic studies to characterize guava rust (*Puccinia psidii*): An invasive pathogen of native Hawaiian forests and a potential threat to Myrtaceae worldwide," presented at the University of Hawai'i at Mānoa on July 13, 2010 by Rodrigo Neves Graça, of the Universidade de Viçosa in Brazil. A partial list of cooperators include Washington State University, University of Hawai'i, University of Idaho, US Forest Service, Hawai'i Department of Land and Natural Resources Division of Forestry and Wildlife, and the US Geological Survey.*



'Ōhi'a rust on rose apple in Hawai'i.

Guava rust was first described in 1884 in Brazil. It is present in Central and South America. It is also known to be present in the Caribbean, Mexico, Florida, California, Hawai'i (2005), and Japan (2007). Although officially unverified as *P. psidii*, a genetically very similar rust has appeared in early April 2010 in a nursery near Sydney, Australia.

The combination of favorable conditions (warm, moist climate) combined with susceptible hosts (the rust infects young leaves and tissue) play a role in level of outbreaks. In Brazil, there are several outbreaks per year, and it is considered one of the most important pests of non-native eucalyptus in large plantations there.

The rust is able to spread long distances via the wind, but can spread to otherwise inaccessible locations when infected plants in the Myrtaceae moved for commercial purposes including for nursery, timber species, biofuel plants, and cut flowers.

The rust infects susceptible plants by secreting a protein enzyme to penetrate the leaf tissue (it does not need an opening or leaf injury). Resistance by resistant plants is controlled by a gene, which allows cells around the penetration site to die, which starves and kills the fungus. In at least some Myrtaceae, some individuals apparently have the gene for resistance, and some do not. Remarkably, this is true even in Australian *Eucalyptus* species (e.g., *E. grandis* is best studied) which have evolved for millions of years in the absence of this rust, but may likely have been exposed to some other rust or related fungi.

Multiple strains of the rust have been identified in South America. Thirty genera of Myrtaceae are affected by one or more strains. Some species are highly resistant to some of the rust strains, while susceptible to other strains. In Hawaii, some of the characteristically susceptible species such as guava are not affected.

Preliminary results indicate that rust strains are uniquely associated with specific Myrtle family species across diverse geographic locations (for example, the same strain of rust can be found affecting *Eucalyptus grandis* in plantations across Brazil). This information will help identify rust strains that may pose particular threats to different Myrtle species.

From samples taken throughout a wide range of infected plants in Hawai'i, it appears that there was a single introduction of a single strain of the rust, which seems not to have evolved any genetic differences from the founding genotype (they are all genetically the same). In addition, they are distinct from all known Brazilian isolates studied so far.

Research in Brazil shows that there are multiple strains of the rust, each affecting different species of Myrtle family plants to varying degrees. Researchers in Hawai‘i are concerned that rust strains not yet present in Hawai‘i could prove devastating to other Myrtle family plants, including ‘ōhi‘a.

In addition, researchers documented in the lab that a clone of *Eucalyptus grandis* (an important forestry species bred for resistance to the particular strain of *Puccinia psidii* that it was susceptible to), maintained its resistance for ten years, then suddenly became susceptible to a strain

that had apparently never been present before. This disturbing event demonstrates the ability of the rust to undergo genetic evolution to attack a previously resistant host, at least in its home range (where genetic variability is highest). This may indicate that the strain of rust currently present in Hawai‘i, could someday become more virulent on ‘ōhi‘a or other Myrtaceae species that are not currently affected.

Why be concerned about the introduction of new *P. psidii* strains to Hawai‘i?

- Potential for more severe damage on its current hosts;
- Potential increased risk of evolution of increased virulence on ‘ōhi‘a and other hosts
- New strains may infect new hosts in Hawai‘i;
- Previous history of overcoming the resistance gene is documented.

In 2007, an interim quarantine was imposed to restrict the importation of all plants and plant parts in the family Myrtaceae from areas known to be infested with ‘ōhi‘a rust. Although *P. psidii* was intercepted twice on incoming Myrtaceae in cut flowers during that time, the rule was allowed to expire.

Due to the potential of other strains of rust being transported to Hawai‘i on Myrtaceae products, and the potential for new strains to exchange genetic material with Hawaii’s current strain and to evolve, the researcher urged Hawai‘i to restrict the import of Myrtaceae. Regulations quickly instituted in Australia provide potential models for regulations. In addition, the Australians have developed a molecular diagnostic test capable of detecting as few as a couple of spores/cells of the rust. In discussion, UH Mānoa project cooperater Dr. Janice Uchida believes that this would be modest in cost and feasible for Hawai‘i to test Eucalyptus seeds for *P. psidii*, as one example.

Next steps:

If Brazilian researchers can obtain samples of the rust strains present in California, Florida, Mexico, Hawai‘i, Japan, and Australia, they will be compared to see if they are more closely related, and perhaps enable a trace-back of the movement of the rust. ‘Ōhi‘a will also be tested in the lab in Brazil with various strains of the rust to see if any are particularly virulent (although the researcher again pointed to the possibility that any strain may change over time).

Hawai‘i Department of Agriculture will pursue administrative rule changes restricting the importation of Myrtle family plants into Hawai‘i in 2011.



Dead rose apple trees underscore the potential threat of new rust strains to Myrtaceae like ‘ōhi‘a.