

Incidence and Evaluation of a New Rust Disease on Myrtaceae in Hawaii: *Puccinia psidii* Winter, Guava Rust

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Background

Distribution: The rust disease, *Puccinia psidii* Winter, or guava rust, was originally described in 1884 from infections on guava in Brazil. Until 2005 this pathogen was unknown outside the Neotropics and the state of Florida. It was first detected in Hawaii in the spring of 2005 on ohia-lehua (*Metrosideros polymorpha* Gaud) and has since spread from Oahu to all major Hawaiian Islands (Killgore and Heu, 2005).

Host Range: *Puccinia psidii* has an unusually broad host range for a rust. Worldwide, the host range currently includes 21 genera and 72 species of Myrtaceae, including such common tropical species as *Eucalyptus* and guava (Simpson and others, 2006). The host range of the pathogen in Hawaii includes 18 susceptible plant species in the family Myrtaceae, including common and endangered native Hawaiian species and numerous introduced species, some of which are invasive and widespread.

Biology: *Puccinia psidii* is generally thought to be a hemicyclic, autoecious rust (Coutinho and others 1998), but some authors think it may actually be a heteroecious macrocyclic rust with an unknown alternative aecial host (Simpson and others 2006). It affects leaves and meristems, inhibiting normal growth and development, and is particularly severe on seedlings, cuttings, saplings, and coppice (Ryachhetry and others 2001). The existence of numerous races, and/or clones of *P. psidii* differing in host pathogenicity (MacLachlan 1938; Tommerup and others 2003) and a wide variation in susceptibility within host plants and provenances have been reported (Simpson and others 2006).

Impacts: Spread of *Puccinia psidii* is a serious threat to forests and forestry in Hawaii and the Asia-Pacific region. Its presence in Hawaii increases the chance of spread to Asia and the Pacific region where host species are important biologically and economically. The pathogen has been a problem in *Eucalyptus* plantations in Brazil and is considered a serious threat to *Eucalyptus* plantations worldwide (Coutinho and others 1998). The strong selection pressure by *P. psidii* on Myrtaceae in its native range suggests a very significant threat to native species of Myrtaceae in the Asia-Pacific region (Simpson and others 2006). Its presence in Hawaii is particularly troubling because ohia-lehua is the dominant overstory tree in over 80% of Hawaii's native forests and is present over a broad environmental gradient in early to late successional stages. Native plant community function, particularly reproductive capacity, could be seriously affected by the spread of the rust.

Hosts of *Puccinia psidii* in Hawaii

*Eucalyptus dunali**
paperbark
*Eucalyptus grandis**
rose gum
*Eucalyptus microcorys**
tallow-wood
*Eucalyptus smithii**
paperbark
*Eucalyptus torelliana**
paperbark
Eugenia koolauensis
nii
Eugenia paniculatum
bush cherry
Eugenia reinwardtiana
nii
Eugenia uniflora
surinam cherry
Melaleuca quinquenervia
paperbark
Metrosideros polymorpha
ohia-lehua
Myricaria cauliflora
jaboticaba
Myrtus communis
myrtle
Psidium guajava
guava
Rhodomyrtus tomentosa
downy rosemyrtle
Syzygium cumini
java plum
Syzygium jambos
rose apple
*Syzygium malaccense**
mountain apple

Species in green are Hawaii native or indigenous species
* artificial inoculations in laboratory

Figure 1. Ohia seedling with pustules.



Photo by D. Ogata

Figure 2. Rose apple dieback caused by *P. psidii*.



Photo by R. Hauff

Survey Objectives and Methods

Determine environmental range of the disease on the native and naturalized Myrtaceous species in Hawaii.

- Survey within 1 m of the edge along trails and roads in representative natural areas throughout the State for symptomatic plants.
- Compile information on disease presence, location and impacts from other field researchers and managers throughout the state.
- Map and correlate disease incidence with environmental factors, including elevation, temperature, rainfall, and prevailing wind direction (windward/leeward).

Determine host range of disease in Hawaii.

- Inoculate ohia and other species with urediniospores collected from infected ohia. Confirm formation of uredia (rust pustules) for pathogenicity.
- Collect urediniospores collected from different hosts forest areas and multiply in the laboratory for cross pathogenicity tests.
- Conduct cross pathogenicity tests between rust isolates collected from ohia-lehua and other Myrtaceous species recorded as hosts in Hawaii (e.g., *Eugenia* spp., *Melaleuca quinquenervia*, *Psidium guajava*, *Rhodomyrtus tomentosa*, *Syzygium* spp.).

Develop a disease severity index.

- Develop a severity index for each host based on amount of leaf area infected.

- Produce descriptive photos.

- Publish a guide for natural resource and conservation organizations and nurseries.

Determine incidence of disease transmission in natural forest areas.

- Monitor infected rose apple (primary host in Hawaii) throughout the year to assess the occurrence of rust epidemics.
- Assess spread by observing susceptible species adjacent to epidemic outbreaks for visible signs of infection.
- Correlate incidence of epidemics and transmission with season, host phenology, weather, existing sources of inoculum, and wind direction.

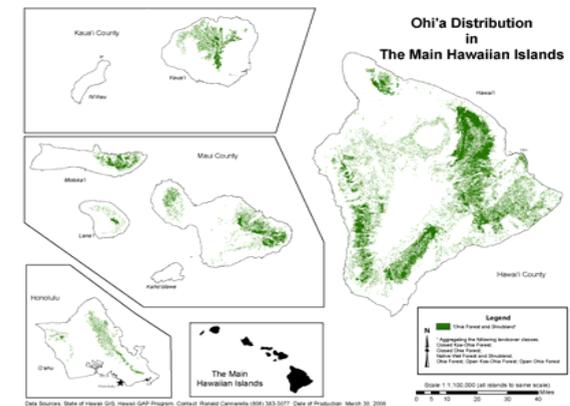
Related Surveys and Research

Complementing the forest survey, the Hawaii Agricultural Research Center is carrying out a nursery survey for *P. psidii*. Nurseries on all of the main islands that provide seedlings to forestry and conservation are being targeted. Data such as host species, disease severity, and host species growing in adjacent natural areas are being collected.

Other related work on *P. psidii* includes molecular work conducted by the University of Hawaii. Dr. Zhong is analyzing genetic material to characterize the disease in Hawaii and comparing it to DNA samples from Brazil and Florida. Disease material from the forest survey will be provided for Dr. Zhong's molecular work to determine variation within Hawaii. His work could support future quarantine rules for preventing further races of *P. psidii* from entering the Hawaii and provide rapid identification capability for detecting spores on imports.

Rob Anderson, a doctoral student at the University of Hawaii who is carrying out the survey, is conducting additional research on disease transmission, pathogenicity testing of Hawaiian Myrtaceae including different varieties of *M. polymorpha*, and describing the life cycle of the disease.

Aerial detection surveys for impacts of *P. psidii* in native forests using a combination of spectroscopy and LIDAR are being explored in collaboration with Stanford University



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