GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: ***Puccinia psidii***

Puccinia psidii **System:** Terrestrial

Kingdom	Phylum	Class	Order	Family
Fungi	Basidiomycota	Teliomycetes	Uredinales	Pucciniaceae

Common name myrtaceae rust (English), eucalyptus rust (English), guava rust (English), ohi`a rust (English, Hawaii)

Synonym
Aecidium glaziovii , P. Henn.
Bullaria psidii , G. Winter (Arthur & Mains)
Caeoma eugeniarum , Link
Puccinia actinostemonis , H.S. Jackson & Holway
Puccinia barbacensis , Rangel
Puccinia brittoi , Rangel
Puccinia camargoi , Putt.
Puccinia cambucae , Putt.
Puccinia eugeniae , Rangel
Puccina grumixamae , Rangel
Puccinia jambolana , Rangel
Puccinia jambosae , P. Henn.
Puccinia neurophila , Speg.
Puccina rochaei , Putt.
Uredo cambucae , P. Henn.
Uredo eugeniarum , P. Henn.
Uredo flavidula , Wint.
Uredo goeldiana , P. Henn.
Uredo myrciae , Mayor
Uredo myrtacearum , Paz.
Uredo neurophila , Speg.
Uredo puttemansii , P. Henn.
Uredo rangelii ,. J.A. Simpson, K. Thomas & C.A. Grgurinovic
Uredo rochaei , Putt.
Uredo seclua , H.S. Jackson & Holway

Similar species

Summary
The Eucalyptus rust (*Puccinia psidii*) is a pathogenic fungus with a very broad host range in the myrtle family (Myrtaceae). It was first described from common guava (*Psidium guajava*) in Brazil in the 1880s and is also known as guava rust. *P. psidii* is native to South and Central America, but has spread to a number of Caribbean islands, Hawai'i, Florida and California. The fungus attacks young tissues of plants and can cause deformation of leaves, heavy defoliation of branches, dieback, stunted growth and sometimes death. The rust disease has caused serious damage in *Eucalyptus* plantations in South and Central America, the Caribbean and North America with significant economic impacts. Eucalyptus rust also threatens to disrupt ecosystems by causing damage to dominant forest trees, such as the *ohia* in Hawai'i. There is concern that it may spread to New Zealand, Australia, South Africa and Brazil where many native species in the Myrtaceae family are widely distributed.

[view this species on IUCN Red List]

Species Description

Puccinia psidii first appears as chlorotic specks that develop into pustules containing uredinia which produce yellow masses of urediniospores. Pustules can coalesce and parts of the plant can be completely covered with pustules. (Liberato *et al*. 2007). Uredinia occur mostly on the underside of leaves, on stems and on flowers and fruit. They appear as pale yellow to yellow-orange dusty spots 0.1-0.5mm in diameter, in groups on brownish or blackish spots up to 5mm. Urediniospores are globose and ellipsoid to ovoid in shape, measuring 19-27 x 15-26 µm. The spore cell walls echinulate, hyaline to yellowish in colour and 1.5-2.5 µm thick with germ pores obscure (Hernández 2006).
Teliospores appear in the uredinia or telia (Liberato *et al*. 2007). Teliospores are club shaped, ellipsoid to oblong measuring 30-48 x 17-22µm.They are rounded at the apex, narrow below and slightly constricted at the septum. The cell walls are pale yellow in colour, smooth and measure 1.5-2.5 µm thick at sides and 2-4 µm at apex (Hernández 2006). Teliospores are bicellular, and both cells can germinate to form basidia. Basidia are 40 to 70 µm in length and only 0.1% produce basidiospores, which are borne on sterigmata (Ferreira 1989 in Coutinho *et al*. 1998). It is not known if the basidiospores are uni- or bi- nucleate (Simpson *et al*. 2006). Aeciospores are morphologically identical to urediniospores (Liberato *et al*. 2007).
Symptoms on susceptible hosts appear as brown to grey lesions with masses of yellow or orange-yellow urediniospores on young, actively growing leaves, shoots, fruits and sepals. Lesions may have sori containing dark brown teliospores. Purpling of leaf and shoot margins occur on older lesions in some host species. Severe disease in young trees may kill shoot tips, causing loss of leaders and a bushy growth form to develop. In eucalypts prolific branching and galling is a symptom of previous rust infection (Glen *et al*. 2007).
Please see PaDIL (Pests and Diseases Image Library) Species Content Page Fungi: Eucalyptus rust for high quality diagnostic and overview images.

Notes

The anamorphic (asexual) stage/morph of *Puccinia psidii* is *Uredo psidii*. A detailed description is available in Simpson *et al*. (2006).
Several races or biotypes of *P. psidii* are known to exist, which differ in their host specificity, environmental tolerances, characteristics of sporulation and spore survival, and virulence. However very little is known of these specialized forms (Glen *et al* 2007).

Lifecycle Stages

Puccinia psidii has variously been reported as an autoecious species, meaning that it uses only one host for its lifecycle (Loope and La Rosa 2008) and heteroecious with an undetermined alternate aecial host (Simpson *et al*. 2006). It has a macrocyclic life cycle, producing aecia, uredinia, telia and basidia which produce aeciospores, urediniospores, teliospores and basidiospores respectively. Spermatia have not yet been found, but due to the reported occurrence of aecia this stage must exist (Coutinho *et al*. 1998). The asexual dikaryotic urediniospores are the most prevalent stage in the life cycle. Teliospores and basidiospores are rare in nature, although teliospores are more frequent on some host species. Telia are usually produced under hot weather or on mature plant tissue. Aeciospores have not been observed or recognised in nature as they are morphologically identical to urediniospores (Glen *et al*. 2007). Old *et al*. (2003) report that \"Disease spread results from airborne urediniospores alighting on leaf surfaces and germinating during darkness and conditions of leaf wetness at temperatures of 15–25°C. Rust lesions then become visible 2–4 days later. Penetration of mature leaves is generally unsuccessful and this is consistent with the observation that, on Eucalyptus, trees less than two years old are susceptible to disease. Coppice shoots of older trees are, however, vulnerable to infection due to their juvenile foliage\". Following penetration on a susceptible plant, the fungus grows intercellularly through the host tissue and produces haustoria within host cells. Germ tubes of basidiospores and aeciospores have been reported to penetrate the host directly (Coutinho *et al*. 1998). In incompatible reactions, caused by non-host species or resistant varieties smaller atypical pustules are formed on leaves (Ferreira and Silva 1982 in Coutinho *et al*. 1998). Hypersensitive reactions, where death of a few cells at the site of penetration have been observed in some non-compatible reactions (Coelho 1988; Ferreira 1989 in Coutinho *et al*. 1998).
A diagram detailing the lifecycle of *P. psidii* is available in Glen *et al*. (2007).

Uses
In Florida, the pathogen has been considered as a biological control agent for the invasive Australian plant, *Melaleuca quinquenervia* (Rayachhetry *et al*. 2001).

Habitat Description
Puccinia psidii has a remarkably wide host range for a rust pathogen (Tommerup *et al*. 2003). Over 70 species in 20 genera of the Myrtaceae family are hosts for *P. psidii* (Simpson *et al*. 2006), and all genera in this family are potentially susceptible (Old *et al*. 2003). It was recently discovered that the fungus is able to infect a species in the Heteropixidaceae family (Alfenas *et al*. 2005). Evidence of host specialisation exists within the pathogen, so isolates from one host genus may or may not infect other genera within Myrtaceae (Old *et al*. 2003).

Reproduction
Asexual: The asexual dikaryotic urediniospores are the most prevalent stage in the life cycle (Coutinho *et al*. 1998).
Sexual: It is not known if *P. psidii* is homo- or hetero-thallic. It is possible that *P. psidii* is apomictic and the first spores produced from basidiospore infections are already urediniospores (Simpson *et al*. 2006).

General Impacts
Puccinia psidii affects members of the Myrtaceae family. According to Liberato (2007) \"The fungus attacks young tissues of new leaves, fruits, flowers, shoots and succulent twigs. The first symptoms are chlorotic specks which become, after a few days, pustules containing uredia producing yellow masses of spores. Pustules can coalesce and parts of the plant can be completely covered with pustules. After about 2-3 weeks, pustules dry and become necrotic. The disease can cause deformation of leaves, heavy defoliation of branches, dieback, stunted growth and even death. On fruits of guava (*Psidium guava*, *Psidium* spp.), Ruberry (*Myrcia* spp., *Myrciaria* spp.) and other native American hosts in the Myrtaceae, the lesions occur mostly on buds and young fruits that eventually rot as the rust matures.\"
Tommerup *et al*. (2003) report that “The disease is particularly severe on susceptible eucalypt seedlings, cuttings, juvenile trees, or coppice from stumps or damaged mature trees. Heavy infection of juvenile eucalypt shoots causes plants to be stunted and multi-branched, reducing their potential to develop into marketable trees”. There is wide variety in susceptibility to *P. psidii* among young eucalypt trees. Usually around 10-20% of a stand is highly susceptible, causing gross malformations and death. The pathogen is particularly virulent on species with no evolutionary history of exposure (naïve hosts) (Loope and La Rosa 2008).
P. psidii has already had devastating impacts on some industries. Oil refineries based on *Pimenta dioica* in Jamaica were forced to close two years after *P. psidii* was first recorded on the island (Maclachlan 1938 in Booth *et al*. 2000).
There is also potential for this pathogen to cause damage in natural ecosystem. The family Myrtaceae consists of approximately 3600 species in 155 genera distributed across Australia, South-east Asia, New Caledonia and other Pacific Islands, South and Central America and southern Africa (Tommerup *et al*. 2003). In many of these countries susceptible trees are significant components of communities. For example in Australia many ecosystems are dominated by *Eucalyptus* (Booth *et al*. 2000), and in Hawai'I the *ohia* (*Metrosideros polymorpha*) is the dominant tree in most of Hawai'I's forests. Outbreaks of *P. psidii* which affect these dominant trees could result in significant changes to the structure, composition, and potentially, the function, of forests on a landscape level. This would likely have impacts on biodiversity of other flora and fauna in these ecosystems (Loope and La Rosa 2008).

Management Info

Preventative measures: Quarantine restrictions are the most effective means of preventing introductions of potentially virulent strains of *Puccinia psidii* (Loope and La Rosa 2008). In 2007 the Hawai'ian state Board of Agriculture passed an order which banned plant products from California, Florida and South America that could be disease hosts. The ban includes any plants of the Myrtaceae family (Tanji 2007).

Detection and Prediction: Early, rapid and accurate pathogen diagnosis is critical for management of high-quarantine-risk pathogens such as *P. psidii*. Langrell *et al*. (2008) developed a species-specific, nested polymerase chain reaction (PCR)-based detection assay for *P. psidii*. They report that “The assay reliably, accurately and sensitively detected the rust from naturally infected, geographically widespread eucalypt and fruit tree plantation and nursery species from diverse tissues types including symptomless or cryptically contaminated plants or plant tissue.” This assay provides an effective biosecurity tool for rapid responses to threats or incursions of *P. psidii* (Langrell *et al*. 2008).

Booth *et al*. (2000) modeled disease-prone regions using climate interpolation and disease-hazard mapping methods. They showed that areas highly prone to the rust occur across tropical and subtropical regions globally. These areas are likely to coincide with major eucalypt- and melaleuca-oil production areas (Booth *et al*. 2000).

Chemical: Fungicide use is most appropriate in nurseries and clonal hedge plantings, as it is not cost effective for large areas. Fungicides used include the protectant fungicide mancozeb and the systemic fungicides triamenol and triforine. In most cases, however, resistant trees are chosen over susceptible varieties, eliminating the need for fungicides (Old *et al*. 2003).

Biological: There are a number of biological control agents with potential for management of *P. psidii*. *Bacillus subtilis* was found to be effective in reducing in vitro germination of *P. psidii*, although there are no field experiments to confirm this and it may be difficult to reproduce in vivo (van Toor *et al*. 2005 in Glen *et al*. 2007). However these initial results are promising and deserve further investigation.

Other biological agents with potential include *Fusarium decemcellulare*, a hyper-parasite of *P. psidii* (Amorium *et al*. 1993 in Glen *et al*. 2007), and other fungi which co-occur in rust pustules. Strains of rhizobacteria (*Pseudomonas aeruginosa*) which have been demonstrated to induce systemic resistance in some trees may be developed into tools for managing disease (Glen *et al*. 2007). Glen *et al*. (2007) however, state that “Much further work is also necessary before any fungus or bacterium can be recommended as a biological control agent.”

Breeding Resistance: According to Glen *et al*. (2007) “Resistance represents the most economically viable approach to controlling *P. psidii* where it has become established.” In Brazil guava cultivars have been evaluated for resistance, and resistant progeny selected for breeding (Ribeiro and Pommer 2004). Also elite hybrid clones of *Eucalyptus grandis* and *E. grandis* x *Eucalyptus rophylla* are widely used by the cellulose and paper industry in Brazil as *E. grandis* is highly susceptible to *P. psidii* (Junghans *et al*. 2004 in Glen *et al*. 2007). Selection of resistant species and clones has been a high research priority in Brazil (Xavier *et al*. 2001 in Glen *et al*. 2007). A single dominant allele conferring rust resistance has been identified and mapped in *E. grandis* (Junghans 2000; Junghans *et al*. 2003 in Tommerup *et al*. 2003), which will further assist selection of resistant offspring.

Pathway

Principal source: Glen *et al*. 2007; Loope and La Rosa 2008; Simpson *et al*. 2006; Tommerup *et al*. 2003.

Compiler: IUCN SSC Invasive Species Specialist Group (ISSG) with support from the Ministry of Agriculture and Forestry (MAF)- Biosecurity New Zealand

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ALIEN RANGE

[1] ARGENTINA
[1] AUSTRALIA
[1] COSTA RICA
[1] CUBA
[1] DOMINICAN REPUBLIC
[1] EL SALVADOR
[1] GUATEMALA
[1] JAMAICA
[1] JAPAN
[1] MEXICO
[1] PUERTO RICO
[1] TAIWAN
[1] TRINIDAD AND TOBAGO
[3] UNITED STATES

Red List assessed species 1: EN = 1;

Eugenia koolauensis **EN**

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