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Uredo rangelii, a taxon in the guava rust complex, newly recorded on Myrtaceae in Australia

A. J. Carnegie[A,F], *J. R. Lidbetter*[B], *J. Walker*[A], *M. A. Horwood*[A], *L. Tesoriero*[C], *M. Glen*[D] *and M. J. Priest*[E]

[A]Forest Biosecurity and Resource Assessment, Biosecurity Research, Industry and Investment NSW, Forest Science Centre, PO Box 100, Beecroft, NSW 2119, Australia.
[B]Forest and Rangelands Ecosystems, Industry and Investment NSW, Forest Science Centre, PO Box 100, Beecroft, NSW 2119, Australia.
[C]Elizabeth Macarthur Agricultural Institute, Industry and Investment NSW, Private Bag 4008, Narellan, NSW 2567, Australia.
[D]Tasmanian Institute of Agricultural Research, University of Tasmania, Private Bag 12, Hobart, Tas. 7001, Australia.
[E]Orange Agricultural Institute, Industry and Investment NSW, Forest Road, Orange, NSW 2800, Australia.
[F]Corresponding author. Email: angus.carnegie@industry.nsw.gov.au

Abstract. *Uredo rangelii* (myrtle rust) is reported for the first time in Australia – detected on 22 April 2010 – from *Agonis flexuosa*, *Callistemon viminalis* and *Syncarpia glomulifera*. This taxon is morphologically distinct from *Puccinia psidii*, the cause of guava rust, but DNA sequence data place it in the *P. psidii* complex. Surveys up to the end of May 2010 have detected *U. rangelii* on cultivated shrubs and trees at four properties (two cut flower farms and two wholesale nurseries) on the Central Coast of New South Wales, with no records in native forest thus far. Containment operations are currently underway on infected properties.

Additional keywords: biosecurity, Eucalyptus rust.

Introduction

Guava rust, *Puccinia psidii*, was first described on guava (*Psidium guajava*) in Brazil (Winter 1884). Subsequently, it has been recorded on several genera of native Myrtaceae in Central and South America. The disease is rarely severe on native vegetation, although occasional epidemics in guava plantations are observed (Ribeiro and Pommer 2004). However, *P. psidii* can cause severe disease of Australian *Eucalyptus* species in nurseries and plantations in South America and other Myrtaceae exotic to South America such as *Syzygium jambos* (Ferreira 1983; Tessmann *et al*. 2001; Alfenas *et al*. 2004). Field observations and inoculation studies have shown that species in other Australian myrtaceous genera, such as *Angophora*, *Callistemon*, *Corymbia*, *Kunzea*, *Melaleuca* and *Syncarpia* are susceptible (Coutinho *et al*. 1998; Rayachhetry *et al*. 2001; Tommerup *et al*. 2003; Simpson *et al*. 2006; Zauza *et al*. 2010).

P. psidii devastated the allspice (*Pimenta dioica*) industry in high-altitude areas of Jamaica within 2 years of the disease being identified on this host (MacLachlan 1938). *P. psidii* was first found in Florida in 1977 (Burnett and Schubert 1985), where it severely damages native American Myrtaceae and also the introduced Australian *Melaleuca quinquenervia* (Leahy 2004). It has also been reported from Hawaii (Killgore and Heu 2007), and once introduced to a new country or region, has been found to spread rapidly (MacLachlan 1938; Burnett and Schubert 1985; Loope and La Rosa 2008). Guava rust has long been considered a significant exotic threat to Australian flora, and a contingency response plan was developed to assist with the rapid introduction of abatement measures in the event of an incursion (Commonwealth of Australia 2006; Office of the Chief Plant Protection Officer 2007). A comprehensive review of the literature on *P. psidii* and assessment of its risks for Australia is given by Glen *et al*. (2007).

Several species of *Puccinia* and *Uredo* have been described on myrtaceous hosts in South America (Walker 1983; Simpson *et al*. 2006), many considered by various authors as synonymous with *P. psidii*. A study of several collections identified as *P. psidii*, including the holotype specimen, showed that while most agreed with the holotype in having completely echinulate, ellipsoidal to obovoid urediniospores, two collections, on *Myrtus communis* from Argentina and *S. jambos* from Jamaica, respectively, had obovoid to pyriform urediniospores showing a smooth patch (tonsure) free of echinulations (Walker 1983). Simpson *et al*. (2006) described this morphologically distinct rust as the new species *Uredo rangelii*, with the *Myrtus* collection as holotype. *U. rangelii* can be regarded as a member of the *P. psidii* sensu lato (s.l., in the broad sense) complex. *P. psidii* sensu stricto (s.s., in the strict sense) is the rust on *P. guajava* described by Winter. Most of the literature deals with *P. psidii* s.l. and includes a mixture of data on *P. psidii* s.s., *U. rangelii* and other possible variants.

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Identification of *U. rangelii* in Australia

On 21 April 2010, a diseased specimen of *Agonis flexuosa* cv. 'Afterdark' was submitted for identification to the Gosford Primary Industries Institute, Narara, New South Wales by a Central Coast cut flower grower. From photographs received on 22 April, an exotic rust was suspected, and specimens were delivered to the Industry and Investment New South Wales forestry laboratories at West Pennant Hills on 23 April. Only urediniospores were present in the yellow sori. These were typical of *U. rangelii* as described by Walker (1983; as *Uredo* sp.) and Simpson *et al*. (2006), and the *Agonis* rust was determined as this species. The DNA sequence of the rDNA ITS region (GenBank accession HM448900) was indistinguishable from that of *P. psidii*. This species also gives a positive result in the nested PCR developed to detect *P. psidii* s.l. (Langrell *et al*. 2008). This is the first record of a member of this complex to be found in Australia. To distinguish the disease caused by *U. rangelii* from guava rust caused by *P. psidii* s.s., authorities managing the incursion named it myrtle rust (Chief Plant Protection Officer 2010), based on the name of the type host *M. communis*.

Surveys for *U. rangelii*

Surveys in and around the initial infected property (IP 1) began on 24 April. Native plants for the cut flower market are grown on the property, including ~1000 3- to 4-year-old plants of *A. flexuosa* cv. 'Afterdark' in two blocks separated by ~100 m, as well as species of *Beaufortia*, *Callistemon*, *Kunzea*, *Leptospermum*, *Melaleuca*, *Syzygium* and others. Typical native forest of the area, containing a component of myrtaceous species including *Angophora costata*, *Corymbia gummifera*, *Eucalyptus haemastoma*, *Leptospermum trinervium*, *Syncarpia glomulifera* and other natives, adjoins the property at distances of up to 100 m on three sides, with some forested areas also occurring on the property.

Myrtle rust was found in both blocks of *A. flexuosa*. All plants in one block were infected, many with abundant sporulation on leaves and young growing stems and shoots (Fig. 1*a–c*). Infection was less prevalent in the second block, with ~75% of plants showing pustules. The grower observed honeybees (*Apis mellifera*) collecting urediniospores from infected plants. Similar behaviour has been reported previously for *P. psidii* on *P. dioica* in Jamaica (Chapman 1964) and for several other rusts (Shaw 1990). A single plant of *Callistemon viminalis* at the property was also infected, as was a row of *S. glomulifera* trees adjacent to the heavily infected block of *A. flexuosa*. The rust was also found on two *S. glomulifera* saplings beside the access road, within 300 m of IP 1. No rust was found in native forest in or around IP 1.

Further surveys on 28–30 April concentrated on nurseries growing Myrtaceae within 25 km of IP 1, on *S. glomulifera* windbreaks (common in the district) and native forest within 1 km of IP 1. On 28 April, a small number of infected *C. viminalis* (cv. 'Hannah Ray') were found on a second property (IP 2) ~8.5 km south of IP 1. There were other *Callistemon* species on the property, but no *Agonis*. During these surveys, no rust was found on any other plants within IP 2, on *S. glomulifera* windbreaks 1.5 km north of IP 2, or in any other nursery. On 30 April, authorities managing the incursion determined that it was not technically feasible to eradicate *U. rangelii* (Department of Agriculture, Fisheries and Forestry 2010). However, authorities in New South Wales on 10 May surveys revisited a cut flower farm, first surveyed on 28 April, which grows ~1000 *A. flexuosa*. Myrtle rust was found on five plants of *A. flexuosa* cv. 'Afterdark' and one of *A. flexuosa* cv. 'Burgundy'. All affected plants were lightly infected (some with only a few pustules). Mechanical transfer of the disease was suspected in this case as cut flowers are sent from IP 1 to IP 3 before being sent to market. Inspection of other Myrtaceae on the property, including *Corymbia*, *Eucalyptus* and *Leptospermum*, did not find any further incidence of myrtle rust. Surveys have continued in the region, concentrating on nurseries, native forest and *S. glomulifera* windbreaks, with over 45 sites surveyed up to the end of May 2010. On 19 May, a single plant of *A. flexuosa* cv. 'Afterdark' was found with myrtle rust at a wholesale nursery (IP 4) ~3 km from IP 3, with no other *A. flexuosa* or other Myrtaceae observed to be infected with rust. This nursery has no direct link to other infected properties. Containment operations have occurred at IP 1, including weekly fungicide applications, and diseased material has been removed and destroyed from IP 2, IP 3 and IP 4, as well as the *S. glomulifera* saplings on the access road to IP 1.

Host range and symptoms

Rusts recorded on Myrtaceae and known hosts are listed by Simpson *et al*. (2006). *Agonis* is a new host genus for any member of the *P. psidii* s.l. complex, and *Syncarpia* and *Callistemon* are new host genera for *U. rangelii.* On the dark purple leaves of *A. flexousa* cv. 'Afterdark', early symptoms of infection were not obvious, but mature, bright yellow uredinial pustules were readily seen on both leaf surfaces, as well as on young stems and growing shoots (Fig. 1*a–c*), and heavy infection resulted in shoot death (Fig. 1*d*). Pustules turned grey with age (Fig. 1*d*). On *S. glomulifera*, initial symptoms appeared as small (1–5-mm) purple flecks and spots on young leaves, often with a faint chlorotic halo (Fig. 1*e*). These later developed the characteristic bright yellow pustules, mostly on the lower surface (Fig. 1*f*). In severe infection, spots and pustules enlarged and coalesced (Fig. 1*e*, inset), often resulting in leaf distortion (Fig. 1*g*). Infection also occurred on young stems (Fig. 1*g*, inset). We also observed infection on new growth in the upper crown of *S. glomulifera* trees up to 10 m. On *C. viminalis*, small (2–5-mm) purple lesions with bright yellow pustules were observed on young leaves (Fig. 1*h*). Field observations indicate that *A. flexuosa* cv. 'Afterdark' is highly susceptible to *U. rangelii*, *S. glomulifera* is moderately susceptible, especially when adjacent a high inoculum source, with *C. viminalis* only slightly susceptible. Examined specimens have been lodged at the New South Wales Plant Pathology Herbarium, Orange (DAR).

Fig. 1. *Uredo rangelii* in Australia. (*a–c*) Uredinia on leaves and shoots of *Agonis flexuosa* cv. 'Afterdark' (Fig. 1*b* inset, close-up of pustules). (*d*) Shoot death of *A. flexuosa* following severe infection. (*e*) Flecks and spots on adaxial surface of *Syncarpia glomulifera* (inset, enlarged and coalesced spots). (*f*, *g*) Leaf spots with uredinia on *S. glomulifera* (Fig. 1*g* inset, close-up of pustule on young stem). (*h*) Leaf spot and uredinia on *Callistemon viminalis.*


(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)

Comments

P. psidii s.l. spread rapidly throughout Jamaica (MacLachlan 1938), Florida (Burnett and Schubert 1985) and Hawaii (Killgore and Heu 2007) after it was introduced. Following its arrival in new areas, *P. psidii* has also been known to dramatically increase its host range (MacLachlan 1938; Rayachhetry *et al*. 2001; Leahy 2004). The pathway by which *U. rangelii* was introduced to Australia is unknown at present, but attempts are being made to trace the source of infection. The close proximity to diseased plants of windbreaks and native bush containing known susceptible plant genera (*Callistemon* and *Syncarpia*), and the distribution of these genera along coastal New South Wales and Queensland, suggests that further spread in eastern Australia may be expected. These hosts are located within areas climatically suitable for *P. psidii* s.l. (Glen *et al*. 2007). Before the introduction of *U. rangelii* to Australia, the only hosts known with certainty were *M. communis* and *S. jambos*; since introduction, it is now known to infect species of *Agonis*, *Callistemon* and *Syncarpia*. Given the wide phylogenetic separation of these taxa (Wilson *et al*. 2005), other new host records can be expected. As *U. rangelii* was only recently separated from *P. psidii* s.l. (Simpson *et al*. 2006), it is likely that literature pertaining to guava rust, including host range and impact, includes reference to disease caused by *U. rangelii*. If this rust spreads, it may have a serious impact on native plant communities and on plant industries based on members of the family Myrtaceae.

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References

Alfenas AC, Zauza EAV, Mafia RG, Assis TF (2004) 'Clonagem e doenças do eucalipto.' (Universidad Federal de Viçosa: Viçosa, Brazil)

Burnett HC, Schubert TS (1985) *Puccinia psidii* on allspice and related plants. Plant Pathology Circular No. 271. (Division of Plant Industry, Florida Department of Agriculture and Consumer Services: Tallahassee, FL)

Chapman GP (1964) Urediospore collections by honey bees from *Puccinia psidii*. *Annals of the Entomological Society of America* **57**, 264.

Chief Plant Protection Officer (2010) Myrtle rust in Australia. International Plant Protection Convention Official Pest Report No. AUS-37/1. Available at https://www.ippc.int/index.php?id=72 [Verified 27 May 2010]

Commonwealth of Australia (2006) Contingency planning for Eucalyptus rust. In 'Records and Resolutions of the Primary Industries Ministerial Council'. (Department of Agriculture, Fisheries and Forestry, Canberra). Available at http://www.mincos.gov.au/pdf/nrmmc_res_10.pdf [Verified 14 May 2010]

Coutinho TA, Wingfield MJ, Alfenas AC, Crous PW (1998) *Eucalyptus* rust: a disease with the potential for serious international implications. *Plant Disease* **82**, 819–825. doi:10.1094/PDIS.1998.82.7.819

Department of Agriculture, Fisheries and Forestry (2010) Myrtle rust (*Uredo rangelii*) detection. DAFF 10/004D. Available at http://www.daff.gov.au/about/media-centre/

Ferreira FA (1983) *Eucalyptus* rust. *Revista Arvore* **7**, 91–109.

Glen M, Alfenas AC, Zauza EAV, Wingfield MJ, Mohammed C (2007) *Puccinia psidii*: a threat to the Australian environment and economy – a review. *Australasian Plant Pathology* **36**, 1–16. doi:10.1071/AP06088

Killgore EM, Heu RA (2007) A rust disease on 'Ohi'a, *Puccinia psidii* Winter. New Pest Advisory 05–04 (updated December 2007). Available at http://www.hawaiiag.org/hdoa/npa/npa05-04-ohiarust.pdf [Verified 14 May 2010]

Langrell SRH, Glen M, Alfenas AC (2008) Molecular diagnosis of *Puccinia psidii* (guava rust) – a quarantine threat to Australian eucalypt and Myrtaceae biodiversity. *Plant Pathology* **57**, 687–701. doi:10.1111/j.1365-3059.2008.01844.x

Leahy R (2004) Recent history of *Puccinia psidii* on Myrtaceae in Florida. Available at http://web.archive.org/web/20050117213153/http:/extlab7.entnem.ufl.edu/PestAlert/tmm-0209.htm [Verified 14 May 2010]

Loope L, La Rosa AM (2008) 'An analysis of the risk of the introduction of additional strains of the rust *Puccinia psidii* Winter ('Ohi'a rust) to Hawai'i. U.S. Geological Survey Open File Report 2008–1008.' (U.S. Geological Survey: Reston, VA) Available at http://www.ctahr.hawaii.edu/forestry/Data/Pests_Diseases/ofr_2008_1008_loope_ohia_rust_assessment.pdf [Viewed 20 May 2010]

MacLachlan JD (1938) A rust of the pimento tree in Jamaica, BWI. *Phytopathology* **28**, 157–170.

Office of the Chief Plant Protection Officer (2007) '*Puccinia psidii*, forestry, rural and urban biosecurity plan. Pest specific contingency plan.' (Australian Government Department of Agriculture, Fisheries and Forestry: Canberra)

Rayachhetry MB, Van TK, Center TD, Elliott ML (2001) Host range of *Puccinia psidii*, a potential biological control agent of *Melaleuca quinquenervia* in Florida. *Biological Control* **22**, 38–45. doi:10.1006/bcon.2001.0949

Ribeiro IJA, Pommer CV (2004) Breeding guava (*Psidium guajava*) for resistance to rust caused by *Puccinia psidii*. *Acta Horticulturae* **632**, 75–78.

Shaw DE (1990) The incidental collection of fungal spores by bees and the collection of spores in lieu of pollen. *Bee World* **71**, 158–176.

Simpson JA, Thomas K, Grgurinovic CA (2006) Uredinales species pathogenic on species of Myrtaceae. *Australasian Plant Pathology* **35**, 549–562. doi:10.1071/AP06057

Tessmann DJ, Dianese JC, Miranda AC, Castro LHR (2001) Epidemiology of a Neotropical rust (*Puccinia psidii*): periodical analysis of the temporal progress in a perennial host (*Syzygium jambos*). *Plant Pathology* **50**, 725–731. doi:10.1046/j.1365-3059.2001.00646.x

Tommerup IC, Alfenas AC, Old KM (2003) Guava rust in Brazil – a threat to *Eucalyptus* and other Myrtaceae. *New Zealand Journal of Forestry Science* **33**, 420–428.

Walker J (1983) Pacific mycogeography: deficiencies and irregularities in the distribution of plant parasitic fungi. *Australian Journal of Botany Supplementary Series* **10**, 89–136.

Wilson PG, O'Brien MM, Heslewood MM, Quinn CJ (2005) Relationships within Myrtaceae *sensu lato* based on *mat*K phylogeny. *Plant Systematics and Evolution* **251**, 3–19. doi:10.1007/s00606-004-0162-y

Winter G (1884) Repertorium. Rabenhorstii fungi europaei et extraeuropaei exsiccati cura Dr. G. Winter, Centuria XXXI et XXXII. *Hedwigia* **23**, 164–172.

Zauza EAV, Alfenas AC, Old KM, Couto MMF, Graça RN, Maffia LA (2010) Myrtaceae species resistance to rust caused by *Puccinia psidii*. *Australasian Plant Pathology*, in press.

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