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Rapid field assessments of impacts of plant fungal pathogen *Austropuccinia psidii* on five high priority Myrtaceae species in New South Wales, Australia

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***Abstract*:** In 2010, the plant fungal pathogen *Austropuccinia psidii* was detected in Australia. It has since spread rapidly through the eastern states of Australia causing significant population declines in a number of susceptible species. However, there are still a number of potentially vulnerable species that lack the necessary field observations that are needed to accurately gauge the risk *Austropuccinia psidii* poses to them. Because of this, rapid field assessments of these species have been given the utmost priority. In the spring of 2018 (October) we carried out rapid field assessments for five high priority species. We did not observe active *Austropuccinia psidii* infection on any of the species at the time of assessment despite the majority of individuals having susceptible new flush. However, we did find evidence of significant previous infection (branch dieback) in the largest *Archirhodomyrtus beckleri* population we assessed. Therefore, to confirm our observations, it is necessary to re-assess this population when environmental conditions are more favourable for infection to occur in order.

Keyword: dieback; infection; Myrtle Rust; plant fungal pathogen; susceptibility

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Introduction and Methods

In 2010 the plant fungal pathogen *Austropuccinia psidii* (commonly known as Myrtle Rust), which is native to South and Central America (Winter, 1884; Granados et al., 2017), was detected in Australia (Carnegie et al., 2010). It has since spread rapidly through the eastern states (New South Wales (NSW), Queensland and Victoria) of mainland Australia as well as to Tasmania and the Northern Territory (Carnegie & Pegg, 2018). It infects the young growing tissue of Myrtaceae species resulting in leaf distortion, defoliation, branch dieback and even mortality in highly susceptible species after multiple re-infection events (Carnegie et al., 2016; Pegg et al., 2017). Despite its short residency time, *Austropuccinia psidii* has already caused dramatic declines in a number of highly susceptible species. For example, Pegg et al. (2017) reported significant population declines in wet sclerophyll forest species *Archirhodomyrtus beckleri*, *Decaspermum humile*, *Gossia hillii* and *Rhodamnia maideniana* in south-east Queensland while Carnegie et al. (2016) reported similar declines in rainforest mid-storey species *Rhodamnia rubescens* and *Rhodomyrtus psidioides* in NSW.

Recently, all the available information regarding the impacts of *Austropuccinia psidii* on native Australian Myrtaceae species was collated in extensive report entitled 'Myrtle Rust reviewed' (Makinson, 2018) and 45 species potentially most at risk of *Austropuccinia psidii* impacts in Australia were identified. However, the necessary field observations that are needed to accurately gauge the risk *Austropuccinia psidii* poses to these species in the natural environment are currently lacking and the report recommended that rapid field assessments of these species should be given the utmost priority.

In the spring of 2018 (3rd-14th of October) we carried out rapid field assessments for five of these species: *Archirhodomyrtus beckleri* (F.Muell.) A.J.Scott, *Austromyrtus dulcis* (C.T.White) L.S.Sm., *Gossia fragrantissima* (F.Muell. ex Benth.) N.Snow & Guymer, *Syzygium hodgkinsoniae* (F.Muell.) L.A.S.Johnson and *Syzygium oleosum* (F.Muell.) B.Hyland (Table 1). We targeted NSW populations of these species as there is a general lack of field observations in this region of their distribution. In south-east Queensland, *Austropuccinia psidii* has been shown to have varying impacts on these species. For *Archirhodomyrtus beckleri,* and to a lesser extent for *Syzygium hodgkinsoniae* (juvenile plants only), *Austropuccinia psidii* has been reported to have caused significant dieback, while for the other three species little or no impact has been observed (Pegg et al., 2017; Makinson, 2018).

Table 1: Growth form and habitat of the five species assessed (from PlantNET www.plantnet.rbgsyd.nsw.gov.au) and locations of populations that were assessed for each species.

Species	Growth form	Habitat	Population	Stand	Location lat/long
Archirhodomyrtus beckleri	Shrub/tree	Rainforest and wet sclerophyll forest	Knorrit SF	1	S 31.7826 E 152.1298
				2	S 31.7868 E 152.1270
			Kerewong	1	S 31.6354 E 152.5345
				2	S 31.6349 E 152.5451
			Coopernook SF	1	S 31.8055 E 152.6203
Austromyrtus dulcis	Semi-prostrate spreading shrub	Heath and dry sclerophyll forest	Pottsville	1	S 28.3913 E 153.5609
				2	S 28.3737 E 153.5709
			Byron Bay	1	S 28.6647 E 153.6151
				2	S 28.6560 E 153.6219
			Bundjalung NP	1	S 29.3636 E 153.2885
				2	S 29.3581 E 153.3441
			Broadwater NP	1	S 29.0393 E 153.3944
				2	S 29.0138 E 153.4610
Gossia fragrantissima	Shrub/tree	Rainforest	Georgica	1	S 28.9773 E 153.2916
			Coraki	1	S 28.6542 E 153.1490
			Boatharbour	1	S 28.7788 E 153.3333
			Main Arm	1	S 28.5194 E 153.4225
				2	S 28.5270 E 153.4268
Syzygium hodgkinsoniae	Tree	Rainforest	Nemarotu	1	S 28.5606 E 153.4035
				2	S 28.5678 E 153.3860
			Lindendale	1	S 28.8131 E 153.3821
			Nightcap NP	1	S 28.6361 E 153.3362
Syzygium oleosum	Tree	Rainforest	Byron Bay	1	S 28.6417 E 153.6293
				2	S 28.6377 E 153.6309
			Bongil Bongil NP	1	S 30.4407 E 153.0626
				2	S 30.4331 E 153.0727
			Bundjalung NP	1	S 29.3581 E 153.3440
			Strickland SF	1	S 33.3786 E 151.3238

For our rapid field assessments, we used the NSW Office of Environment and Heritage repository of biodiversity data (BioNET, www.bionet.nsw.gov.au) to select 3-4 populations per species, which were spaced across a large proportion of the species distributions in NSW. Selected populations within a species were separated by a minimum of 30 km. When possible, we assessed two stands within each population, with each stand consisting of 10 individuals of varying heights. Individuals ≤1 m in height were classified as seedlings, while individuals >1 m in height were classified as mature plants. This classification was not used for *Austromyrtus dulcis* as the majority of individuals were ≤1 m in height despite being mature plants. Stands were separated by a minimum of 500 m and a maximum of 3 km. At the individual-level, we recorded presence/absence of flower production, fruit production, susceptible new growth flush and active *Austropuccinia psidii* infection, as well as the extent of branch dieback. At the stand-level, we recorded if recruitment was occurring (i.e. if seedlings were present). It should be noted that it was extremely difficult to distinguish signs of previous *Austropuccinia psidii* infection on leaves from other factors that cause leaf damage (e.g. heat stress, attack by other natural enemies) so we do not comment on it in this communication.

Results and Discussion

We did not observe active *Austropuccinia psidii* infection on the leaves of any of the species assessed, despite the majority of individuals (>90%) having susceptible new growth flush. Three species were in flower (*Austromyrtus dulcis*, *Syzygium oleosum*) or fruiting (*Syzygium hodgkinsoniae* and *Syzygium oleosum*), but no active *Austropuccinia psidii* infection was observed on the reproductive structures of these species. With the exception of *Archirhodomyrtus beckleri*, all of the species had at least one population that was in close proximity to other highly susceptible species that were observed to be severely infected with *Austropuccinia psidii* at the time of assessment. We observed severely infected individuals of *Gossia hillii* (Nightcap National Park, Wardell), *Rhodamnia maideniana* (Urlip) and *Syzygium jambos* (Lismore) close to populations of the species we assessed suggesting that environmental conditions were favourable for infection to occur (15-25°C at 95% humidity). So the lack of infection observed on our study species cannot be ascribed to lack of exposure to the pathogen. We observed branch dieback in all of the five species we assessed (Table 2), but with the exception of *Archirhodomyrtus beckleri,* we attributed this to factors other than *Austropuccinia psidii* infection. These factors included senescence (*Gossia fragrantissima*, *Syzygium hodgkinsoniae*, *Syzygium oleosum*), stands being in close proximity to anthropogenic disturbances such as sugar cane farms (*Austromyrtus dulcis, Gossia fragrantissima*), natural enemy attack (*Gossia fragrantissima, Syzygium oleosum*), and/or the drought conditions that existed at the time of assessment (*Austromyrtus dulcis, Gossia fragrantissima*). Considering this, we suggest that the *Austromyrtus dulcis*, *Gossia fragrantissima*, *Syzygium hodgkinsoniae* and *Syzygium oleosum* populations we assessed are likely to be resistant or only slightly susceptible to *Austropuccinia psidii* infection. However, it should be acknowledged that south-east Queensland populations of *Austromyrtus dulcis*, *Syzygium hodgkinsoniae* and *Syzygium oleosum* have been assigned a spread of susceptibility ratings ranging from relatively tolerant to highly susceptible (Pegg et al., 2018). Therefore, the observations we made during our rapid field assessments may not necessarily be applicable to NSW populations as a whole.

For the *Archirhodomyrtus beckleri* populations we assessed (the only species we assessed south of Port Macquarie), it is likely that environmental conditions were not favourable for infection to occur; *Gossia hillii* and *Rhodamnia rubescens* individuals that occurred this far south did not have any active infection despite showing obvious signs of previous severe infection (leaf distortion, defoliation and branch dieback). Like the other four species we assessed, the Kerewong and Coopernook State Forest populations of *Archirhodomyrtus beckleri* appeared to have little to no impact from *Austropuccinia psidii*. However, the Knorrit State Forest population did show clear signs of previous *Austropuccinia psidii* infection, with obvious defoliation (compared to individuals of the same species from the other populations) and branch dieback (>30% whole dieback and >90% part dieback; see Table 2). Surprisingly, the smaller seedlings in this population did not display the same signs of previous infection as their mature counterparts, perhaps due to these seedlings germinating or developing most of their biomass since the last significant infection event in this area. Although the individuals in this population did not have any active infection, neither did co-occurring individuals of the highly susceptible *Rhodamnia rubescens*, providing strong evidence that environmental conditions were not favourable for infection at the time of assessment. Therefore, to confirm our observations, it is necessary to re-assess this population when environmental conditions are more favourable for infection to occur. Considering that this was by far the largest population of *Archirhodomyrtus beckleri* we assessed (>50 individuals), and that this species is displaying significant declines in south-east Queensland, we suggest that confirming our observations in relation to *Austropuccinia psidii* impact is critical to better inform management decisions for *Archirhodomyrtus beckleri*.

From our rapid field assessments, it is clear that *Austropuccinia psidii* was only impacting populations of *Archirhodomyrtus beckleri,* and not the populations of the other four species. For *Archirhodomyrtus beckleri*, the notable between population differences in branch dieback, suggests that certain populations may be more resistant to infection than others. Therefore, we can conclude that *Austropuccinia psidii* does not currently pose a significant extinction threat to *Archirhodomyrtus beckleri* at the overall species-level, at least in NSW. At the population-level, specifically the Knorrit State Forest population of *Archirhodomyrtus beckleri*, we suggest that *Austropuccinia psidii* does not pose an immediate threat, as the population had significant recruitment, and displayed no visible signs of whole seedling or mature tree mortality (e.g. skeletons of dead individuals). Rapid field assessments may only provide

a narrow timeframe in which to observe *Austropuccinia psidii* impacts on susceptible species, but because impacts (e.g. leaf distortion, defoliation, branch dieback) are generally visible for an extended period of time, we believe it is still a useful method to gauge impacts with reasonable confidence. However, repeated monitoring efforts still represent the best strategy to accurately determine a species susceptibility to *Austropuccinia psidii* within and across populations; this is vital to identify highly resistant individuals or populations that could be utilised as genetic resources for potential recovery actions for highly susceptible populations.

Table 2: Information on branch dieback (both whole and part) and on potential for recruitment (presence/absence of flowers, fruit and seedlings) for each assessed population of each species. For the dieback data, the number of assessed individuals from each height class (seedling, mature) is given in brackets. Seedling data is not presented for *Austromyrtus dulcis* because most individuals were ≤1m (seedling class) in height despite being mature plants. Note that no individuals had active *Austropuccinia psidii* infection on their leaves, flowers or fruit at the time of assessment (October 2018) despite the majority having new growth flush. NP=National Park, SF=State Forest.

Species	Population	Stand	Presence of flowers/fruit	Presence of seedlings	Whole/part branch dieback-seedlings (%)	Whole/part branch dieback-mature (%)
Archirhodomyrtus beckleri	Knorrit SF	1	N/N	Y	38/100 (n=1)	31/100 (n=9)
		2	N/N	Y	3/9 (n=6)	34/94 (n=4)
	Kerewong	1	N/N	Y	5/80 (n=2)	4/26 (n=8)
		2	N/N	Y	9/57 (n=6)	18/88 (n=4)
	Coopernook SF	1	N/N	Y	0/16 (n=3)	6/36 (n=7)
Austromyrtus dulcis	Pottsville	1	N/N	-	-	0/4 (n=10)
		2	N/N			0/4 (n=10)
	Byron Bay	1	N/N	-	-	7/28 (n=10)
		2	N/N			5/30 (n=10)
	Bundjalung NP	1	N/N	-	-	3/6 (n=10)
		2	Y/N			11/37 (n=10)
	Broadwater NP	1	N/N	-	-	12/18 (n=10)
		2	Y/N			10/19 (n=10)
Gossia fragrantissima	Georgica	1	N/N	Y	16/92 (n=3)	16/84 (n=7)
	Coraki	1	N/N	N	NA	15/100 (n=10)
	Boatharbour	1	N/N	N	NA	18/89 (n=5)
	Main Arm	1	N/N	Y	0/0 (n=1)	21/70 (n=9)
		2	N/N	Y	8/37 (n=4)	6/43 (n=6)
Syzygium hodgkinsoniae	Nemarotu	1	N/N	N	NA	0/2 (n=10)
		2	N/Y	Y	0/0 (n=5)	16/14 (n=5)
	Lindendale	1	N/N	Y	6/0 (n=6)	0/0 (n=4)
	Nightcap NP	1	N/N	Y	0/0 (n=2)	6/60 (n=8)
Syzygium oleosum	Byron Bay	1	Y/N	Y	18/66 (n=1)	9/60 (n=9)
		2	N/N	Y	20/0 (n=2)	8/40 (n=8)
	Bongil Bongil NP	1	Y/N	Y	0/50 (n=1)	1/29 (n=9)
		2	Y/N	Y	0/11 (n=3)	8/26 (n=7)
	Bundjalung NP	1	N/Y	N	NA	9/74 (n=10)
	Strickland SF	1	Y/N	Y	20/31 (n=2)	14/50 (n=8)

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References

Carnegie A.J., Lidbetter J.R., Walker J., Horwood M.A., Tesoriero L., Glen M. & Priest M.J. (2010) *Uredo rangelii*, a taxon in the guava rust complex, newly recorded on Myrtaceae in Australia. *Australasian Plant Pathology*, 39, 463-466.

Carnegie A.J., Kathuria A., Pegg G.S., Entwistle P., Nagel M. & Giblin F.R. (2016) Impact of the invasive rust *Puccinia psidii* (Myrtle Rust) on native Myrtaceae in natural ecosystems in Australia. *Biological Invasions*, 18, 127-144.

Carnegie A.J. & Pegg G.S. (2018) Lessons from the Incursion of Myrtle Rust in Australia. *Annual Review of Phytopathology*, 56, 457-478.

Granados G., McTaggart A., Barnes I., Rodas C., Roux J. & Wingfield M. (2017) The pandemic biotype of *Austropuccinia psidii* discovered. *Australasian Plant Pathology,* 56, 267–275.

Makinson R.O. (2018) Myrtle Rust reviewed: the impacts of the invasive pathogen *Austropuccinia psidii* on the Australian environment. Plant Biosecurity CRC, Canberra.

Pegg G., Taylor T., Entwistle P., Guymer G., Giblin F. & Carnegie A. (2017) Impact of *Austropuccinia psidii* (Myrtle Rust) on Myrtaceae-rich wet sclerophyll forests in south east Queensland. *PloS* one, 12, e0188058.

Pegg G., Carnegie A., Giblin F. & Perry S. (2018) Final Report: Managing Myrtle Rust in Australia. Plant Biosecurity CRC, Canberra.

Winter G. (1884) Repertorium. Rabenhorstii fungi europaei et extraeuraopaei. Centuria XXXI et XXXII. *Hedwigia*, 23, 164–175. In: Glen M., Alfenas A.C., Zauza E.A.V., Wingfield M.J., Mohammed C. (2007). *Puccinia psidii*: a threat to the Australian environment and economy—a review. *Australasian Plant Pathology*, 36, 1-16.

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