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ORIGINAL PAPER

Austropuccinia psidii on the move: survey based insights to its geographical distribution, host species, impacts and management in Australia

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Abstract *Austropuccinia psidii* is a plant fungus native to South and Central America which causes myrtle rust disease, affecting the growth and reproduction of species in the Myrtaceae family. *Austropuccinia psidii* was first detected in Australia 8 years ago in New South Wales. Since then it has spread rapidly along the east coast, and to date is known to infect more than 375 native Myrtaceae species in Australia. Despite this, its rapid spread is not well documented and the potential threat to additional Myrtaceae species remains unknown, with no systematic surveillance or monitoring program in Australia. In order to better understand the extent of *A. psidii* geographic distribution and impacts on Australian landscapes, a survey was sent to national park, botanical garden, local council, nursery and forestry agency employees in all states and territories where the disease is known to be present. More than 500 surveys were sent, and 254 responses were received. The survey confirms that *A. psidii* is widespread in New South Wales and Queensland urban environments as well as in native vegetation communities. Four new host species were confirmed, as well as four new local government areas in two different states

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reporting *A. psidii* infection. The disease severity was classified as medium to high for most host species, with especially negative impacts for *Rhodamnia rubescens* and *Rhodomyrtus psidioides*. These survey results provide up-to-date information on the geographical distribution, host species and impacts of *A. psidii*, which will assist in making management decisions relating to this pathogen across Australia.

Keywords *Puccinia psidii* · Invasive species · Plant pathogen · Myrtaceae

Introduction

Invasive plant pathogens pose a significant biodiversity conservation challenge worldwide, with impacts ranging from species- to ecosystem-level. Well known examples include the fungus *Cryphonectria parasitica* that causes chestnut blight in North America (Anagnostakis 1987; Loo 2009) which has caused significant mortality of the American chestnuts (*Castanea dentata*); and the soil-borne pathogen *Phytophthora cinnamomi*, which has not only altered the structure of *Eucalyptus* forests in Western Australia (WA) but also indirectly affected faunal species that rely on affected forests for habitat in New South Wales (NSW) and Victoria (VIC) [e.g. *Pseudomys fumeus* (smoky mouse) and *Isoodon obesulus obesulus* (southern brown bandicoot) (Cahill et al. 2008)]. Pathogens can be particularly destructive when they infect keystone species, as well as endemic, endangered or rare species, given their intrinsic value for biodiversity conservation (Ellison et al. 2005; Loo 2009).

Austropuccinia psidii is a pathogenic plant fungus native to South and Central America that affects species in the Myrtaceae family (Coutinho et al. 1998; Glen et al. 2007). It causes a disease known as myrtle-, eucalyptus-, guava- or ohia rust, depending on the species or group of species that it affects in different countries. Myrtaceae is the dominant plant family in Australia (Wiltshire 2004), which is why the introduction and spread of *A. psidii* is of particular concern for Australian vegetation, including iconic *Eucalyptus*, *Melaleuca* and *Leptospermum* species. *Austropuccinia psidii* infects young growing tissues such as new leaves, tender shoots, flowers and fruits (Coutinho et al. 1998; Glen et al. 2007). Responses to infection are species-specific, with symptoms ranging from purple flecks in resistant species to characteristic yellow urediniospores that can lead to leaf distortion, defoliation, reduced reproduction (by infection of flowers and fruits) and death (Rayachhetry et al. 2001; Uchida et al. 2006; Carnegie et al. 2016). Carnegie et al. (2016) assessed the impacts of *A. psidii* on two highly susceptible native species in Australia, brush turpentine (*Rhodamnia rubescens*) and native guava (*Rhodomyrtus psidioides*). In these species, as a result of *A. psidii* infection, the canopy cover was significantly reduced by 76% and 95% respectively, with repeated damage causing mortality in 12% and 57% of these two species across their native range (Carnegie et al. 2016). Pegg et al. (2017) also reported significant levels of canopy damage and tree mortality in a range of Myrtaceae species in moist rainforest ecosystems unique to Australia. It is clear that *A. psidii* is having severe impacts at the species-level, which may have potential consequences at the ecosystem-level.

The dispersion of *A. psidii* occurs with spores being transported long distances by wind and animals, allowing it to spread easily (Uchida et al. 2006). The pathogen has spread to several countries and continents including North America (Florida, California and Hawaii), southeast Asia (Japan, China, Indonesia and Signapore), South Africa, New Caledonia and more recently New Zealand (Marlatt and Kimbrough 1979; Kawanishi et al. 2009; Roux et al. 2013; Zhuang and Wei 2011; DOC 2017; Soewarto et al. 2017). It was first detected in Australia north of Sydney, NSW in 2010, where it was first called myrtle rust (Carnegie et al. 2010). The rust is currently present along the east coast of Australia with restricted distributions in VIC, Northern Territory (NT) and Tasmania (TAS) (Berthon et al. 2018), a distance of over 5000 km. The most recent expansion in distribution reported is Lord Howe Island, NSW (Kelly 2016). At present the only states where it has not been reported are South Australia (SA) and Western Australia (WA).

In order to effectively monitor the spread of *A. psidii* and assess its impacts, we must first determine which Myrtaceous species are susceptible. As determined by laboratory based pathogenicity tests and field observations, at least 376 Australian Myrtaceous species are known to be susceptible to *A. psidii* (Giblin and Carnegie 2014; Berthon et al. 2018; Makinson 2018; Berthon et al. unpublished data).

However, the national host species list dates from 2014 and there have been limited efforts to keep it updated. There is no systematic surveillance or national program of monitoring the spread and impact of *A. psidii* in Australia. Up-to-date information on the distribution and impacts of *A. psidii* is essential for governments, scientists and natural resource managers to make informed decisions for preventing further introduction into new areas and managing existing affected plant communities. The aim of this study was to investigate and collate information on the geographical and host range expansion of *A. psidii* and its effects (infection severity) on newly reported susceptible hosts in four states and two territories in Australia. In addition, our objective was to determine the current distribution range of *A. psidii* in Australia as well as quantifying its impacts and identifying the control measures, if any, currently used to moderate these impacts.

Methods

We developed and implemented an online survey in order to gather and compile the currently fragmented information concerning *A. psidii* distribution, host species and impacts in Australia (See Online Resource 1 for the complete survey). All studies were conducted with the approval of the Faculty of Science and Engineering Human Research Ethics Sub-Committee at Macquarie University (Reference number: 5201500739). The software 'Qualtrics' (https://www.qualtrics.com; Macquarie University) was used to support the survey. An internet link was created and sent to participants via email to be answered online. The completion of the questionnaire was taken as indication of voluntary consent to participate.

The survey was sent to employees from a number of organisations including botanical gardens, national parks, local land services, local councils, forestry agencies, nurseries and bush regeneration groups in all states (four) and territories (two) where *A. psidii* has previously been reported to occur within Australia (Fig. 1) [Queensland (QLD), NSW, Victoria (VIC), TAS, ACT and NT]. The email accounts were obtained from official internet websites or via personal recommendation. The survey was sent in December 2015 to 548 email addresses and from here some contacts re-distributed the survey or published the link in professional forums.

The questionnaire comprised of a series of yes/no questions with free responses following 'yes' answers, as well as adequate space for other comments. Participants were asked to identify any species infected by *A. psidii* they had seen, their location [locality name and local government area (LGA)] and the plant community type they occurred in. The list of LGAs which were reported to contain *A. psidii* was collated and then mapped using the spatial analysis software ArcMap 10.3 (ESRI 2012). These were then compared with an updated dataset of myrtle rust records (Berthon et al. 2018) to find LGAs which had not previously been reported to contain *A. psidii*. The separation of plant community type into natural (rainforest, tall open forest, coastal woodland, riparian/gully, swamp sclerophyll forest, dry sclerophyll forest, and closed forest) and human mediated landscapes (garden, street tree, plant nursery, botanical garden, and park) was made a posteriori for analysis purposes. For this category, participants used a variety of terminologies, which were grouped together if similar or synonymous (i.e. tall open forest with wet sclerophyll forest and ornamental with garden; for complete list refer to Online Resource 2).

Information was also obtained on which plant structures were affected (e.g. leaves, flowers, fruits), level of infection (low, medium or high; see Online Resource 3 for more details), presence of defoliation and plant mortality. Further questions referring to control measures taken such as the cutting of infected branches, removal of infected individuals or fungicide application as well as the respondent's personal opinion regarding the possibility of *A. psidii* being a long term threat for native communities were also asked. If participants said they had not seen *A. psidii* in their area, they would skip the following questions and be provided with a short explanation about the pathogen and a link to the national host species list (https://www.anbg.gov.au/anpc/images/Puccinia%20psidii%20Australia%20Hostlist%2024Sept2014%20WORDtable.pdf). Finally, the survey was concluded by asking all participants whether they had received information from government sources about the *A. psidii* incursion, who they were employed by (local, state or federal government or private consulting) and if they were willing to receive the results of the

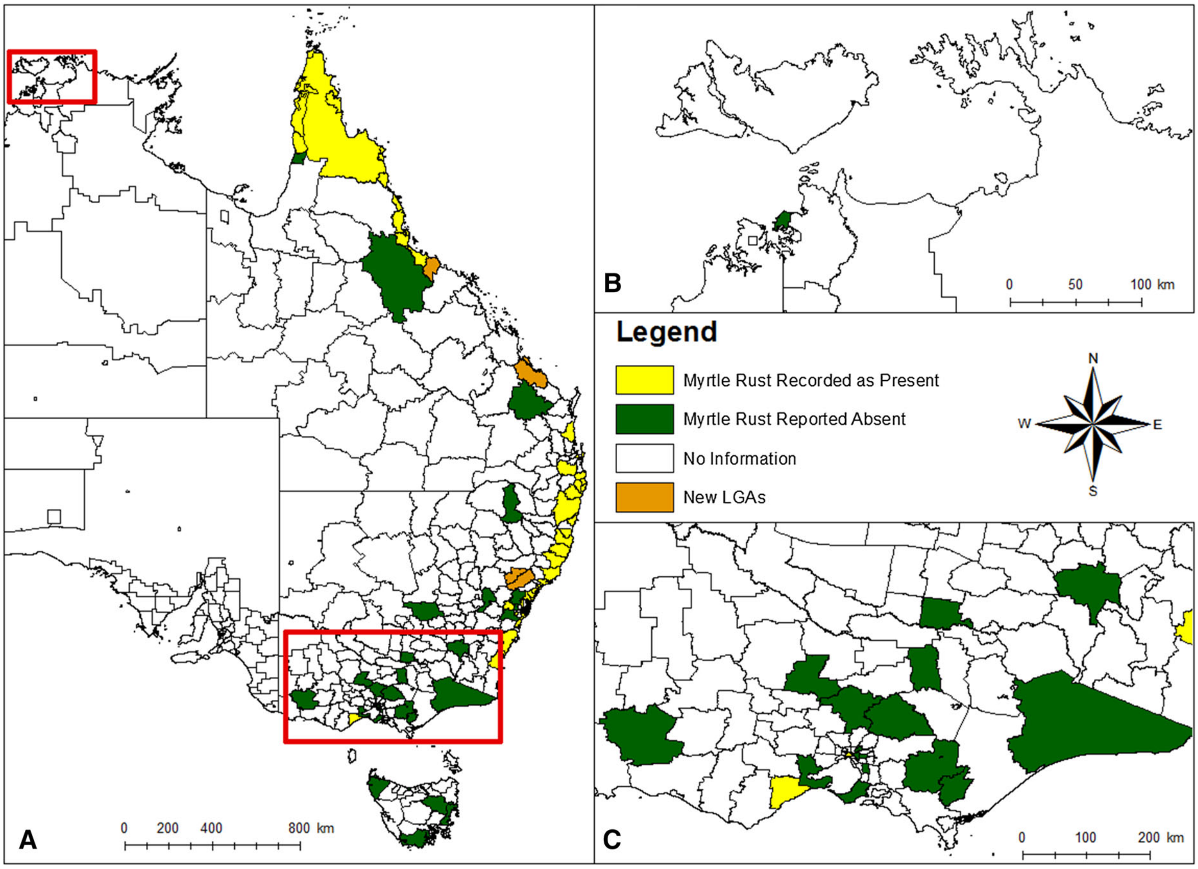

Fig. 1 **a** Local government areas (LGAs) where *A. psidii* was observed ("Present", in yellow) and where it has not been detected by participants ("Not present", in green). LGAs where we do not have information were left uncoloured and new LGAs can be found in orange. Zoomed in maps of the Northern Territory **(b)** and Victoria **(c)** help visualize different LGAs

survey as well as updated information on the invasion of *A. psidii*.

The survey was closed on February 2016, resulting in 254 responses, of which 200 participants replied to all the questions (Table 1). As not all the questions were compulsory, there were differences in sample sizes across the different components (which can be observed in Table 1). Most answers were descriptive, giving qualitative results, therefore no statistical analyses were undertaken.

Table 1 Number of responses received from the survey of 254 individuals within four states (NSW, QLD, VIC and TAS) and two territories (NT and ACT) in Australia, regarding whether they had seen plants infected by *A. psidii*

	Yes	No
NSW	89	45
QLD	19	7
VIC	5	35
TAS	0	12
NT	0	4
ACT	0	5
Unknown	10	23
Total	123	131

Results and discussion

Host range expansion

Respondents of the survey identified 51 susceptible (infected) species from 29 genera, including five species not present in the updated national list of host species for *A. psidii* (Table 2); see Giblin and Carnegie (2014) for original national host species list, updated

Table 2 Plant species or genera reported by survey respondents as infected with *A. psidii* in Australia

Species	Disease severity	Plant structures affected	Defoliation	Plant mortality
Acmena sp. (1)	Medium	Leaves		
Acmena smithii (2)	Medium	Leaves, new growth		N
Acmenospermum claviflorum (1)		Leaves	Y	
Agonis/Agonis sp. (3)				
Agonis flexuosa "Afterdark" (1)				
Agonis flexuosa "Nana" (2)	High	Leaves, all growth		N
Austromyrtus spp. (5)	Med to high	Leaves, stems	Y	N
Austromyrtus dulcis (4)	Med to high	Shoot tips, leaves	Y	N
Austromyrtus inophloia	High	Leaves		**Y, high**
Backhousia myrtifolia (3)	High	Young tender foliage		
Backhousia oligantha (1)		Leaves		
Callistemon viminalis (1)				
Chamelaucium hybrids (1)	Medium	Leaves, **flower buds**		
Chamelaucium uncinatum (2)		Leaves		
Corymbia maculata (1)	Low to med	Leaves		N
Decaspermum humile (2)	Medium	L, **flowers, fruits**		
Eucalyptus amplifolia (1)		Leaves	Y	**Y**
Eucalyptus tereticornis (1)		Leaves	Y, severe	**Y**
Eugenia reinwardtiana (3)	High	Leaves, **fruits**	Y	
Gossia spp. (3)				
Gossia acmeniodes (1)				
Gossia floribunda (1)	Med to high	Leaves	Y, severe	
Gossia fragrantissima (1)	Low	New leaf tips		
Gossia inophloia (1)				
Kunzea parvifolia (1)	Medium	New shoots		
Lenwebbia lasioclada (1)		Leaves		
Leptospermum laevigatum (1)				
Leptospermum myrtifolium (1)	Low to med	Leaves, stems		
Lithomyrtus obtusa (1)				
Lophomyrtus obcordata (1)		New shoots and **fruits**		
Melaleuca spp. (3)				
Melaleuca leucadendra (2)		New growth		**Y** med
Melaleuca nodosa (1)				
Melaleuca quinquenervia (13)	Low to high	Leaves, green stems		
Metrosideros spp.(1)				
Metrosideros kermadecensis[a] (1)		Leaves	Y	**Y** med
Myrtaceae family (5)				
Myrtus communis (2)				
Rhodamnia spp. (9)	Med to High	Leaves, stems	Y	Y
Rhodamnia acuminata (1)		Leaves		
Rhodamnia maideniana (1)	Med to high	Leaves and **fruits**		
Rhodamnia rubescens (27)	High	L, **flowers, fruits**	Y, severe	**Y, high**
Rhodamnia spongiosa (1)	High	Leaves		N
Rhodomyrtus spp. (2)				
Rhodomyrtus pervagata (1)		Leaves		

Table 2 continued

Species	Disease severity	Plant structures affected	Defoliation	Plant mortality
Rhodomyrtus psidioides (10)	High	Leaves, all parts	Y	**Y, high**
Rhodomyrtus sericea (1)				
Rhodomyrtus tomentosa[a] (1)				**Y**
Sphaerantia discolor (1)		Leaves		
Syncarpia glomulifera (4)	Medium	Leaves		
Syzygium spp. (4)				
Syzygium anisatum (1)	High	Young tender foliage		
Syzygium australe (1)				
Syzygium corynanthum (1)		Leaves	Y	N
Syzygium dansiei (1)		Leaves	Y	
Syzygium jambos[a] (12)	Low to high	Leaves only	Y	
Syzygium luehmannii (1)	Low	Leaves	Y	
Syzygium paniculatum (1)	Low	Leaves, **fruits**	Y	
Syzygium smithii var. minor (1)				
Syzygium tierneyanum (1)		Leaves	Y	
Tristaniopsis sp. (1)				
Tristaniopsis laurina (2)	Low	Leaves		
Uromyrtus metrosideros (1)		Leaves		
Waterhousea sp. (1)				
Xanthostemon fruticosus (1)				

The number of respondents that have seen these taxa with symptoms of infection or pustules are shown in parentheses, with information on disease severity, plant structures affected, occurrence of defoliation and plant mortality (Y = yes, N = no). In total 51 species were reported from 29 different genera. Previously unknown susceptible species are shown in bold, as well as crucial information (i.e. when susceptible tissues are flowers or fruits and occurrence of mortality). New information not previously reported is underlined

[a]Exotic species: *M. kermadescensis* (New Zealand); *R. tomentosa* and *S. jambos* (Asia)

by Makinson (2018). Species that dominated the list of recorded susceptible species were the natives *Melaleuca quinquenervia*, *Rhodamnia rubescens*, *Rhodomyrtus psidioides* and the exotic *Syzygium jambos*. The new host species reported were *Lophomyrtus obcordata* in VIC and *Kunzea parvifolia*, *Leptospermum myrtifolium*, *Eucalyptus amplifolia* and *Lophostemon confertus* in NSW.

In order to confirm the new host species, we contacted the participants to ask how confident they were on both the host plant species identification and the pathogen. For *Lophomyrtus obcordata,* symptoms of *A. psidii* infection of plant structures were confirmed by the Curator at the Environmental Horticulture (Peter Symes) at Royal Botanical Gardens, VIC, which has now been included in the national host species list (Makinson 2018). *Lophomyrtus obcordata* is not a native species in Australia, but endemic to New Zealand. *Kunzea parvifolia* and *L. myrtifolium* were confirmed by the Manager of Eurobodalla Regional Botanic Gardens, who observed symptoms on new leaves and some stems, with low to medium levels of infection. *Eucalyptus amplifolia* was reported to have infected leaves and plant mortality in a nursery. However, this could not be supported with photographic proof. The species has previously been shown to be susceptible in Japan (Kawanishi et al. 2009), and *E. amplifolia* subspecies *amplifolia* was found to be susceptible in Brazil (Zauza et al. 2010). Even though it was known to be susceptible in other countries, this is the first time it has been reported as a host in Australia, but the participant could not confirm it. Therefore, we performed additional glasshouse susceptibility tests on *E. amplifolia* subspecies *sessiliflora* (Blakely) and confirmed it as host (Berthon et al., unpublished), and as such will be added to the National Host species list. Finally, it was reported that *L. confertus* showed slight symptoms mainly on new growth where leaf tips tended to die, however previous tests by Sandhu and Park (2013) found it to be resistant, and it had not been reported previously from surveys in NSW (Carnegie and Lidbetter 2012) or QLD (Pegg et al. 2014). Thus, we could not confirm *L. confertus* as a host of *A. psidii,* and suspect this is a dubious record.

Infection and disease severity

This study collated information on which plant structures are affected by *A. psidii*, as well as disease severity, defoliation and mortality at a species-level, for several Myrtacecae species not previously reported by any other study (see Table 2, where underlined information is new to the bibliography). Of the 25 species that disease severity information was obtained for (Table 2), it was reported that 13 species had high severity while a further seven species had medium severity. *Rhodamnia rubescens*, *R. psidioides* and *Gossia inophloia* (previously *Austromyrtus inophloia*) were reported to have particularly high disease severity leading to mortality (Table 2). Other species recorded as suffering mortality were *Metrosideros kermadecensis* (medium susceptibility), *Rhodomyrtus tomentosa* and seedlings of *E. amplifolia* and *E. tereticornis*. Most species were described as showing symptoms of infection on newly developed leaves (39 of 51 species), while *Melaleuca quinquenervia* and *Leptospermum myrtifolium* had infected stems as well. *Decaspermum humile*, *Eugenia reinwardtiana*, *Rhodamnia maideniana*, *R. rubescens* and *Syzygium paniculatum* were reported to have infection on flower buds and/or fruits, which may reduce their reproductive output and subsequently have long-term population-level effects. This information is critical in assessing the vulnerability of susceptible species to *A. psidii* so that informed management decisions can be made to ensure the conservation of species that are most at risk. Interestingly in terms of synergetic effects of pest interactions, a participant reported that *Syzygium* cultivars become more severely infected with *A. psidii* after psyllid attack. This may be due to new leaf and shoot production resulting from psyllid attack being especially susceptible to *A. psidii*. Similar interactions have been reported to affect the invasive *M. quinquenervia* in Florida, USA, where infection by *A. psidii* is compounded by attack from the weevil *Oxyops vitiosa* (Rayamajhi et al. 2010). Similarly, Pegg et al. (2018) reported the combined impacts of repeated infection by *A. psidii* and a range of insect damage types, including mirids, on *M. quinquenervia* in northern NSW.

Expansion to new geographical areas and related containment

Four new local government areas (LGAs) where myrtle rust has not been detected before were reported in this survey: two in QLD (Burdekin and Gladstone) and two in NSW (Singleton and Muswellbrook) (Fig. 1 and S4, Supplementary materials). Note that if respondents did not report myrtle rust in a particular area, it does not necessarily mean that it is absent from that area.

Austropuccinia psidii was reported in a wide range of landscapes in NSW and QLD, ranging from urban areas to native environments. In contrast, the fungus was reported only in urban areas in VIC while no occurrences were reported for NT or TAS in our survey (Table 1), although the rust is present. Overall, slightly more respondents reported an absence of the rust in their area (51.6%) compared to those who reported that they had seen it (48.4%). In natural landscapes, *A. psidii* was most frequently observed in rainforests (51%, N = 90) and sclerophyll forests (24%, N = 90) (Fig. 2a). In urban landscapes, private gardens (53%, N = 72) as well as street trees and nurseries (17% each, N = 72) were most frequently observed to have *A. psidii* ocurrence (Fig. 2b). This may be due to humidity being higher in rainforest and private gardens (naturally in the former and artificially due to frequent watering in the latter) which creates optimal conditions for *A. psidii* spores to germinate (MacLachlan 1936; Ruiz et al. 1989). Furthermore, frequent watering and fertilising in private gardens also favours host growth which increases the amount of susceptible new growth. It is also possible that the rust is more common in private gardens or other populated areas due to facilitated spore dispersal by humans. It should be noted that urban landscapes may have been over-represented in the survey as the majority of respondents would generally spend more time in these landscapes.

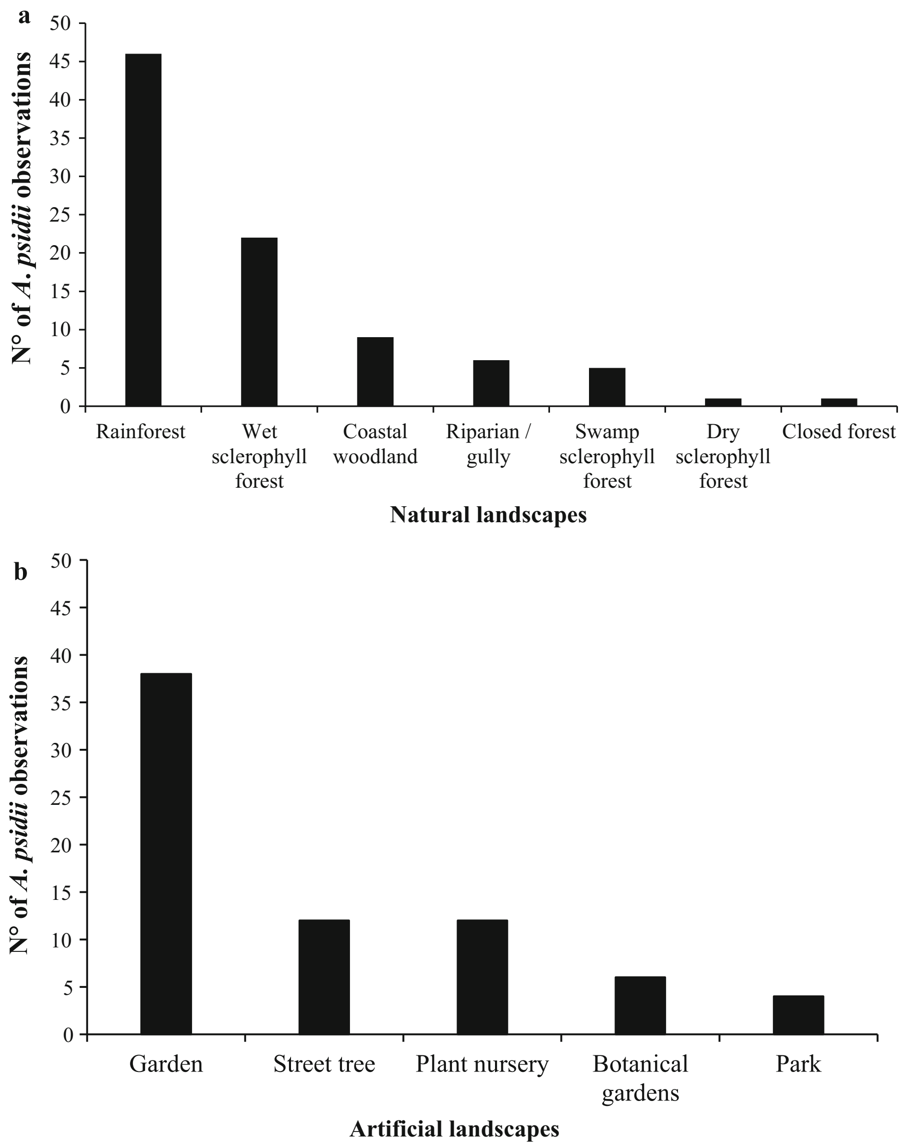

Fig. 2 **a** The natural plant community types where respondents recorded occurrence of *Austropuccinia psidii*. **b** The human mediated environments where respondents recorded occurrence of *Austropuccinia psidii*

Given that the pathogen continues to expand geographically, containment measures are still needed to avoid *A. psidii* from spreading into South and Western Australia, the latter of which contains a high number of endemic species and is a recognised global biodiversity hotspot (http://www.environment.gov.au/biodiversity/conservation/hotspots). Given its easy spread through airborne spores, *A. psidii* has recently arrived in New Zealand (DOC 2017), and unless it encounters climate barriers (e.g. dry conditions, low/high temperatures; see Kriticos et al. 2013; Berthon et al. 2018) it seems likely that it will spread to the two remaining unaffected Australian states. At the local-level, more than half of the respondents (60%, N = 47) that reported *A. psidii* do not attempt to control or contain it. The primary reason given for this lack of control is that it affects plants in the natural landscapes (78%, N = 42). Other reasons, especially in NSW and QLD, included 'control being fruitless', 'not feasible', the affected areas were not under their jurisdiction, time constraints and cost. When control measures were applied, several different methods were used.

These ranged from cutting infected branches or removing infected shrubs/trees, to application of fungicide spray. Fungicide application was mainly undertaken by nurseries and botanical gardens using the following products: mancozeb, triforine, copper oxychloride and copper sulphate.

In an international context, quarantine is crucial to prevent new strains of the pathogen from arriving into Australia. These additional strains could lead to an increase in the number of susceptible host species or in the level of infection of those already vulnerable. This could be triggered by the new strain itself, or by hybridization of strains, as there are currently at least nine biotypes of *A. psidii* that have been identified worldwide (Stewart et al. 2018). Restrictions on the imports of Myrtaceous species are currently in place for all seeds arriving from other countries where occurrence of *A. psidii* has been reported. Imports require a phytosanitary certificate stating the plant materials destined for Australia to be free of quarantine pests (BICON 2018). In conjunction with these measures, we suggest that it is also imperative that a nationally coordinated strategy is implemented to provide the public and natural resource managers with information on *A. psidii* to enable early detection and containment.

Stakeholder opinion and engagement

Most stakeholders (53%) surveyed think that *A. psidii* undoubtedly represents a long-term threat to specific species and/or plant communities in Australia. A further 14% think that there is a *possibility* it may be a long term threat, 16% think it is no threat while 17% are not sure (N = 76). Stakeholders who believe *A. psidii* is a threat in Australia were most concerned with the devastating effects it may have on the composition and structure of affected plant communities, introduction of new strains, mutation of the current strain and the effects related to infection of new growth post-fire.

Stakeholder concern about *A. psidii* has also resulted in a number of botanical gardens and nurseries no longer cultivating highly susceptible Myrtaceae species. For example, the highly susceptible *Austromyrtus inophloia* (Blushing Beauty) is no longer grown in nurseries and *Uromyrtus metrosideros* has been removed from Joseph Banks Native Plants Reserve (Sutherland, NSW) (information provided by survey participants). Furthermore, there are examples where local governments no longer recommend the use of some species in urban landscapes, for example *Agonis flexuosa*, *Eugenia reinwardtiana, M. quinquenervia*, *R. rubescens* and *S. jambos*. Updated information on species susceptibility should be made widely available to the nursery and landscape architecture industries and authorities responsible for planting and management of street trees, parks and gardens. In this regard, Pegg et al. (2018) made information on species susceptibility publicly available through the Plant Biosecurity Cooperative Research Centre (PBCRC) website (https://www.pbcrc.com.au/publications/pbcrc2206). It should be noted that all state biosecurity websites have information on *A. psidii* and the list of host species identified as susceptible, although these lists have not been updated for several years.

In terms of stakeholder engagement, the majority of survey participants (80%, N = 73) reported that they had received information from a government agency, mainly in NSW (73%), but also in QLD (20%) and VIC (7%, N = 59). Interestingly, the majority (91%) of participants surveyed that reported the occurrence of *A. psidii* (48%) were willing to be contacted about the threat and receive more information. People who did not report seeing the rust or did not know what it is (52%), were less likely to be interested in being contacted (83%). A large proportion of the people surveyed work for the government (76%); mostly at the local-level (77%), but also at the state (19%) and federal (4%) level. The remaining respondents work either for non-profit organisations (12%), private consulting companies (9%) or forestry agencies (3%).

Conclusion

In this study we collated information from a wide range of respondents on the invasion of *Austropuccinia psidii* in Australia. We identified four confirmed new host species in Australia (*Eucalyptus amplifolia*, *Kunzea parvifolia*, *Leptospermum myrtifolium* and *Lophomyrtus obcordata*), thus increasing the number of native susceptible species to 380 in 50 genera (Berthon et al. unpublished data). The identification of four new locations in QLD and NSW suggests that this pathogen is still expanding its distribution range in Australia. Therefore, we recommend that the Australian government introduce a program to provide information on *A. psidii* distribution, impacts and control methods to land managers and the public as this study shows they are willing to receive it and have high concern for the potential impact of the pathogen. Furthermore, we support continued management directions currently in place which focus on quarantine measures to avoid the rust spreading to SA and WA as well as maintaining biosecurity restrictions to stop different strains of the pathogen from entering Australia.

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