An invasive ant distribution database to support biosecurity risk analysis in the Pacific

Monica A.M. Gruber[1, 2]*, Meghan Cooling[2], Allan R Burne[2]

1 Centre for Biodiversity and Restoration Ecology, School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand

2 Pacific Biosecurity, Victoria Link Limited, Victoria University of Wellington, PO Box 1762, Wellington, New Zealand

* Corresponding author.

E-mail addresses: Monica.Gruber@vuw.ac.nz (M.A.M. Gruber), Megan.Cooling@vuw.ac.nz (M. Cooling), Allan.Burne@vuw.ac.nz (A.R. Burne).

Abstract

Invasive species are one of the most serious threats to biodiversity. Up-to-date and accurate information on the distribution of invasive species is an important biosecurity risk analysis tool. Several databases are available to determine the distributions of invasive and native species. However, keeping this information current is a real challenge. Ants are among the most widespread invasive species. Five species of ants are listed in the IUCN list of damaging invasive species, and many other species are also invasive in the Pacific. We sought to determine and update the distribution information for the 18 most problematic invasive ant species in the Pacific to assist Small Island Developing States (SIDS) with risk analysis. We compared the information on six public databases, conducted a literature review, and contacted experts on invasive ants in the Pacific region to resolve conflicting information. While most public records were accurate we found some new records had not yet been incorporated in the public databases, and some information was inaccurate. The maintenance of public databases faces an enormous challenge in balancing completeness (~15,000 ant species in this case) with accuracy (the impossibility of constantly surveying) and utility.

Keywords: biosecurity, invasive species, biological invasions

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Accurate information on the distributions of invasive species is important for biosecurity risk analysis. We report on distribution information for 18 key threat invasive ant species to the Pacific. Our goal is to assist Small Island Developing States (SIDS) with risk analysis.

Introduction

Invasive species are among the most serious threats to biodiversity, and six ant species are listed in the IUCN selection of 100 of the world's worst invasives (Lowe *et al.* 2004). Accurate information on the distribution of invasive species is essential for reliable biosecurity risk analysis. Knowing which invasive species are already present in a country helps biosecurity agencies separate new incursions from resident species. In addition, knowledge of the invasive species present in partner countries is critical to conducting risk assessments for new imports and existing pathways. National and regional agencies, such as the Secretariat for the Pacific Community (SPC), manage pest list databases specifically for this purpose. In addition, multiple public databases document the global distributions of invasive species, including the Global Biodiversity Information Facility (GBIF), Global Invasive Species Database (GISD) and Global Register of Introduced and Invasive Species. Supplementing these invasive species databases, taxon-specific databases provide information on both introduced and native species. For example, for ants these databases include Antkey (http://antkey.org/en), AntWeb (https://www.antweb.org) and AntWiki (http://www.antwiki.org). In addition, Antmaps.org / The Global Ant Biodiversity Informatics database (GABI) (Guenard et al. 2017) provides a useful visualisation of the global distributions of all ants.

As part of our work collating a toolkit of resources to prevent and manage invasive ants in the Pacific (Gruber *et al.* 2016), we wanted to provide up-to-date information on the distribution of the key invasive ant threats in and to the Pacific to assist Small Island Developing States (SIDS) in risk analysis. This initiative stemmed from our observations that remote Pacific territories with highly restricted access to web-based resources and low computing capacity are hindered in their risk-analysis capacity as they find it difficult to obtain this type of information. Regionally managed tools, such as the pest list databases, require specific training

63 and software that are difficult for some territories to maintain. Internet access can be
64 slow and sporadic in many Pacific SIDS. Here, we provide a simple tool based on an
65 excel spreadsheet that these SIDS can easily access.

66 **Materials and methods**

67 Hundreds of ant species have been recorded in the Pacific region, with 187 in
68 Fiji alone (Sarnat and Economo 2012). Forty-four of the ant species recorded in the
69 Pacific are considered invasive (Sarnat 2008). Keeping distribution information up to
70 date for ants on Pacific Island states alone would require regular surveys of more
71 than 20 countries and territories, some of which have 1,000 or more separate
72 landmasses (islands, atolls and islets within atolls). Given the impracticality of such
73 a programme, we selected 18 key invasive species based on their level of risk to the
74 Pacific, and sought to confirm their distributions in the Pacific. These included the
75 species considered the six most widespread and damaging ants globally (Holway *et*
76 *al.* 2002). Five of these are also on the International Union for the Conservation of
77 Nature's "100 of the world's worst invasive alien species" list (Lowe *et al.* 2000).
78 These six species are also the ants that are most commonly targeted in eradication
79 programmes, because of the problems they cause (Hoffmann *et al.* 2016). These ant
80 species are all known to damage infrastructure, reduce agricultural yields and
81 negatively impact many different native species (Holway *et al.* 2002). Three of these
82 species also have painful stings or spray acid, which impact quality of life in infested
83 areas (Holway *et al.* 2002). In addition to these key species we selected 12 species as
84 lesser or emerging threats. Ten of these are already common invaders across the
85 Pacific and were selected based on their threat ranking (Sarnat 2008). The other two
86 species are not yet widespread but have documented negative effects elsewhere, and
87 may cause harm in nations in the Pacific region in future (Table 1).

88 We collated data on the national presence / absence of the chosen species
89 globally from six databases and 19 papers in a spreadsheet freely available at
90 http://piat.org.nz/problem-ants/invasive-ant-distribution. Our database is possibly
91 unique in that we list both the earliest record of species presence in a country (by
92 year) and the last confirmed sighting of the species in that country. The sightings
93 were based on either journal articles in which species were collected and identified,
94 or more commonly, on specimen records on AntWeb and the Global Biodiversity

Information Facility. In some cases the species was listed as present in a country on AntWeb or AntWiki, but we were unable to find a specimen record confirming this. In these cases we listed the year for the latest source as "no date" (i.e. the record should be considered unconfirmed). We did not use sources where the ant was simply listed as present in a country without out any references, or the references were simply statements without confirmation (i.e. we followed the provenance of every record). We included observations from our own recent work in Kiribati and Tokelau and contacted experts on the Pacific regional ant fauna to confirm distributions.

Results

Our update of distributions are freely available in a spreadsheet at http://piat.org.nz/problem-ants/invasive-ant-distribution. This database provides an easy to use tool for biosecurity officers in SIDS to undertake a simplified risk analysis of invasive ants.

Most of the distribution information we assessed was accurate. However, we found three erroneous records of presence, that of little fire ant *Wasmannia auropunctata* in Tuvalu (Matio Lonalona and Maclean Vaqalo, personal communications), which was listed as present by Waterhouse (1997). Red imported fire ant, *Solenopsis invicta,* was erroneously recorded as present in Singapore and Malaysia in the GISD database, based on error in An and Lee (2001), confirmed to be mistaken by Wetterer (2013). We also found that Antmaps.org recorded *Anoplolepis gracilipes*, *Solenopsis geminata*, *Solenopsis invicta* and *Wasmannia auropunctata* as introduced indoors in New Zealand. None of these species are present in New Zealand. New records include our observations of *Lepisiota* sp. (likely *Lepisiota frauenfeldi*) in Kiribati (Kiritimati Island, Gruber 2013), and *Anoplolepis gracilipes* in Nauru (Eric Edwards, personal communication, Saurara and Vaqalo 2015).

Discussion

Keeping distribution databases current is a monumental challenge. Ideally, these databases provide accurate information for all species. For ants, this requires up-to-date information on more than 15,000 species (https://www.antweb.org/). The challenge of this task results in inertia in database updates and lapses in the currency of information. To assist risk analysis by focussing on those species that pose the most serious threat is one way to make the task more manageable, without sacrificing utility.

Species distributions in potential trading partner nations need to be known for effective risk analysis. And effective risk analysis requires that this information be reliable. Generally, the distributions we studied were accurate. However, the mistaken presence of high profile invasive species, such as the little fire ant, *Wasmannia auropunctata,* and red imported fire ant incidences that we noted could have potential trade ramifications, unless they can be verified. For example, when yellow crazy ants were detected on Kiritimati Island, Kiribati in 2013, the Fiji Sun newspaper reported that as part of precautionary measures Biosecurity Fiji had placed ant detection lures around the wharves in ports and on the shipping containers coming from Kiribati (http://fijisun.com.fj/2013/04/15/baf-fights-crazy-ants/). However, the yellow crazy ant is already widely distributed in Fiji (Wetterer 2005; E. Sarnat, personal communication 2015), so this action was unnecessary. In fact, as the yellow crazy ant is not present in Tarawa, which is the key transport point between Kiribati and Fiji, Kiribati faces a high risk of this species arriving from Fiji. Developed countries such as Australia, New Zealand and the United States can verify these incidences as a matter of course, but isolated Pacific SIDS can find this type of activity challenging, often due to significant barriers in communications infrastructure.

Often information on distributions are reported by country rather than landmass. Although locality information for a detection can be found with some research effort, the heterogeneity of distributions is not obvious, as records are typically collapsed according to geo-political boundaries. For example, the Republic of Kiribati is made up of three island groups (Gilbert, Phoenix and Line Islands). The yellow crazy ant has been detected on only one island group, the Line Islands

(Fanning Island, Wilson and Taylor 1967; Kiritimati Island, Gruber 2013). Moreover, the current presence is only certain on Kiritimati Island (the author's personal observations 2016). However, the GBIF lists the location as being in the Gilbert Islands group over 3,000 km distant, where there is no evidence of the species. From a biosecurity perspective, identifying presence of a threat species by country alone can thus be misleading if multiple ports export to different places, as is the case in Kiribati. Antmaps.org denotes distributions by landmass, which is very useful. Our distribution database is being progressively updated to include this more specific information also.

Of course, like all other collections of information, our database is subject to lapsing in currency over time. The initiative for which the database was built continues until December 2019. Until that time we will continue to keep the database up to date with periodic reviews, which is manageable as we focus only on 18 species. After 2019, the initiative will be transferred to the regional agencies that have a mandate for biosecurity and invasive species management in the Pacific (SPC and the Secretariat of the Pacific Regional Environment Programme [SPREP]). Global and regional agreements require new detections of invasive species to be reported to SPC and other biosecurity organisations, so they are ideally placed as custodians of this information.

As well as information currency, another challenge is the expertise required for accurate identification of ant species. Many species are cryptic, or belong to species complexes that are very difficult to delineate from each other. Pacific SIDS typically lack such specific taxonomic expertise and rely on regional agencies and research institutions for assistance. However, these agencies also have limited resources to pay for experts or recruit and train staff with highly specific expertise. Restricting focus on only the highest risk species would enable easier targeting of resources. Rather than having to exactly identify every intercepted species, being able to exclude a species as a threat would make biosecurity more straightforward and effective in these isolated Pacific countries and territories.

The maintenance of public databases faces an enormous challenge in balancing completeness and accuracy with utility. Periodic, focussed reviews such as

the one we have conducted may be a cost-effective compromise to wide-ranging surveys for the purposes of simplified biosecurity threat analysis.

Author contributions

MAMG conceived the work. MC and ARB collected the data. All authors contributed to writing the manuscript.

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245 Table 1: Invasive ant species that were selected for inclusion based on either being invasive in, or posing a threat to, the Pacific region.
246 The ants were selected based on their presence on the IUCN worst 100 list (Lowe et al. 2004), the Holway et al. (2002) list of the world's six
247 most damaging ants, and the Pacific Invasive Ant Key threat ranking (Sarnat 2008), together with two emerging threats.

Common name (s)	Species	Lowe et al. (2004)	Holway et al. (2002)	Sarnat (2008)	emerging
African big-headed ant; coastal brown ant	*Pheidole megacephala*	X	X	High	
Argentine ant	*Linepithema humile*	X	X	Medium	
bicoloured pennant ant; Guinea ant; penny ant	*Tetramorium bicarinatum*			Medium	
bicoloured trailing ant; flower ant	*Monomorium floricola*			Low	
black crazy ant; longhorn crazy ant	*Paratrechina longicornis*			High	
browsing ant	*Lepisiota frauenfeldi*			-	X
difficult white-footed ant	*Technomyrmex difficilis*			Medium	
Fijian white-footed ant	*Technomyrmex vitiensis*			Medium	
ghost ant	*Tapinoma melanocephalum*			Medium	
little fire ant; electric ant	*Wasmannia auropunctata*	X	X	High	
pharaoh ant	*Monomorium pharaonis*			Medium	
tawny crazy ant; Rasberry crazy ant	*Nylanderia fulva*			-	X
red imported fire ant	*Solenopsis invicta*	X	X	High	
similar groove-headed ant	*Tetramorium simillimum*			Medium	

Singapore ant; destroyer ant; ninja ant	*Trichomyrmex destructor*			Medium
tropical fire ant; ginger ant	*Solenopsis geminata*		X	Medium
white-footed house ant	*Technomyrmex albipes*			Medium
yellow crazy ant; long-legged ant	*Anoplolepis gracilipes*	X	X	Medium

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