Managing the risk of invasive exotic ants establishing in New Zealand

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Abstract

Between 2002 and 2005, a large number of post border detections of invasive exotic ant species were discovered at the Container Repairs & Storage (CRS) facility in Mount Maunganui, New Zealand. Sea containers originating from the Pacific Islands are considered the likely pathway of entry to New Zealand. Ants had spread from the sea containers and established founding nests in surrounding areas. In response to this, MAF Biosecurity New Zealand (MAFBNZ) implemented incursion responses and surveillance activities to determine the scale of each infestation and feasibility of eradication. The programmes implemented were expensive, resource intensive and involved managing the biosecurity risk posed by the ants after they had established. To manage the risks more effectively, MAFBNZ implemented an Offshore Sea Container Hygiene programme to better manage sea container contamination risks offshore, at the source, and reduce the threat of invasive pests such as exotic ants arriving into New Zealand. The response surveillance and eradication measures and the new offshore risk management programme are discussed with regard to their effectiveness and significance.
Keywords: Offshore sea container hygiene programme, biosecurity, risk management, surveillance, response.

Introduction

Increasing international trade and travel present New Zealand with an ever-growing risk of incursions of invasive exotic ant species. Exotic ants are among the worst invasive species in the world (DPI undated).

Invasive exotic ants can reduce horticultural crop production by (1) increasing populations of honeydew-producing homopterans, which in turn, increase the incidence of disease vectored by homopterans, (2) reducing crop seed set and yields, (3) interrupting the pollination process by insects, (4) damaging field equipment and (5) decreasing field labouring efficiency. As well as impacting on the horticultural industry, invasive ants can cause significant impacts on other sectors of society including the general public.

Around 65% of invasive ants detected at the New Zealand border arrive on or in sea containers or goods from the Pacific Islands (Nendick et al. 2006). The Container Repairs and Storage (CRS) facility in Mount Maunganui receives approximately 25% (about 5200 per annum) of all empty sea containers that arrive into New Zealand from the Pacific Islands (O'Connor 2003).

Since 2003, there have been 46 recorded interceptions of exotic ants in containers from the Pacific Islands at CRS, Mount Maunganui. On 9 April 2003, the first post border discovery of *Paratrechina longicornis* (crazy ant) at the CRS facility was detected during the National Invasive Ant Surveillance Programme. Follow up surveillance found further *P. longicornis* populations, as well as *Anololepis gracilipes* (yellow crazy ant), *Solenopsis geminata* (tropical fire ant) and *Monomorium destructor* (Singapore ant). Eradication programmes were immediately implemented. These findings confirmed sea containers from the Pacific Islands as a high risk pathway for invasive ants arriving into New Zealand.

As a result, the need to reduce the risk of invasive ants arriving into New Zealand in sea containers was investigated. The best way to achieve this was to focus on effective offshore risk management programmes with on-arrival monitoring rather than relying on costly post-border surveillance systems and incursion responses. A 3-month offshore container management programme between MAF Biosecurity New Zealand (MAFBNZ) and industry was trialled between April and June 2006 to reduce the risk of contamination by invasive ants on sea containers prior to the containers arriving into New Zealand.

This paper summarises the pre-border and post-border programmes that MAFBNZ have initiated as a result of the finds at CRS. Their implementation, effectiveness and implications are discussed.

Methodology

Response surveillance and eradication programmes

Four delimiting surveys were carried out from April 2003 to April 2005 to determine if *P. longicornis*, *A. gracilipes* and *S. geminata* had spread beyond the detected nests at CRS.

The surveyed area (i.e. up to 500 m from a nest site), was divided into 10 x 10 m grids. Each 10 x 10 m grid was visually inspected and attractant bait traps using protein-based (sausage meat, soy oil, peanut butter) and sugar-based (cotton wool soaked in 20% sugar solution) baits were positioned within each grid near ideal ant habitats. Visual inspection and baiting were conducted on days when air temperatures were at a minimum of 20°C and rain was unlikely between placement and collection of baits.

Areas deemed 'high risk' received a minimum of 8 baits per 10 x 10 m grid (Ashcroft 2003; Ashcroft & Gunawardana 2004a). All other areas within 150 m of where the ants were found and areas from 150 to 500 m that fell within 10 m of open and closed drains, creeks and cess pits, received a minimum of two baits per grid. Baiting was conducted inside buildings from 0 to 150 m but not within 150 to 500 m, except where water sources existed around the building (i.e. water taps, leaky pipes, sprinklers and drainage outlets). Bait traps were retrieved after 2 hours, labelled and submitted for identification. If invasive ants were found, a programme aimed at locating and destroying the nest was implemented.

Attractant baits were used to locate nests, and baits were inspected after 15, 30, 60, 90 and 120 minutes. Ant trails were followed to determine the nest location. If a nest was discovered in a porous substrate, Direct 20P (200 g/litre diazinon) soil drench was used within a 2 metre radius of the nest site. If the nest was located in a non-porous substrate, Pyrethrum (Permethrin) gas and Permex Insect Dust (2.5% permethrin) were dispersed in likely nest entrance and exit holes. Depending on the ant species found, Maxforce® Insect Granules (1% hydramethlynon) and/or Xstinguish® (0.1 g/kg fipronil) and/or Exterm-an-ant (80 g/litre boric acid; 56 g/litre sodium borate) toxic baits were placed within 0 to 30 m of the nest. If no nests were discovered, the appropriate toxic bait(s) were positioned near suspect nest entry and exit holes, favourable ant habitat and foraging pathways (Ashcroft et al. 2003). To determine treatment efficacy, a post-treatment monitoring programme was implemented. The programme consisted of visual inspection of treated nest sites as well as servicing of toxic baits.

Where feasible, a nest extraction to determine colony characteristics (i.e. nest age, life stages and social type) of each nest was conducted after nest destruction was confirmed (Ashcroft & Gunawardana 2003). Where a nest extraction could not be undertaken, direct observations of the colony were noted. The size of the area to extract was determined by the location of nest entrance and exit holes and adjusted accordingly if lateral galleries were present. Using a spade, 3 cm soil layers were removed up to a depth of 1 metre (Taber 2000). If brood was found, another 3 soil layers below the brood area were extracted to ensure no vertical or lateral galleries were present. Each 3 cm soil layer was placed inside labelled sealed bags. All soil was double bagged and transported to the MAFBNZ Investigation & Diagnostic Centre, Auckland, for analysis and subsequent destruction.

Each soil sample was placed in a water bath containing 10% salt water (Ashcroft & Gunawardana 2004b). The water was gently stirred to separate ants and organic debris from the soil. Ants were collected and stored in 70% ethanol. The numbers found for each lifestage were recorded for each soil layer.

Offshore container management programme

The programme called EQ2 (Equivalent Quarantine 2) was trialled at three ports, Lae and Port Moresby in Papua New Guinea and Honiara in the Solomon Islands, between April and June 2006.

Under the EQ2 programme, empty containers were decontaminated using a combination of interior sweeping and internal and external high pressure washing (Nendick et al. 2006). The external surfaces were treated with a residual insecticide Biflex (bifenthrin) in areas where ants could take refuge. All containers were then stored on clean wharf areas prior to shipping to New Zealand. These areas were treated with Maxforce® granules on a monthly basis, followed 1 week later by a residual granular insecticide Pyrifos G (chlorpyrifos) to exclude and kill ants. Where required, Exterm-an-ant was used where it was not appropriate to use the granular applications. In addition weeds and debris were removed to limit favourable ant habitats. Containers that were loaded on board vessels were segregated from containers originating from other 'non EQ2 system' ports. This was to reduce the likelihood of cross contamination on board the vessel from other containers that were not part of the trial.

In order to measure the success of the trial, MAFBNZ set a target contamination threshold of 0.16%. The threshold was determined by analysing ant interception data relating to imported containers obtained between 2002 and 2006. Containers that were part of the EQ2 trial were 100% inspected by MAF Quarantine Service (MAFQS) upon arrival into New Zealand to verify contamination levels. MAFQS inspection results were monitored for the 3-month trial period and monitoring continued every 3 months thereafter to assess contamination levels.

Results

Response surveillance and eradication programmes

Over 15,000 attractant bait traps were laid during the four delimiting surveys (Fig. 1). There were 27 ants detected visually and bait traps attracted much larger numbers of ants. Positive finds were recorded for *A. gracilipes*, *P. longicornis* and *M. destructor*. No further *S. geminata* were found within the surveyed areas (Table 1). Daytime temperatures in excess of 21°C were common.

Additional finds of *P. longicornis* were made during the monitoring programme at 3 grids, whereas there was no further evidence of live activity for *S. geminata* and *A. gracilipes* (Table 2).

Nests were confirmed for *S. geminata* (x1), *A. gracilipes* (x2) and *P. longicornis* (x2) (Table 3). The *S. geminata* nest was the largest colony with approximately 1960 workers and 40 larvae, whereas one of the two *P. longicornis* nests discovered was the smallest with 50 to 100 workers observed. Although *P. longicornis* workers were found in 3 grids and *M. destructor* in 1 grid, no additional nests were confirmed. Post treatment monitoring of all sites found no further evidence of live activity.

Offshore container management programme

The incidence of invasive ants substantially decreased from approximately 16.8% prior to the trial period to 0.2% after the trial at Honiara (Fig. 2a). Similarly, contamination rates dropped from 1.2% to 0.1% for Port Moresby and 0.4% for Port Lae (Fig. 2b). Overall, there has been a 98.5% reduction in ant contamination rates following the EQ2 system implementation across the 3 ports involved.

Table 1. Delimiting survey results for *P. longicornis*, *A. gracilipes*, *S. geminata* and *M. destructor* at CRS.

Species	Detection	Date found	2003[1] Apr-May 150 m	2003[1] Jul-Aug 150 m	2004[1] Feb-Mar 500 m	2005[1] Feb-Apr 500 m
P. longicornis	A	Apr 2003	X	X	X	X
	B	Jun 2003			X	X
	C	Dec 2003			X	X
	D	Mar 2005				√
	E	Mar 2005			X	X
A. gracilipes	F	Jun 2003		X	X	X
	G	Jul 2003		√	X	X
S. geminata	H	Jun 2003		X	X	X
M. destructor	I	Feb 2005				√

[1] =not applicable; X=negative; √=positive.

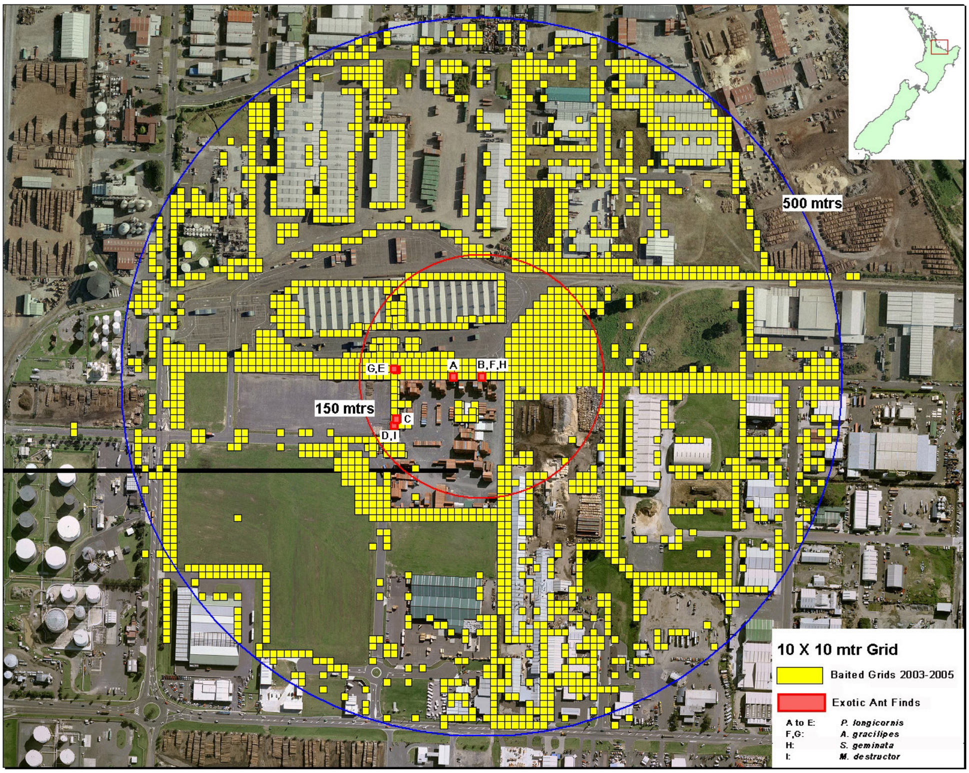

Figure 1. CRS Surveillance area showing areas where attractant baiting occurred as well as areas where invasive exotic ants were found (Source: AsureQuality).

Table 2. Post treatment monitoring results for *P. longicornis*, *A. gracilipes*, *S. geminata* and *M. destructor* at CRS.

Detection	Date found	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
		2003[1]								2004[1]		2005[1]	
		P. longicornis											
A	Apr 2003	√	X[2]	X	X	X	X	X	X[2]	X	X		
B	Jun 2003		√	X	X	X	X	X	X	X	X		
C	Dec 2003								√	X	X		
D	Mar 2005											√[2]	X
E	Mar 2005											√	X
		A. gracilipes											
F	Jun 2003		X	X	X	X	X	X	X	X	X		
G	Jul 2003				X	X	X	X	X	X	X		
		S. geminata											
H	Jun 2003		X	X	X	X	X	X	X	X	X		
		M. destructor											
I	Feb 2005											X	X

[1] ▒=not applicable; X=negative; √=positive.
[2] Discovery of invasive ants in another grid.

Table 3. Colony life stages for *P. longicornis*, *A. gracilipes*, *S. geminata* and *M. destructor* nests at CRS.

Species	Detection	Life stage: Queens	Workers	Larvae	Alates
P. longicornis	A	1	1092	22	0
	B	0	20	0	0
	C	0	50-100	Present	0
	D	0	8	0	0
	E	0	48	0	0
A. gracilipes	F	2	>100	0	0
	G	15	>300	0	0
S. geminata	H	1	1960	40	0
M. destructor	I	0	9	0	0

Continued auditing of the EQ2 system after the 3-month trial period revealed that contamination rates increased above threshold levels (0.16%) for Port Lae from 2007 onwards (Fig. 3). Port Honiara also increased above threshold levels from February 2008 while Port Moresby has remained below the 0.16% threshold since April 2006 when the EQ2 system was first trialled. Additionally, no ants have been detected at all in containers from Port Moresby since November 2007.

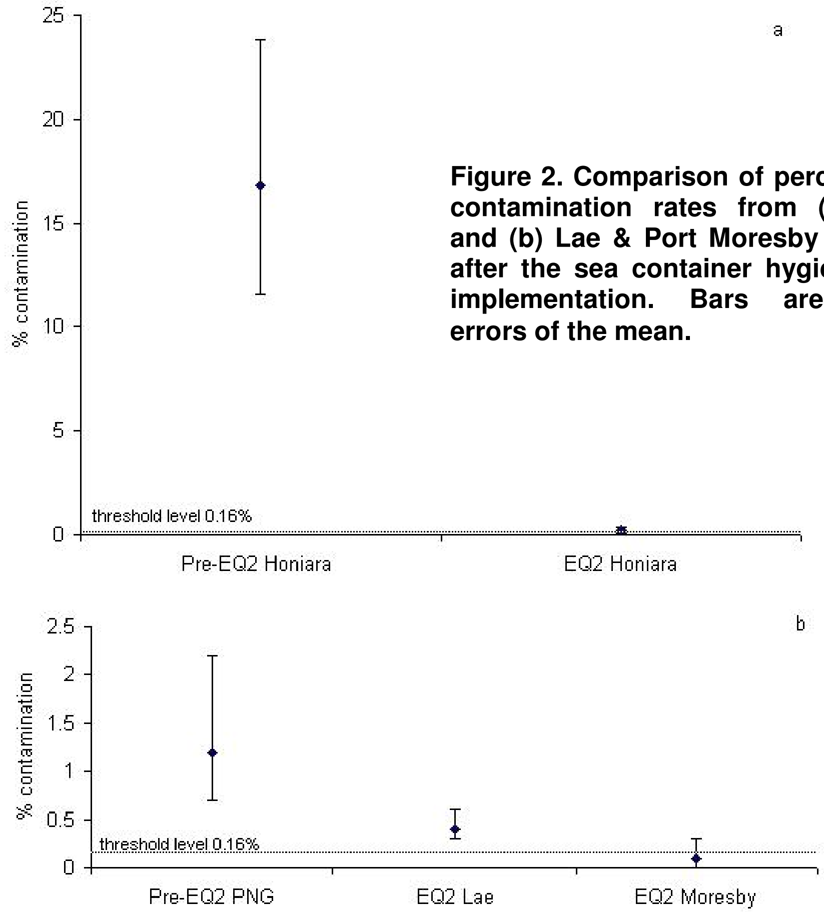

Figure 2. Comparison of percent (%) ant contamination rates from (a) Honiara and (b) Lae & Port Moresby before and after the sea container hygiene system implementation. Bars are standard errors of the mean.

Discussion

Response surveillance and eradication programmes

The use of protein-based baits in locating the *S. geminata* nest and treating it using Direct 20P (diazinon) proved highly successful as no further populations were found during post-treatment monitoring of the nest. As *S. geminata* disperse by nuptial flight, there was no evidence to suggest spread had occurred within 500 m of the nest. The absence of *S. geminata* alates (males & virgin queens) indicates the nest was not old enough, or temperatures were sub-optimal, to allow colony development to occur beyond a critical mass when reproductives are produced (C. Vanderwoude, pers. comm. 2003; Harris undated). Hence a nuptial flight is unlikely to have taken place. The social type of *S. geminata* can be either monogyne (single queen colony) or polygyne (multiple queens) (Taber 2000). The presence of only one queen suggests the nest may have been monogyne.

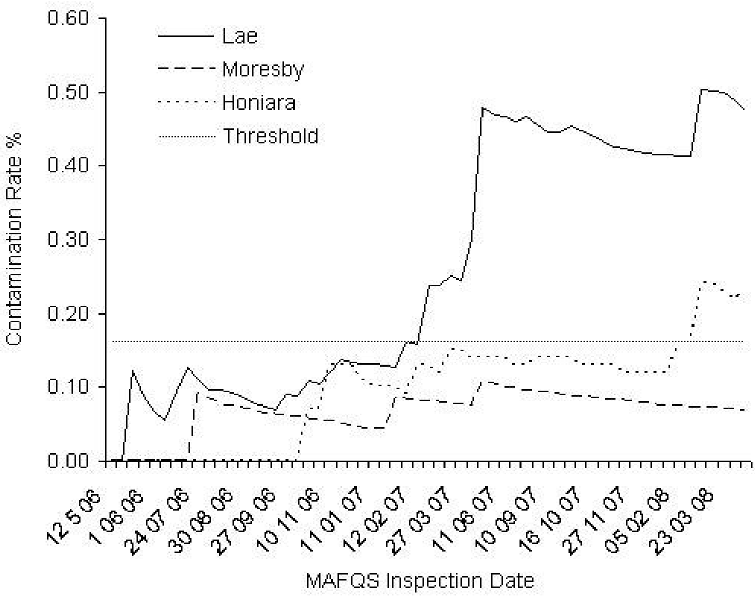

Figure 3. Contamination rate (%) of shipping containers from Ports Lae, Moresby and Honiara upon arrival into New Zealand from 12 May 2006 to 16 May 2008.

Budding (when one or more queens leave the nest accompanied by workers to establish a new colony) is the primary mode of dispersal for *A. gracilipes*, with queens budding up to 100 m from the founding nest (N. Reimer, pers. comm. 2003). The discovery of a second *A. gracilipes* nest within 100 m of the first nest, suggests budding may have taken place, but it is not known whether the two nests are related or if they were founded independently. *A. gracilipes* nests are polygyne. Both *A. gracilipes* nests contained multiple queens but no brood was found. Nest eradication was successful, as no further *A. gracilipes* were found during post-treatment monitoring. In addition, spread had not occurred beyond these two sites.

P. longicornis has polygyne colonies (Passera 1994), but only one queen was found (in one of the two nests) at CRS. Post-treatment monitoring of *P. longicornis* and *M. destructor* sites, confirmed eradication was successful for both species.

There is a lack of data on cold climate tolerance and growth rates of *S. geminata*, *A. gracilipes* and *P. longicornis* for accurately estimating nest age. New Zealand's temperate climate is likely to limit spread and colony development of these tropical species to favourable microhabitats only (Abbott et al. undated; Harris & Abbott undated; Harris undated). This could partly explain the reason why all nests were confined to a sheltered north facing bank. Although conditions may have been favourable for local establishment, it is not known whether each nest was newly founded by a single fertilised queen from a shipping container or whether the colony migrated from a container to where they were found. Nests of *S. geminata*, *A. gracilipes* and *P. longicornis* are known to migrate in times of disturbance hence processing and clearance of containers at CRS may prompt this behaviour.

Offshore container management programme

Initial trialling of the EQ2 system over the 3-month period at Ports Moresby, Honiara and Lae demonstrated that the mitigation measures implemented under the system were very effective in lowering the contamination levels of invasive ants close to or below the 0.16% threshold. However, continued monitoring of the system in 2007 and 2008 showed a significant increase in contamination levels above the threshold for shipping containers from Port Lae and Honiara. Port and Stevedore management had a direct bearing on the success or otherwise of the offshore system at Port Lae and to a lesser extent in Honiara.

In Lae, a change in Port management resulted in a decline in performance of the EQ2 programme. This led to system non-compliance, where contamination rates were above the threshold. In addition the period of non-compliance coincided with summer (February 2007 and February 2008), with the increase in daytime temperatures (at Port Lae and Honiara) presumably increasing ant activity, which may have contributed to a rise in contamination rates.

The success of the EQ2 system in Port Moresby indicates that off-shore programmes of this type can very effectively mitigate the risk of contaminated pathways offshore, before imports arrive in New Zealand. Continued compliance with the EQ2 system reduces the need to inspect "system compliant" containers on arrival into New Zealand. This results in a reduction in time delays for processing containers upon arrival, which provides direct cost and time savings for the importer, Port companies and MAFBNZ. A continuation and expansion of this programme to other Pacific Islands is critical to mitigate the risk of invasive ants reaching New Zealand.

The importance of expanding the EQ2 programme is evident by the number (n=56) of new interceptions of exotic ants found at the CRS facility from April 2006 to May 2008 during ongoing surveillance. In addition to receiving "EQ2 system compliant" shipping containers, the facility also receives containers from other Pacific Island ports where the EQ2 programme is not operating. Extending the programme to other ports is likely to significantly decrease the number of post-border invasive exotic ant finds in New Zealand and at CRS. This will contribute to further cost savings and allow MAFBNZ resources to be used on mitigating other potential invasive organism pathways.

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