PERSPECTIVES IN
Biosecurity
RESEARCH SERIES 1/2016

Perceptions and Impacts:

An Observational Pilot Study of the Effects of Argentine Ants on Honey Bees in New Zealand

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This publication may be cited as:
Jones, G., Fenwick, S-J., Lallu, U. and Fraser, D. (2016). Perceptions and Impacts: An Observational Pilot Study of the Effects of Argentine Ants on Honey Bees in New Zealand. ***Unitec ePress Perspectives in Biosecurity Research Series*** (1). Retrieved from http://www.unitec.ac.nz/epress/

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On the cover is the Australian tachinid fly (***Trigonospila brevifacies***), a parasitoid of other insects, specifically larvae of a number of Lepidoptera. It was introduced into New Zealand as a biological control agent for pest leaf roller moths, is also known to affect non-target and non-pest species, and to compete with native parasitoids.

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ISSN 2422-8494

Perceptions and Impacts: An Observational Pilot Study of the Effects of Argentine Ants on Honey Bees in New Zealand

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Abstract

The Argentine ant (Linepithema humile) *is an invasive species first identified in New Zealand in 1990. It is an aggressive tramp species that can form very large 'super colonies' extending over vast areas and has been reported to rob honey and predate honey bees in hives. This pilot study sought to establish, from a circulated survey of beekeepers, which ant species were present in their hives and what awareness the beekeepers had of the potential impact of Argentine ants. In addition, a simple method of quantifying the effects of the Argentine ant on brood abundance was trialled in the field. Results indicate that several species of ant are commonly found in hives and that surveyed beekeepers generally regard ants as passive occupiers. A percentage cover estimate of brood cover in frames may be a simple way of measuring ant impact when comparing hives uninfected by ants. Photographic evidence is presented as further indication that* L. humile *foraged within the hive and actively fed on both honey and emerging brood.*

Introduction

The honey bee (*Apis mellifera* Linnaeus 1758) in New Zealand is well known for the production of honey as well as other products such as beeswax, pollen, propolis and royal jelly. These products had an annual value of NZ$4.4 million at the end of 2013 (NZ House of Representatives, 2014). More importantly, the honey bee is a significant pollinator of native and agricultural/horticultural plant species with an estimated value of $5.1 billion per annum to the New Zealand economy (NZ House of Representatives, 2014). The role of honey bees in pollination services is of global importance for the sustainability of food production and wild plant diversity (Klein et al., 2007; Ollerton et al., 2011; Potts et al., 2010). However there are serious threats to honey bee populations both globally and in New Zealand due to a range of impacts. These include parasites such as the Varroa mite (*Varroa destructor* Anderson & Trueman 2000), diseases such as American foul brood *Paenibacillus larvae* (White 1906; Ash et al. 1994), competitive invasive species, the overuse of pesticides, anthropogenic pollution and loss of genetic diversity and vitality (Ellis & Delaplane, 2008; NZ House of Representatives, 2014; Potts et al, 2010). These present major threats to apiary management and productivity. Another potential invader, the Argentine ant (*Linepithema humile* Mayr 1868) could similarly present major challenges to the industry (Barlow & Goldson, 2002).

In its invasive range, the Argentine ant is known to have significant negative impacts on native invertebrates including native ant species (Rowles & O'Dowd, 2009; Walters, 2006), and vertebrate biodiversity (Suarez et al., 2000), which can inhibit ecosystem services such as pollination and seed dispersal (Rowles & O'Dowd, 2009; Walters, 2006). The Argentine ant is an aggressive tramp species that can form very large 'super colonies' extending over vast areas (Giraud et al., 2002; Walters & MacKay, 2005). The species was first identified in Auckland in 1990 (Green, 1990) and has been identified as a significant pest of horticultural crops, particularly due to its tending of some

species of sap sucking hemiptera. (Lester et al., 2003). Argentine ants have also been reported to rob honey and predate honey bees in hives, resulting in weakening of the hive and negative impacts on the efficiency of pollination and honey production by honey bees (Harris, 2002; Lester et al., 2003).

This species is now relatively widespread in the north of New Zealand, and due to its high association with humans and its spread via human mediated 'jump' dispersal (Suarez et al., 2001; Ward et al., 2005; Ward et al., 2010), it has been suggested that these ants may still be in the early stages of invasion, indicating that, without control, the future spread and impacts of this species are likely to increase significantly (Ward et al. 2010). Protection from the negative impacts of Argentine ants in New Zealand is vital to ensure ongoing economic and ecosystem functions provided by honey bees. However, the extent of awareness among apiarists and the productivity impact on hives in New Zealand is largely unquantified. This pilot study involved a three-pronged approach: first to survey beekeepers for their awareness and perception of the impact that ant species may have on their hives, secondly to identify ant species from specimens supplied by them and third, to trial a simple method of quantifying the effect of the Argentine ant on brood development in hives.

Method

Part 1: Survey

A survey of 40 beekeepers was conducted in the North Island, New Zealand, in 2013. Participants were contacted via data bases including the National Beekeepers Association, bee clubs and beekeeping internet forums. The survey questioned the extent to which ants were perceived to be impacting upon hive vitality and whether beekeepers were aware of the different ant species which may occupy their hives (Appendix 1).

Questionnaires were sent out together with specimen vials for the collection of any ants present in the hives. Instructions for the freezing and packaging of samples was provided and all samples were identified at Unitec Environmental and Animal Sciences Network's entomological facility. The limited data obtained did not allow for extensive analysis but were nonetheless indicative.

Part 2: Impact of Argentine ants on bee brood and honey.

This pilot study focused on a single Argentine-ant-infested hive located at Redhill, Te Kopuru, Northland, and four non-infested hives from two locations (Baddeley's Beach, Tawharanui Peninsula, eastern Rodney and Unitec, Mount Albert, Auckland, New Zealand). All were assessed in October 2013.

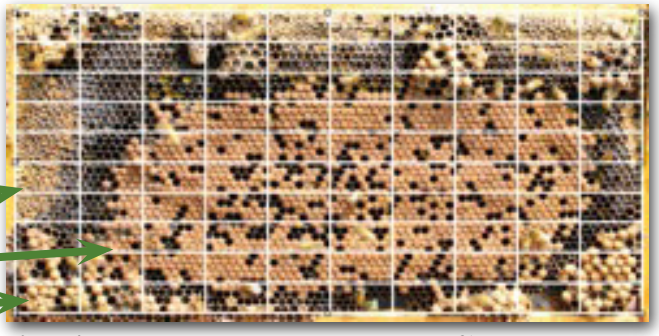

Figure 1. Hive frame showing grid for estimating % cover of brood, honey and empty cells.

Individual frames were removed and inspected during the routine hive management and each frame in the brood chamber photographed. A grid pattern was then laid over the image which allowed the amount of brood and honey cover to be estimated as a percentage cover of the total frame area (Figure 1). Brood was identified as both capped cells containing pupae and uncapped cells containing eggs and larvae. Honey cover was assessed as capped and uncapped honey cells. An estimate of unused cells was also included.

As honey and brood stores are not evenly distributed within the hive, both sides of the inner four and outer six frames within the ten-frame box (or 'super') were considered as separate entities and in combination in order to find out if spatial distribution was of significance.

The limited data generated did not lend itself to any meaningful statistical analysis and only descriptive observations are presented for this pilot study.

Results

Part 1: Survey results

Fifteen completed surveys (38%) were returned, of which 14 reported the presence of ants within hives. The most common species identified was the white-footed ant (*Technomyrmax jocosus* Foret 1910) which was present in seven of the hives, while the common black house ant (*Ochetellus glaber* Mayr 1862) and the Argentine ant (*Linepithema humile*) were found in two, and a species of parrot ant (*Nylanderia spp.*) was present in one.

While ants were a familiar presence in hives, most beekeepers considered their presence to be of low to moderate concern (Table 1). None of the survey respondents were able to identify individual species.

Perceived severity of ant problem (5 point scale)	No. of respondants
5 (big problem)	2
4	0
3	5
2	5
1 (no problem)	2

Table 1. Number of beekeepers identifying ants as a problem in their hives

Part 2: Impact of Argentine ants within the hive

The results (Table 2) indicate that overall, there was about half the brood cover in the infested hive when compared with non-infested hives (18% vs 32%). However when inner and outer frames of the hive were compared separately, brood cover in the outer frames was substantially reduced (0.0% vs 23.5%) whereas the centre of the colony (inner frames) showed no difference. Honey stores appeared to show little difference regardless of where they were distributed.

Observations of Argentine ant activity within the hive indicated that both honey and brood were taken by the ants (photographic evidence in Figures 2-4).

Figure 2. Argentine ants in prolific numbers on the queen excluder.

	Mean infested brood cover (%)	Mean non-infested brood cover (%)	Difference (%)	Mean infested honey cover (%)	Mean non-infested honey cover (%)	Difference (%)	Mean infested unfilled cells cover (%)	Mean non-infested unfilled cells cover (%)	Difference (%)
All frames	18.0	32.4	-44	64.0	55.5	+15	17.5	12.0	+46
Outer frames	0.0	23.5	-100	75.4	61.2	+23	24.6	15.2	+62
Inner frames	48.9	51.4	-5	42.9	45.0	-5	4.3	6.1	-30

Table 2: Mean percentage cover of brood, honey and unfilled cells and percentage change in one *L. humile*-infested hive compared with four uninfested hives.

Figure 3. Argentine ants raiding honey stores.

Figure 4. Evidence of direct attack of emerging brood by Argentine ants.

Discussion

One part of this pilot study attempted to find a simple way to quantify the impact that Argentine ants have on both hive honey stores and brood. The method of estimating percentage cover of brood and honey stores proved to be a quick and simple way of generating comparative data which could prove useful in future studies. Limited data made it impossible to perform a statistically valid analysis but these results may be seen as indicative. A study with replicated infested and non-infested hives would be necessary to substantiate these observations.

This study showed that an infestation of Argentine ants in one beehive resulted in a lower percentage cover of brood within the infested hive compared with the other hives (Table 2). Although honey supply seemed little affected, the substantial decrease in brood and increase in the proportion of unfilled cells suggests an overall reduction in hive productivity. Due to the known impact of Argentine ants in other invertebrate species (Rowles & O'Dowd, 2009; Walters, 2006), it is not unexpected that an impact on honey bees would be detected. Additional photographic documentation has added further evidence that *L. humile* foraged within the hive and actively fed on both honey and emerging brood.

This impact of Argentine ants was particularly evident in the edge of the bee colony, i.e. outer frames, where there was 100% reduction in brood, 23% increase in honey and 63% increase in unfilled cells (Table 2). The greater vulnerability of the outer region of the bee colony suggested by the observations may be related to the size of the bee colony able to defend its resources. However, more data would be required to substantiate the effect of colony size. It is suggested that in order to validate the methodology this pilot technique be pursued further in areas where substantial numbers of both Argentine-ant-infested and non-infested hives are present.

The beekeeper survey information and samples returned indicated that various ant species are commonly associated with beehives and that beekeepers in general did not differentiate between the species present in their hives. The surveyed beekeepers largely perceived ants to be fairly passive hive occupiers with only two out of 14 reporting ants to be a serious problem. Due to the importance of the pollination and honey-production role of the honey bee, both in primary production and the environment in general, the expansion of this pilot study into a full trial is important to determine the invasive impact of Argentine ants. Once this has been confirmed farmers, horticulturalists, beekeepers and ecologists can be made aware of the impacts of this hive invader. With the anticipated increased spread of Argentine ants, particularly in the light of climate change (Ward et al., 2010), the impact of this invasive ant species on honey bees is likely to be of major concern to the beekeeping industry in the future.

Acknowledgements:

The authors owe a debt of gratitude to Mel Galbraith for his assistance with ant identification, Peter Visser, Key Industries Ltd, for funding the project, to the apiarists who kindly consented to be part of the survey and to the reviewers who cast a critical eye and provided valuable suggestions.

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Appendix 1: Beekeeper survey

The following survey is designed to record information of apiarists and their perception of ants in beehives in the North Island of New Zealand.

All Information provided will be used for research purposes.

Are you a commercial or hobby apiarist?

Commercial	
Hobby	

What type of habitat are your hives located in? Tick as many boxes applicable:

Coastal	
Pasture	
Forest edges	
Riverside/ streamside	
Wetland fringes	
Agricultural areas, e.g. orchards	
Urban garden	
Urban fringes	

How many hives do you have that are presently operating?

Have you noticed any ants in any of your hive/s?

Yes	
no	

If yes, do you know which species?

If there are ants present in your hive/s, have you noticed any changes in the hives' productivity?

Yes	
No	
don't know	

Do you think the ants are consuming the honey?

Yes	
No	
don't know	

Do you think the ants are having an effect on the brood?

Yes	
No	
don't know	

Are you concerned about the presence of ants in your hives?

1 not a problem	2	3	4	5 very concerned

On a scale from one to five, rate how much of a problem do you think ants are to your hive/s.

1 not a problem	2	3	4	5 very concerned

Do you have any further comments about ants in your beehives?

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