

The apparent establishment and subsequent eradication of the Australian giant bulldog ant *Myrmecia brevinoda* Forel (Hymenoptera: Formicidae) in New Zealand

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Abstract The Australian giant bulldog ant *Myrmecia brevinoda* Forel was first observed in New Zealand in 1940 (Keall 1981). Further observations of this species were made at a location in Devonport in 1948 and 1965, and a nest destroyed at this site in 1981. Since this time no further observations have been made, yet the status of this species is commonly listed as “uncertain establishment” on New Zealand faunal lists. We describe the control procedure used in 1981. In addition, to determine its current status we resurveyed ants in the area of earlier infestation using visual searches, pitfall trapping, and a reward for discovery posted to local residents. No evidence of *M. brevinoda* was found, though several other invasive species were found, including the Argentine ant *Linepithema humile* (Mayr), *Pheidole rugosula* Forel, and a recently established Australian cryptic *Solenopsis* species. Given the results of our survey and the absence of other reports of *M. brevinoda* over the last 24 years, we consider this species to be extinct or eradicated from New Zealand.

Keywords eradication; exotic and invasive ants; extinction; *Myrmecia brevinoda*; survey; Argentine ants *Linepithema humile*; *Solenopsis* sp.

INTRODUCTION

The eradication of an exotic species is a common goal for biodiversity managers. Substantial effort is often invested at the time of the eradication attempt, but until recently much less effort has been put into follow-up studies, and descriptions of control methodology are rarely published. One of the most publicised, failed eradication attempts was with the red imported fire ant *Solenopsis invicta* Buren in the southern United States (Klassen 1989). However, exotic ants have been reported as being successfully eradicated from areas or countries elsewhere, though the methods for very few of these operations have been published (Abedrabbo 1994; Hoffmann & O’Connor 2004). A major reason for the lack of such publications is uncertainty of success: what period of time should be allowed before treatment and pronouncement of eradication? And to confirm eradication, how much sampling should be undertaken? Here, we give details of the eradication of the Australian giant bulldog ant *Myrmecia brevinoda* Forel from New Zealand, as deduced from a previous visual search (Green 1997) and a current survey of ant fauna in Devonport.

The native range of the ant genus *Myrmecia* is limited to Australia and New Caledonia (Crosland et al. 1988). The giant bulldog ant, *M. brevinoda* Forel, is a large, conspicuous and often painfully obvious species. Workers range in size from 13 to 36 mm (Higashi & Peeters 1990) and vigorously defend their nests with “painful stings and powerful bites” (Freeland 1985). Location records from the Australian National Insect Collection show that it has a wide distribution within Australia, from southern New South Wales to Queensland.

Myrmecia brevinoda was first observed in New Zealand in 1940 at Milford on the North Shore of Auckland (Keall 1981). No specific details were given for its location at that time, but it was subsequently observed at a domestic location in Devonport, Auckland, in 1948 and again at locations c. 30 m away in the same street in 1965 and 1981. It was identified in 1981 when a person reported

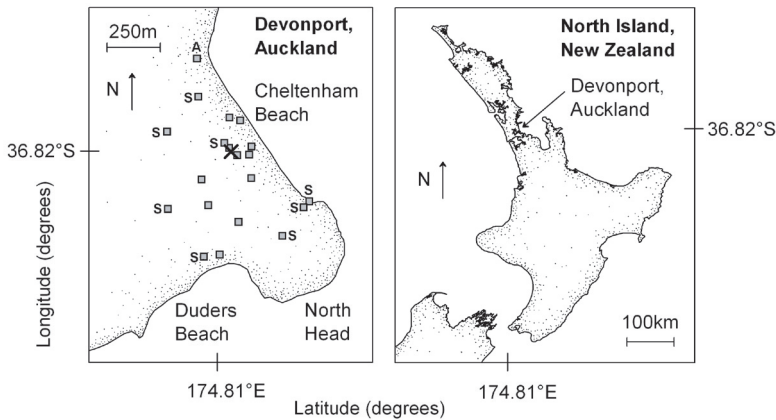


Fig. 1 The locations of pitfall traps (squares) in Devonport Auckland. ×, the location of the *Myrmecia brevinoda* nest treated in 1981; S, pitfall traps with the undescribed Australian *Solenopsis* sp.; and A, the only trap with Argentine ants. The three most eastern samples are on the edge of the North Head Reserve, which encompasses grassland and remnant forest.

an attack to quarantine authorities. Keall (1981) considered that *M. brevinoda* was likely to have been established in this small area for the entire 41 years, although it is possible that there were three repeated separate introductions of the same species to the same general area (though as this species is not known to have previously spread outside of its native range, repeated introductions seem unlikely). It has now been c. 24 years since the last recorded observation of *M. brevinoda* in New Zealand (Keall 1981). At least one limited search has been undertaken for it at the historic recorded location without observing this species (Green 1997). However, *M. brevinoda* remains on faunal lists of New Zealand ant species (e.g., Valentine & Walker 1991).

MATERIALS AND METHODS

Nest destruction and post-destruction monitoring in 1981

In March 1981, a member of the public notified agriculture quarantine authorities of an unusual ant found in Devonport, Auckland (-36.824°S , 174.808°E) (Fig. 1). Quarantine authorities, including JBK, visited the location on several occasions and located an entry hole for a single nest adjacent the gatepost and footpath. An area of c. $50 \times 75 \times 50$ cm (width \times width \times depth) was excavated, and the nest plus a number of ants collected. Approximately 6 litres of Chlordane®, a persistent organochlorine insecticide (1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene), was added to the area and the hole subsequently filled, and sealed with asphalt. Unfortunately, the concentration of the pesticide was

not recorded. The area was revisited in the following weeks to visually examine for any surviving ants.

Ant survey in 2005

We used several assessment techniques, including visual searches during both day and night, pitfall traps, and a mail-out to local residents offering a \$100 reward for capturing a bulldog ant. This investigation had the added benefit of surveying current ant species and their distribution within Devonport. The area of our search concentrated on the area within a 1 km diameter circle centred on the previous observations of *M. brevinoda* in 1948, 1965, and 1981. These nest locations were separated by <40 m (Keall 1981). This area encompassed primarily urban residential housing, but also a wide variety of habitats including beaches, parks, and reserves containing grassland and some remnant forest (Fig. 1). We visited this area during 4–9 April 2005 for a further examination of the ant fauna using visual searches, pitfall traps, and a survey of local residents. April is late summer or early autumn in the Southern Hemisphere. Thus, the timing of the survey for this period would have allowed these ants to build up large populations over the summer, allowing for more likely observation should they have been present. Visual searches were carried out during daylight, dusk, and at night using a torch as *Myrmecia* spp. often forage at night (Freeland 1985). Trunks of trees, buildings, grass, gardens, and pavements were examined. All ant species observed were collected for identification in the laboratory. Bait trapping techniques (e.g., Lester et al. 2003) were not used, as these ants are predaceous in nature. Hourly temperature and humidity data for the sampling period was obtained from the nearby National Institute

of Water & Atmospheric Research (NIWA) weather station at Khyber Pass in Auckland, 5.9 km from the study site (−36.868°S, 174.771°E).

A total of 20 un-baited pitfall traps were placed within the search area, with placement in a non-random fashion, to achieve higher densities of pitfall traps in the area encompassing the previous infestation sites (Fig. 1). Five of the 20 traps were placed within 50 m of the recorded infestations. Pitfall traps were plastic containers with a diameter of 75 mm at the top, 50 mm at the base, and were 90 mm high. Approximately 50 ml of 50:50 ethylene glycol and water were added, with a drop of detergent added to break the surface tension. They were dug into the soil so that the upper lip was below the soil surface and left for 48 h. The entire contents of the pitfall traps were taken to the laboratory for analysis.

RESULTS

Nest contents in 1981

Although the owners of the Davenport property had lived there for about 10 years, they had noticed these ants foraging only during the previous year. The ants were generally seen in the evenings. The single nest recovered contained including numerous workers, males, larvae, and pupae (exact numbers were not recorded). No queen was found, though for this species to maintain itself in Auckland for 41 years queens must have existed. No *M. brevinoda* were found in two subsequent visits to the site or

the surrounding area in the weeks following the Chlordane® treatment.

Ant survey in 2005

No specimens of *M. brevinoda* were found during our survey or were sent to us as a result of the \$100 reward posted to residents in the Devonport area. Local residents, questioned about the presence of this ant, indicated that they had not observed any ants matching its description. Weather conditions during the survey were suitable for ant collecting and observation. Mean hourly temperatures were 19.1, 21.2, and 18.1°C for the overall temperature, searches during daylight hours (9 a.m.–6 p.m.), and during night searches (8–11 p.m.), respectively. The mean hourly humidity was 74.8% (range = 49–94%). The weather was generally sunny or occasionally overcast with little rain falling during the survey.

Ants of 12 other species were collected. All species represented were of exotic origin, except *Monomorium fieldi* Forel (Table 1). By far the most common and frequently collected species was *Pheidole rugosula* Forel. Argentine ants, *Linepithema humile* (Mayr), were collected only in the most northern pitfall trap (Fig. 1), nearest the suburb of Takapuna where larger infestations were known. No other ant species were recorded from this most northern trap. An unstudied cryptic *Solenopsis* species was also widely distributed, caught in eight of the 20 pitfall traps and also observed during hand searches in daylight (Table 1, Fig. 1), in a range of sites from mixed native and exotic vegetation in North Head Reserve to urban sites.

Table 1 Ant species collected in pitfall traps and by visual search and hand collecting during hours of daylight (D) or night (N). Mean abundance per pitfall trap (\pm SE) is shown, along with the number and percentage of the 20 pitfall traps in which each species was observed.

Subfamily	Species	Hand collected	Pitfall traps		
			No.	(%)	Abundance (SE)
Dolichoderinae	<i>Doleromyrma darwiniana</i> (Forel)	D	0	0	–
	<i>Iridomyrmex anceps</i> (Roger)	D, N	2	10	1.5 (0.2)
	<i>Linepithema humile</i> (Mayr)	D, N	1	5	2.0 (0.0)
	<i>Ochetellus glaber</i> (Mayr)	D, N	0	0	–
	<i>Technomyrmex albipes</i> (Smith)	D, N	4	20	1.3 (0.1)
Formicinae	<i>Paratrechina vaga</i> (Forel)	D, N	9	45	12.0 (2.3)
Myrmicinae	<i>Monomorium fieldi</i> Forel	D	0	0	–
	<i>Pheidole rugosula</i> Forel	D, N	17	85	60.0 (14.2)
	<i>Solenopsis</i> sp.	D	8	40	5.3 (1.1)
	<i>Tetramorium bicarinatum</i> (Nylander)	D, N	0	0	–
	<i>Tetramorium grassii</i> Emery	D, N	8	40	8.3 (2.6)
Ponerinae	<i>Hypoponera eduardi</i> (Forel)	D	2	10	1.5 (0.2)

Pitfall traps appeared to underestimate the abundance of some species. For example, *Technomyrmex albipes* (Smith) was probably the most frequently encountered species foraging on trees at night and may be much more widespread than the trap numbers indicated. Similarly, *Ochetellus glaber* (Mayr) was observed foraging arboreally during both day and night, but was never found in pitfall traps. Species observed to have a limited distribution in visual surveys, such as *Tetramorium bicarinatum* (Nylander) and *Doleromyrma darwiniana* (Forel), were not often found in the pitfall traps (Table 1).

DISCUSSION

No specimens of *M. brevinoda* were found in our 2005 survey. By itself, this result is probably insufficient for us to conclude that this ant has been successfully eradicated from New Zealand. However, a previous survey in 1996 also failed to find it (Green 1997). This is a large, conspicuous ant, likely to be noticed and reported by residents given the heightened awareness of biosecurity issues within New Zealand and the public interest in the reward. Given that it is 24 years since it was last recorded, we consider it safe to conclude that this species has been successfully eradicated from New Zealand.

It is not clear why this species did not spread further than Devonport or into the wider Auckland area. Location records from the Australian National Insect Collection show that it lives in a wide variety of climates, from as far south as Wilsons Promontory National Park (39.00°S; the southern tip of the state of Victoria) to as far north as coastal Stony Creek, Queensland (-15.83°S, 145.21°N). There is even a distribution record from the alpine region of Kosciusko National Park. Thus, it seems likely that it should have tolerated the climatic conditions in Auckland and other areas of New Zealand.

Upon establishment in a novel environment, some invasive species remain at low densities for long durations (Mack et al. 2000). Perhaps *M. brevinoda* may have spread further if it had been left alone, though there are no documented cases of such long lag periods for ant introductions, and 41 years is a reasonable period of time for establishment. On the other hand, a recent statistical model examining the key factors for determining the success of exotic ants in New Zealand predicted that *M. brevinoda* would not establish in New Zealand, primarily because of its large size (Lester 2005). Other research

has confirmed that large ants are much less likely to establish in exotic locations, though the specific reasons remain elusive (McGlynn 1999). It would be difficult to explain the failure of *M. brevinoda* to spread further without experimentation.

Whatever the reason for its lack of spread, its extremely limited distribution in New Zealand made its eradication easy. It is unlikely that many invasive ant species, after an establishment period of 41 years, could be eradicated with the treatment of only one nest. However, since only one nest was ever found, that appears to be the case here.

Other ants found in the survey

Altogether, 12 ant species were collected in this study, representing about a third of New Zealand's total ant species diversity. All of them were of exotic origin, except for *M. fieldi*. The cryptic *Solenopsis* sp. observed here is likely to be an unstudied Australian species. It was first observed in New Zealand in St Heliers Bay (across the Auckland Harbour, c. 3 km from this site) in 2002, so appears to be spreading rapidly. The array of different habitats in which it was observed during this survey suggests that this *Solenopsis* sp. is likely to tolerate a wide variety of habitat types, perhaps including native forest vegetation. As it is an unstudied species, we have no way to predict its potential effects for the New Zealand flora and fauna.

In the pitfall traps, the most abundant species was *P. rugosula*. This species was first collected in 1958, in nearby Takapuna (Berry et al. 1997). Argentine ants (*L. humile*) were observed only in the northernmost site, where they are probably moving southward from a larger infestation in Takapuna. Argentine ants were first observed in New Zealand in 1990 (Green 1990). They are known to extirpate other ant species (e.g., Human & Gordon 1997) and, similarly, we caught no other species in the same traps here. Thus, despite establishing after *M. brevinoda*, the other exotic species *P. rugosula*, *Solenopsis* sp., and *L. humile* have attained a much greater range and abundance. The eradication of these species would be much more difficult, if not impossible.

ACKNOWLEDGMENTS

We thank Steve Shattuck for assistance with location data from the Australian National Insect Collection in Canberra. Victoria University of Wellington funded this project.

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