



# Prey-baiting as a conservation tool: selective control of invasive ants with minimal non-target effects

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**Abstract.** 1. Invasive ants are considered a significant threat to urban, agricultural, and natural habitats worldwide and the control of invasions is often a priority for conservation management. The spread and impact of invasive ants is often controlled using chemical management tools, predominantly toxic baits. The preferred outcome of such interventions is the recovery of indigenous species following the removal of the alien invader. Nonetheless, management actions may have unintended consequences such as non-target impacts. Non-target impacts are often a significant concern in areawide eradication programs because toxic baits are typically attractive to a wide range of animals and may kill non-target fauna, especially other invertebrates.

2. Development of effective techniques to control populations of invasive ants while protecting the non-target fauna is important for conservation of native biodiversity. This study utilised laboratory and field experiments to evaluate a novel approach for managing invasive Asian needle ants (*Brachyponera chinensis*) utilising live, insecticide-treated termite prey. The goal was to examine the potential ecological impact of toxic prey-baiting on native ant fauna and to determine if toxic prey-baiting is adequately selective to be used as a tool for eradicating Asian needle ants while preserving native ant communities. Protein marking was used to track the consumption of termite prey by target and non-target ant species.

3. Results demonstrate that prey-baiting using live, fipronil-treated termites is highly effective against Asian needle ants. Furthermore, prey-baiting is highly specific with detrimental effects against the target species and negligible effects on native ants.

4. Results demonstrate a novel management tool for conservation agencies working to eradicate invasive ants globally. While traditional bait treatments are typically non-selective and eradicate a wide range of non-targets, prey-baiting is highly effective and target specific and may offer an effective alternative to traditional bait treatments. Additionally, prey-baiting may provide environmental benefits with regard to pesticide residues in ecologically sensitive environments and other protected landscapes where invasive ants pose a threat to native organisms and must be carefully managed to avoid non-target effects.

**Key words.** Asian needle ant, bait, *Brachyponera chinensis*, fipronil, predation, protein marking, *Reticulitermes flavipes*, termite.

## Introduction

Invasive ants are considered a significant threat to biodiversity, agricultural productivity, human health, and

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economies (Lowe *et al.*, 2000; Holway *et al.*, 2002; Lach & Hooper-Bui, 2010). Despite decades of efforts in containment, control, and eradication, no established invasive ant species has been eradicated on a regional scale. Successful eradication campaigns have been demonstrated on islands and other geographically limited areas (e.g. Abedrabbo, 1994; Causton *et al.*, 2005; Hoffmann, 2010; Buczkowski & Krushelnycky, 2012). The main reason for this failure is the prevailing control methodologies are not compatible with the behaviour, nesting habits, and population structure of invasive ants, especially unicolonial species such as Argentine ants (Silverman & Brightwell, 2008).

Toxic baits have been used to control a wide range of invasive ants (Daane *et al.*, 2008; Spicer-Rice *et al.*, 2012; Drees *et al.*, 2013; Buczkowski *et al.*, 2014). Despite some successes with toxic baits (e.g. Lester & Keall, 2005; Hoffmann 2010), baits suffer a number of disadvantages that limit their use. This includes relatively short life span under field conditions, susceptibility to environmental factors, environmental contamination due to residues, and non-target effects. Non-target issues are a serious concern in area-wide treatments in natural areas where conservation of native fauna is a concern. Toxic baits are typically attractive to a wide range of ants, other insects, as well as vertebrates. As a result, toxic baits may kill non-target fauna they are used to protect. Non-target effects can be limited by offering granular baits with particle sizes optimal for target species, thus increasing bait selectivity (Hooper-Bui *et al.*, 2002). Bait selectivity may also be achieved by utilising bait formulations that most closely mimic natural food sources of target species. For example, Argentine ants feed largely on hemipteran honeydew. Liquid baits with sucrose most closely resemble this natural food source and are the most attractive (Silverman & Brightwell, 2008). Finally, bait selectivity may be achieved indirectly through reliance on the target ant's superior interference and exploitative ability. Buczkowski and Bennett (2008) demonstrated Argentine ants outcompete native ants at toxic baits and consequently become the primary target of baits.

Non-target impacts are often a serious concern in areawide eradication programs. In some cases, eradication attempts have been deemed inappropriate due to the delicate nature of infested habitats and presence of sensitive non-target wildlife (Abedrabbo, 1994; Marr, 2003). In other cases, ant eradication efforts have been stopped due to environmental concerns (Van Schagen *et al.*, 1994; Buhs, 2004). Despite such concerns, no published study has ever investigated the direct effects of ant baiting programs on non-target species and prior work has focused solely on documenting the impacts on the target species. Other studies have documented native ant recovery following the eradication of invasive ants (Hoffmann *et al.*, 2010).

*Brachyponera chinensis*, the Asian needle ant, is an invasive ant species that has become widespread in parts of the southeastern US and is now a common pest in urban

and natural habitats (Guenard & Dunn, 2010). In mature temperate forests, *B. chinensis* causes a decline in native ant diversity and abundance (Guenard & Dunn, 2010; Rodriguez-Cabal *et al.*, 2012). Moreover, they may not outcompete all native ants. For example, Guenard and Dunn (2010) reported 36 native species in areas invaded by *B. chinensis* versus 48 species in non-invaded areas. *Brachyponera chinensis* is predatory and a termite specialist (Bednar & Silverman, 2011). Due to dietary specialisation, a previous study evaluated a novel approach for managing *B. chinensis* in natural habitats based on use of poisoned termite prey (Buczkowski, 2016). Fipronil-treated termites scattered on the forest floor provided rapid control of *B. chinensis* and ant densities in treated plots decreased by 98% within 28 days. Also, the potential non-target effects of toxic prey-baiting have not been examined. Termites are an attractive prey for a number of ant species and the poisoned termites may have been retrieved by native ants or other non-target wildlife. Preliminary observations indicated *B. chinensis* retrieved the majority of the poisoned termites and previous research indicates *B. chinensis* are able to discover and dominate termite prey more effectively than native ants (Bednar *et al.*, 2013). Moreover, the exact fate of the poisoned termites and the potential effects on non-native ants were unknown.

The goal of this study was to examine the potential ecological impact of toxic prey-baiting on the native ant fauna. The main objective was to utilise protein marking to track consumption of insecticide-treated termite prey throughout the target pest and any non-target ant species. Previously, protein marking has proven an effective tool in field studies of various aspects of ant ecology including predator-prey interactions (Buczkowski & Bennett, 2007) and colony spatial structure (Buczkowski, 2012). The goal was to determine if toxic prey-baiting is selective enough to be effectively used as a tool for controlling *B. chinensis* while preserving the local ant fauna.

## Materials and methods

### *Preparation of protein-marked and fipronil-treated termites*

Colonies of eastern subterranean termites, *Reticulitermes flavipes*, native to areas invaded by *B. chinensis*, were collected from cardboard-baited traps buried in areas known to harbor termite colonies (Buczkowski *et al.*, 2007). Termites were brought into the laboratory and allowed to migrate into plastic containers with moistened pine wood provided as food and harborage. Colonies were maintained at 25–27°C, >80% RH, and in constant darkness. Fifth through seventh instar workers were used in all assays. Termites were first marked with the protein marker (rabbit IgG), followed by exposure to the insecticide (fipronil). To mark the termites with the protein marker, technical grade rabbit immunoglobulin (IgG) (Sigma Chemical Co., St. Louis, MO, USA) was prepared in

distilled water at a concentration of 5.0 mg IgG mL<sup>-1</sup> (Buczkowski & Bennett, 2007). A 100 cm<sup>2</sup> piece of paper towel was treated with 500 µL of the marker solution and the treated paper was placed in a plastic container (14 × 14 × 3 cm high) with 500 termites starved for 24 h. The box was provisioned with 300 g sand mixed with 60 mL water and the paper was placed on top of the sand. Termites were allowed to feed on the paper for 24 h. Previous research indicates 100% of the termites test positive for the marker within 24 h and termites retain the marker for at least 4 days (Buczkowski *et al.*, 2007). Immediately following exposure to the protein marker, the termites were transferred to a plastic box (14 × 14 × 3 cm high) containing sand treated with 25 ppm fipronil and were exposed to the treated sand for 60 minutes. To prepare 25 ppm fipronil-treated sand, 138 µL of Termidor SC (9.1% fipronil; BASF Corp., RTP, NC, USA) was dissolved in 100 mL water and thoroughly mixed with 500 g sand. The 25 ppm dose was selected based on Saran and Rust (2007) who reported individual termites pick up approximately 10 ng fipronil when exposed to sand treated with 25 ppm fipronil. Additionally, previous baiting for *B. chinensis* using fipronil-treated termites demonstrated that 25 ppm dose is sufficient to achieve satisfactory control (Buczkowski, 2016).

#### Prey competition experiments – laboratory study

One difficulty of documenting non-target effects in field situations is tracking ants after insecticide treatments. Species eliminated by treatments would not recruit to monitoring stations in post-treatment assessments and this would bias results toward species that survived treatments and recruited to the monitoring stations. To study such effects under more controlled laboratory conditions a prey competition experiment was set up between Asian needle ants (*Brachyponera chinensis*) and native silky wood ants (*Formica subsericea*). Colonies were provided with protein-marked and fipronil-treated termites which allowed tracking the insecticide in both species. *Formica subsericea* was selected as the competitive species because preliminary tests at the study site showed it was the most common native ant in plots invaded by *B. chinensis* and was present in all test plots. Furthermore, previous research indicates ants of the genus *Formica* are able to tolerate or even benefit from the presence of *B. chinensis*, although the mechanisms for such tolerance are unknown (Guenard & Dunn, 2010). Colonies of both species were collected in wooded areas at Tanglewood Park Golf Course in Clemmons, NC (36.00°N, -80.40°W) and Bermuda Run Country Club in Bermuda Run, NC (36.00°N, -80.42°W). Five colonies were collected for each species. Experimental colonies of both species were prepared in the laboratory by placing 100 workers and several brood from stock colonies in artificial nests consisting of a glass test tube (15 mm diameter × 200 mm long) half filled with moist soil. The test tube was stoppered with a cork that

contained a single hole to allow entry. Each tube was wrapped in aluminum foil to keep it dark and the aluminum sleeve could be withdrawn to observe ant activity inside the tube. Ants were allowed to acclimate to the nest for 24 h without food. Experimental colonies were placed in opposite corners of 100 × 100 × 6 cm high Fluon-coated plastic arenas. After acclimation, the experimental prey (10 protein-marked and fipronil-treated termites) were introduced in the center of the test arena. Behavioural interactions between ants and termites were observed continuously until all termites were harvested. Additionally, mortality in both ant species was monitored hourly for 12 h. A sample of 20 dead ants was collected for both species and analysed by DAS-ELISA (double-antibody sandwich enzyme-linked immunosorbent assay; see protocol below). The experiment was replicated five times. All experiments were performed at 25 ± 2°C, 60 ± 10% RH, and 14:10 L:D cycle. Control tests (*n* = 5) consisted of ant colonies provided with protein-marked termites that had not been exposed to fipronil.

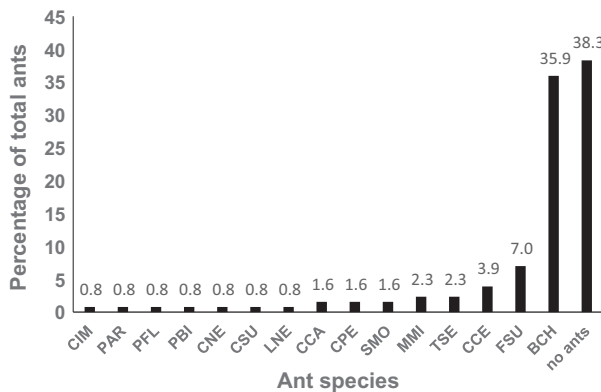
#### Effect of prey-baiting on non-target ants – field study

Field plots containing colonies of *B. chinensis* were established at Tanglewood Park Golf Course and Bermuda Run Country Club. Four plots, 6 by 6 m each were established at each location. Each was separated by buffer zones at least 25 m wide. All plots were located in golf course roughs and wooded out-of-bounds areas surrounding the fairways. Ant abundance and diversity was estimated by sampling the plots on a 2 by 2 m grid (9 sub-plots; 16 baits per plot) using note cards baited with a blend of canned tuna and corn syrup (Buczkowski & Krushelnycky, 2012). Note cards were placed on the ground for 2 h then collected to record the presence of *B. chinensis* and native ant species. Following census baiting, each 36 m<sup>2</sup> plot was subdivided into 1 m<sup>2</sup> sections and each section was provisioned with 15 protein-marked termites (540 termites per plot). Within each 1 m<sup>2</sup> section, termites were scattered on the ground, concentrating on any logs present within the plots. To determine the ant species that subsequently fed on the termite prey, the plots were sampled again 24 h later. Within each plot, ants were collected from three different colonies of *B. chinensis* and three different colonies of native ants, 10 workers per colony. In each plot, native ants included *Formica subsericea* which was the most common native species, and two other species. The other species were those the most common during the initial survey, available in sufficient numbers, most likely to be predatory, and representing a variety of taxa. To ensure adequate numbers of ants of each species were collected, manual sampling was performed. This included digging up nests, extracting colonies from logs, and sifting through leaf litter. Ants collected within the plots were placed in individual tubes, frozen at -20°C, and later analysed by double antibody sandwich enzyme-linked immunosorbent assay (DAS-

ELISA, see below). Each ant was scored positive if it was carrying the protein marker, or negative if not. The percentage of ants testing positive was calculated within each plot. All field experiments were performed in April–May 2016.

#### Protein marking with ELISA

Sandwich ELISA was performed on individual ant samples using previously described techniques (Buczowski & Bennett, 2007). Ant samples were individually homogenised in 150  $\mu$ L phosphate buffered saline (pH = 7.4) and assayed for the presence of the rabbit immunoglobulin protein. Each well of a 96-well microplate was coated with 100  $\mu$ L of anti-rabbit IgG (developed in goat) (Sigma Chemical Co.) diluted 1:500 in distilled water and incubated for 2 h at 4°C. After incubation, the primary antibody was discarded and 310  $\mu$ L of 1% non-fat dry milk (Bio-Rad Laboratories, Hercules, CA, USA) in distilled water was added to each well to block any remaining non-specific binding sites. After 30 min incubation at 26°C, the milk was discarded. Ant samples were vortexed, added to each well, and incubated for 1 h at 26°C. The samples were then discarded and each well was washed three times with PBS Tween 20 (0.05%) and two times with PBS. Anti-rabbit IgG conjugated to horseradish peroxidase (50  $\mu$ L) diluted 1:1000 in 1% non-fat milk was added to each well and incubated at 26°C for 1 h. All wells were washed again as above and 50  $\mu$ L of TMB HRP substrate (BioFX Laboratories, Owings Mills, MD, USA) was added to each well and incubated for 30 min.



**Fig. 1.** The abundance of *B. chinensis* (BCH) and native ant species within the experimental plots. In total, 14 native ant species were detected in the experimental plots: CIM (*Colobopsis impressus*), PAR (*Prenolepis arenivaga*), PFL (*Prenolepis flavipes*), PBI (*Pheidole bicarinata*), CNE (*Camponotus nearcticus*), CSU (*Camponotus subbarbatus*), LNE (*Lasius neoniger*), CCA (*Camponotus castaneus*), CPE (*Camponotus pennsylvanicus*), SMO (*Solenopsis molesta*), MMI (*Monomorium minimum*), TSE (*Tapinoma sessile*), CCE (*Crematogaster cerasi*), and FSU (*Formica subsericea*). Numbers above bars indicate the percentage of bait stations on which the given species was detected.

Samples were analysed on a Beckman Coulter AD 340 Absorbance Detector set at 620 nm. Six negative controls (ants never exposed to protein marker) and six blanks (PBS buffer only) were processed on each plate.

#### Statistical analysis

For protein marking tests, individual ants were scored positive for the presence of the marker if the ELISA optical density value exceeded the mean negative control value by three standard deviations (Sutula *et al.*, 1986; Buczowski & Bennett, 2007). The mean ( $\pm$ SE) percentage of ants scoring positive for the marker were determined in all plots. The percentage values were converted to proportions and arcsin transformed. A *t*-test was used to test for differences in the percentage of ants testing positive and the percentage of ants dying due to consumption of toxic prey. All statistical analyses were performed using Statistica 12 (StatSoft, Inc., 2014) and the level of significance was set at  $\alpha = 0.05$ .

## Results

#### Ant diversity in experimental field plots

Ant diversity in the experimental plots was examined using a total of 128 bait stations (8 plots  $\times$  16 stations per plot). *Brachyponera chinensis* was found in all plots and was present at 46 of 128 (36%) bait stations (Fig. 1). The mean number of *B. chinensis* colonies per plot was  $5.8 \pm 1.4$  (range 4–8 colonies). All plots also contained a variety of native ant species. Native ant species were present at 33 of 128 (26%) bait stations (Fig. 1). The mean number of native ant species per plot was  $4.1 \pm 1.0$  (range 3–6 colonies). In total, *B. chinensis* was found cohabiting the experimental plots with 14 different native ant species representing 10 different genera (Fig. 1). Among native ants *Formica subsericea* was the most common species and was present in all plots. It was detected at 9 of 128 (7%) bait stations (Fig. 1). No ants were detected at 49 of 128 (38%) bait stations. Overall, the results indicate *B. chinensis* is the dominant and the most abundant ant species in all plots. The native ants are also present as reported in previous studies (Guenard & Dunn, 2010).

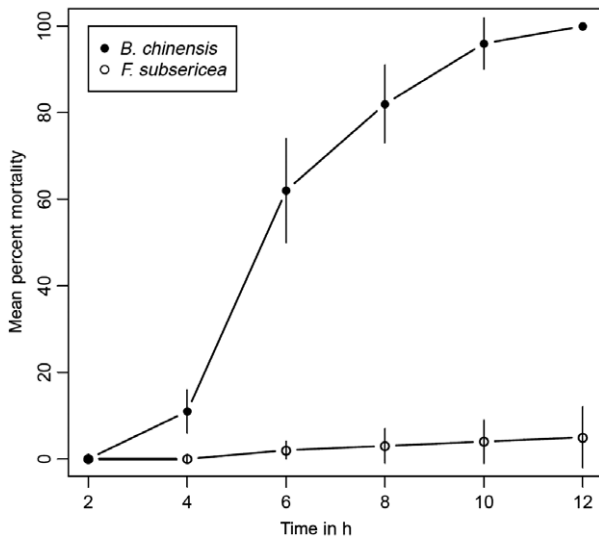
#### Prey competition experiments – laboratory study

The results of prey competition experiments between *B. chinensis* and *F. subsericea* demonstrate *B. chinensis* is the dominant species. Behavioural observations indicated *F. subsericea* were generally more active and explored the experimental arenas in greater numbers, while *B. chinensis* mostly stayed in the nest. Once termites were discovered by *B. chinensis* the ants recruited quickly and retrieved all

termites. A clear behavioural difference was observed in the way the two species interacted with the termites. *Formica subsericea* either ignored them or sprayed them with formic acid, but failed to kill them. In contrast, *B. chinensis* immediately killed the termites and carried the dead termites to the nest. Very few interactions were observed between *B. chinensis* and *F. subsericea*. When the two species came into contact, they mostly avoided each other and did not engage in fights. All of the termites placed within the experimental arenas were ultimately killed and retrieved by *B. chinensis*. Consequently, *B. chinensis* also suffered the greatest mortality, while *F. subsericea* were largely unaffected (Fig. 2). Mortality in *B. chinensis* was observed as early as 2 h and 100% mortality was reached in 12 h. In contrast, mortality in *F. subsericea* was significantly lower (*t*-test,  $t = 7.64$ , d.f. = 58,  $P < 0.0001$ ) and did not exceed  $5 \pm 7\%$  during the same period. In control tests, mortality in *B. chinensis* was  $1 \pm 2\%$  and  $3 \pm 4\%$  *F. subsericea*. Mortality in *F. subsericea* in tests with fipronil-treated termites was not significantly different from mortality in tests with blank termites (*t*-test,  $t = 2.31$ , d.f. = 58,  $P = 0.54$ ). This suggests that mortality in tests with fipronil-treated termites was natural mortality and not due to fipronil. In addition, 83  $\pm$  11% of *B. chinensis* tested positive for the protein marker while only  $2 \pm 4\%$  of *F. subsericea* tested positive (*t*-test,  $t = 9.49$ , d.f. = 8,  $P < 0.0001$ ).

#### Effect of prey-baiting on non-target ants – field study

The results of field testing corroborate the results of the lab test and confirm *B. chinensis* is the dominant species in interactions with native ants and therefore the primary target of prey-baiting. In *B. chinensis*, 21 of 24 colonies



**Fig. 2.** The mean ( $\pm$ SD) percent mortality in laboratory colonies of *B. chinensis* and *F. subsericea* provided with fipronil-treated termites.

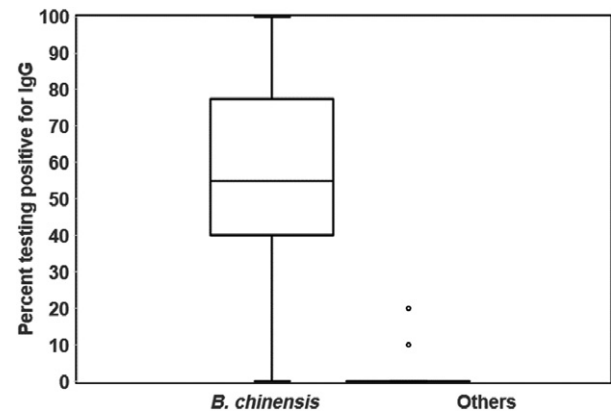
(88%) tested positive for the protein marker and the mean percentage of individuals testing positive was  $54 \pm 27\%$  (range 0–100%) (Fig. 3). In contrast, only 3 of 24 native ant colonies (13%) tested positive for the marker and the mean percentage of individuals testing positive was  $2 \pm 6\%$  (range 0–20%) (*t*-test,  $t = 9.19$ , d.f. = 46,  $P < 0.0001$ ).

A total of 12 native ant species were collected across all plots provided with protein-marked termites. This included all species listed in Fig. 1 with exception of *Colobopsis impressus* and *Camponotus subbarbatus*. The most abundant species was *F. subsericea* with a single colony analysed in each plot ( $n = 8$ ). None of the 8 *F. subsericea* colonies tested positive for the marker corroborating the results of the laboratory test which demonstrated *F. subsericea* do not effectively compete for termites with *B. chinensis*.

## Discussion

Development of effective techniques to control populations of invasive ants while protecting the non-target fauna is important for the conservation of native biodiversity.

Results of this study demonstrate prey-baiting using live, fipronil-treated termites against *B. chinensis* is target specific with detrimental effects against the target species and negligible effects on native ants. Prey competition tests revealed *B. chinensis* is able to discover and dominate termite prey more effectively than the native *F. subsericea*. All termites placed within the experimental arenas were killed and retrieved by *B. chinensis* which suffered complete colony mortality, while *F. subsericea* were largely unaffected. This is in agreement with a previous study indicating *B. chinensis* are better at harvesting termite resources relative to native ants (Bednar *et al.*, 2013). Ants of the genus *Formica* are typically large, highly active, and very aggressive. They often live in large



**Fig. 3.** The percentage of *B. chinensis* and native ants scoring positive for the protein marker following predation on termites in the field experiment.

supercolonies (Higashi, 1976) and are known to be predatory and eat a wide range of insects, including other ants (Carroll & Janzen, 1973). They have been previously introduced into forests (Storer *et al.*, 2008) and orchards (Daane & Dlott, 1998) as a means of controlling insect pests. In contrast, *B. chinensis* live in relatively small colonies, are cryptic, and non-aggressive (Guenard & Dunn, 2010). Despite *F. subsericea* being larger and more active relative to *B. chinensis*, they did not compete with *B. chinensis* for termite prey. Behavioural observations suggest differences in life history traits may allow both species to cohabit forested areas with minimal impact on each other. *B. chinensis* actively hunts termites (Matsuura, 2002) and termites are its preferred prey (Bednar & Silverman, 2011). In contrast, relatively few native ants actively hunt termites and *F. subsericea* may prefer other insect prey. Other mechanisms may include temporal-seasonal and/or spatial avoidance. Such mechanisms have been suggested to explain the persistence of native ants. Tolerance of invasive species by a subset of native species has been shown in other ants including *Solenopsis invicta* (Helms & Vinson, 2001), *Anoplolepis gracilipes* (Sarty, 2007), and *Linepithema humile* (Ward, 1987).

Previous studies show the diversity and abundance of native ants is negatively associated with the presence of *B. chinensis* (Guenard & Dunn, 2010). In a study in North Carolina, native species abundance in areas invaded by *B. chinensis* was half as great as in uninvaded plots and the abundance of *B. chinensis* was two times greater than the abundance of all native ants (Guenard & Dunn, 2010). Moreover, *B. chinensis* do not completely outcompete all native ants and a number of studies report relatively high native ant diversity in invaded areas (Guenard & Dunn, 2010; Rodriguez-Cabal *et al.*, 2012; Buczkowski, 2016). Results of the field test demonstrated *B. chinensis* outcompetes native ants as a termite predator and only 3 of 24 native ant colonies (13%) tested positive for the marker. This suggests prey-baiting is highly selective and mainly targets the invasive *B. chinensis* while protecting native ants from the harmful effects of the insecticide. The non-target impacts may appear in other arthropod groups that scavenge on dead ant bodies or dead termites that have not been retrieved by the target species. Such indirect effects have been previously observed in field studies that utilised commercial baits to control invasive ants. For example, Plentovich *et al.* (2011) reported that a granular hydramethylnon bait effectively controlled *Pheidole megacephala*, but reduced numbers of exotic cockroaches.

A small subset of ant species, especially *Formica* sp. and *Camponotus* sp. appear to benefit from the presence of *B. chinensis* (Guenard & Dunn, 2010). In this study, 5 of the 14 native ant species (36%) detected in the study plots were either *Formica* (one species) or *Camponotus* (three species). None of them tested positive for the marker suggesting *Formica* and *Camponotus* do not effectively prey on exposed termites when *B. chinensis* are present and do not become targets of prey-baiting. Additionally, *B. chinensis* disrupts ant-seed dispersal mutualisms by

displacing native ant species, especially the keystone mutualist *Aphaenogaster rudis* (Rodriguez-Cabal *et al.*, 2012). Both *A. rudis* and *B. chinensis* prey on termites (Buczkowski & Bennett, 2007; Bednar & Silverman, 2011), but *B. chinensis* is better able to utilise termite prey which may contribute to the displacement of *A. rudis* by *B. chinensis* (Bednar *et al.*, 2013). Consequently, use of poisoned termite prey in areas where the two species co-occur might lead to greater target selectivity and reduced non-target effects by selectively targeting *B. chinensis* and sparing *A. rudis*.

Among native ant species none of the other species tested positive for the marker with the exception of *Crematogaster cerasi* and *Monomorium minimum*. Interestingly, both *C. cerasi* and *M. minimum* possess a functional stinger and are known to have predatory feeding habits. This suggests certain predatory ants may be susceptible to the effects of prey-baiting if they are able to compete with *B. chinensis* for the prey. Another possibility is *C. cerasi* and *M. minimum* obtained the marker indirectly by feeding on dead *B. chinensis* (secondary transfer) rather than feeding directly on termites. Overall, the majority of native ants in areas invaded by *B. chinensis* do not appear to feed on termites. This may be due to non-predatory feeding habits or inability to effectively compete for termites.

Traditional bait treatments that rely on commercial formulations of various active ingredients are frequently used for controlling invasive ants in natural areas. The goal of such treatments is to protect the native communities from the invaders. Nonetheless, toxic baits are typically attractive to a wide range of ants and other wildlife. As a result, toxic baits may kill non-target fauna they are being used to protect. A number of studies have previously evaluated toxic baits for invasive ant eradication and control (e.g. Abedrabbo, 1994; Krushelnycky & Reimer, 1998; Hoffmann & O'Connor, 2004; Causton *et al.*, 2005). Nevertheless, no published study has investigated the direct effects of ant baiting programs on non-target species and prior work has focused solely on documenting the impacts on the target species. The current results demonstrate prey-baiting is highly target specific and mainly targets the invasive *B. chinensis* while protecting native ants from harmful effects of the insecticide. Future studies should focus on testing the prey-baiting approach for other invasive ant species, especially those with predatory feeding habits. This includes species such as Argentine ants (*Linepithema humile*), red imported fire ants (*Solenopsis invicta*), big headed ants (*Pheidole megacephala*), and little fire ants (*Wasmannia auropunctata*), among others. The specific prey could be customised for each species depending on their feeding preferences.

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