ANT MANAGEMENT

Argentine Ant (*Linepithema humile*)

Compiled by the IUCN SSC Invasive Species Specialist Group (ISSG)

1.0 Preventative measures

Prevention, quarantine and rapid response are the best management strategies for preventing the establishment of invasive ants. To be successful they require active surveying, early detection and subsequent rapid treatment procedures often along with quarantines. This type of management approach remains the most practical strategy for dealing with invasive ants (Krushelnycky Loope and Reimer 2005).

1.1 Risk assessments

The first step to solving any problem is to identify whether it exists and define what it is. Preparing risk assessments is a vital management tool for addressing the issue of invasive ants in a country or region. Mapping the potential range of invasive ant species is also a useful tool for assessing risk, preparing risk assessments and estimating the potential threat an invasive ant poses to people and the environment.

Computer software that generates maps showing potential ant distribution based on survival range data are extremely useful management tools for assessing the potential impact of any given invasive ant. Based on over 200 records from around the globe Hartley Harris and Lester (2006) modelled the potential future range of the Argentine ant (*Linepithema humile*). They found that it is most likely to occur where the mean daily temperature is between 7 and 14°C in mid-winter and maximum daily temperatures during the hottest month is an average of between 19°C and 30°C. Un-invaded regions considered vulnerable to future establishment include: southern China, Taiwan, Zimbabwe, central Madagascar, Morocco, high-elevation Ethiopia, Yemen and a number of oceanic islands. For a discussion about modelling, decision-making and the accuracy of predictions please see Hartley Harris and Lester (2006).

In Haleakala National Park (Hawaii) the range of Argentine ant populations was analysed by scientists to map potential distribution. The patterns of spread of the two populations suggested that the Argentine ant have the potential to invade nearly 50% of the park and 75% of the park's subalpine shrublands and aeolian zones (Krushelnycky *et al*. in press b, in Krushelnycky Loope and Reimer 2005). This lends considerable support to its status as one of the most significant threats to the park's unique biodiversity.

In New Zealand an invasive ant risk assessment project (prepared for Biosecurity New Zealand by Landcare Research) identified ant species which pose the greatest potential threat to New Zealand. This project was divided into five sections: (i) gathering data on native and non-native New Zealand ants, (ii) producing a preliminary risk, (iii) producing information sheets on medium-risk and high-risk taxa, (iv) producing a detailed pest risk assessment for the eight highest-risk species, and (v) re-ranking these eight species (Harris undated). An assessment of the current risk of *L. humile* (already present in the country) establishing itself further in New Zealand (based on climate similarity of native and introduced ranges) lead to the prediction that it would be "likely to establish significant distribution in NZ, particularly in urban areas and disturbed habitat" (R. Harris unpubl. data, in Stanley 2004).

1.2 Quarantine and Monitoring

It is very importance to monitor ants following treatment and detect re-invasions. Xstinguish® bait has been successfully trialled to eliminate several populations of *L. humile* in large-scale operations in New Zealand and has successfully reduced populations to very low numbers, or even eradicated populations (Harris 2002, Harris *et al*. 2002a, in Stanley 2004). Failure to eradicate populations has usually been a result of lack of monitoring and follow-up treatment, rather than failure of the bait itself (R. Harris, pers. comm., in Stanley 2004).

1.3 Ant Prevention in the Pacific Region

The Pacific island region includes over 25 countries, most of which are served by two important regional international organizations, the Secretariat of the Pacific Community (SPC), which addresses agricultural issues, and the South Pacific Regional Environment Programme (SPREP), which addresses biodiversity issues. The biodiversity of the Pacific is particularly vulnerable to effects of invasive species (SPREP 2000).

Special concern regarding ant invasions has arisen now that the red imported fire ant occurs at or near the coast on both sides of the Pacific, and the little fire ant has arrived in Hawaii and is spreading in the western Pacific. These and other species threaten all Pacific islands, including Hawaii and the U.S. affiliated islands of Guam, Commonwealth of the Northern Marianas, Federated States of Micronesia, American Samoa, and Palau.

The SPC-Plant Protection Service (SPC-PPS) works in partnership with 22 Pacific members to maintain effective quarantine systems and to assist with regionally coordinated eradication/containment efforts. Priorities for emphasis are determined by member countries, which meet periodically as the Pacific Plant Protection Organization (PPPO).

A workshop sponsored by the Invasive Species Specialist Group (ISSG) of IUCN was held in Auckland, New Zealand, in September 2003, and resulted in the compilation of a draft Pacific Ant Prevention Plan (Pacific Invasive Ant Group 2004). The Pacific Ant Prevention Plan was presented to and embraced by 21 Pacific island countries and territories present at a PPPO meeting, the "Regional Biosecurity, Plant Protection and Animal Health" meeting held by SPC in Suva, Fiji, in March 2004 (Pacific Plant Protection Organization 2004). Like Hawaii's Red Imported Fire Ant Prevention Plan, the Pacific Ant Prevention Plan is still a conceptual work, but ISSG and others are working toward obtaining the international funding needed to implement the plan with the assistance of SPC. The project presents an exceptional opportunity for agriculture and conservation interests to work together with international and bilateral aid entities at regional and country levels to build much needed quarantine capacity. Increased quarantine protection is desperately needed by PICT in order to address invasions that jeopardize both agriculture and biodiversity.

The information for this section was sourced directly from Krushelnycky Loope and Reimer (2005).

2.0 Chemical Control

2.1 General Considerations

Most if not all ant eradications have employed the use of baits and toxicants, many of which are developed for agriculture or urban settings. However, indiscriminate pesticide use in natural areas and fragile island ecosystems is not advocated. While some toxins such as hydramethylnon break down quickly in the environment, any and all pesticide use is likely to be accompanied by at least some undesirable non-target effects. These include increased runoff or drift outside the intended area, adverse affects on beneficial insects and non-target impacts on native species (Krushelnycky Loope and Reimer 2005).

Non-target impacts must be weighed up carefully against the benefits of ant eradication. Cleary, treating whole ecosystems or islands is too risky as entire populations of rare invertebrates may be at risk of extinction. On the other hand, eradicating populations of exotic ants before they become established in a natural ecosystem or island has the potential to prevent the potentially disastrous consequences of ant invasions (Krushelnycky Loope and Reimer 2005).

Baits should be designed with the specific foraging strategies of the target ant in mind. The preferred size, type and dispersal of bait and the nesting, foraging and behavioural traits of the ant should be considered in the planning stages of the operation. The use of appropriately designed and chosen baits and toxins will help reduce the impact of toxins on native ants and non-target fauna (McGlynn 1999). For information on non-target ant species please see Stanley (2004) which contains notes on food preferences of non-target ants and the attraction of toxic baits to non-target ants.

2.2 Bait Design

Baiting trials suggest that several invasive ants including *L. humile*, *Wasmannia auropunctata* and *Pheidole megacephala* consider carbohydrate-rich resources such as honey or sugar water equally, if not more, attractive than protein-rich resources such as tuna during much of the year (Baker *et al*. 1985, Krushelnycky and Reimer 1998, Rust *et al*. 2000, Brinkman *et al*. 2001, Hahn and Wheeler 2002, Cornelius and Grace 1997, in Ness and Bronstein 2004). Trials in Georgia found honey and canned tuna to be far more attractive to *L. humile* than peanut oil, with raw egg being somewhat attractive (Brinkman *et al*. 2001, in Stanley 2004). The preference for carbohydrates may be attributable to morphological traits that facilitate the storage of liquids (Davidson 1998, in Ness and Bronstein 2004). Researchers have stressed that broadcast baits for *L. humile* control should use protein as an attractant to target the queen in spring and summer when brood are being produced (Baker *et al*. 1985, Davis *et al*. 1993a, Rust *et al*. 2000, in Stanley 2004).

The carrier must also be considered in bait selection. Silverman and Roulston (2001, in Stanley 2004) found more *L. humile* workers fed on gel sucrose baits than liquid sucrose baits, but that substantially more of the liquid bait was consumed. Hooper-Bui *et al*. (2002, in Stanley 2004) found workers prefer solid bait particles in the range 840–1000 µm, while most commercial baits have a particle size of 1000–2000 µm. *L. humile* workers are strongly attracted to protein and carbohydrate paste formulations, provided the bait is reasonably fresh and moist (Harris 2002, Naidu 2002, in Stanley 2004).

2.3 Ant Toxins

Ant toxins can be classed into three categories: "stomach" poisons (or metabolic inhibitors), Insect Growth Regulators (IGRs) and neurotoxins. Stomach toxins include hydramethylnon (eg: Maxforce® or Amdro®), sulfuramid and sodium tetraborate decahydrate (eg: Borax). IGRs include compounds such as methoprene, fenoxycarb or pyriproxyfen. Neurotoxins include fipronil (eg: Xstinguish®). Stomach poison kills all workers and reproductives it comes into contact with. IGRs work by disrupting development of the queens ovarian tissues, effectively sterilising the colony. Neurological inhibitors disrupt insect central nervous systems by blocking neuron receptors. The onset of mortality is contingent upon the type of active ingredient. In general, ant baits that contain active ingredients that are metabolic inhibitors have a two to three day delay before extensive mortality occurs in the colony (Oi Vail and Williams 2000). Baits containing IGRs take several weeks before colony populations are reduced substantially (Oi Vail and Williams 2000). The latter (IGRs) provide gradual long-term control, while metabolic inhibitors provide short-term, localised and rapid control (Oi Vail and Williams 2000). This is because while stomach poisons are faster than IGRs, they sometimes eliminate workers before the toxin can be effectively distributed throughout the colony (O'Dowd Green and Lake 1999).

Many toxicants have been employed against the Argentine ant over the past century (Haney 1984). More recently, hydramethylnon, fipronil and sulfluramid have been used in agricultural, urban and natural areas to control the ant (Forschler and Evans 1994; Krushelnycky 1998b; Hooper-Bui and Rust 2000). Hydramethylnon suppresses normal colony activities, including budding dispersal, for some period of time. It has a low acute toxicity towards birds and mammals, is not taken up by plants, is practically insoluble in water and does not leach from soil (EPA 1998, Bacey 2000, in Krushelnycky *et al*. 2004). However the toxin is highly soluble in water and may harm aquatic invertebrates (Hoffmann and O'Connor 2004).

While the concentration of boric acid is too high in most available commercial baits, at low concentrations (e.g., 1% boric acid in 10% sugar-water) it is extremely effective at killing laboratory colonies of *Monomorium pharaonis*, *Tapinoma melanocephalum*, *Solenopsis invicta* and *L. humile* (Klotz and Williams 1996, Klotz *et al*. 1997, Ulloa-Chacon and Jaramillo 2003, in Stanley 2004). Klotz and Williams (1996, in Stanley 2004) found hydramethylnon killed only 40% of laboratory colonies, compared with the 100% mortality achieved by boric acid. High concentrations of boric acid in liquid baits (eg: 5.4% in Terro Ant Killer®) have been shown to kill ants too rapidly and prevent recruitment, and are also repellent to some species (Klotz and Williams 1996, Hooper-Bui and Rust 2000, in Stanley 2004). Borax and disodium octaborate tetrahydrate can be effective substitutes for boric acid in baits (Klotz *et al*. 2000a, in Stanley 2004).

Australian-manufactured IGR baits developed for *S. invicta* control, Engage® (methoprene) and Distance® (pyriproxyfen), have a lipid attractant and are unlikely to be attractive to such species as *Linepithema humile*, *Tapinoma melanocephalum* or *Paratrechina longicornis*. Soybean oil on defatted corn grits as a bait matrix is very attractive to *S. invicta*, however, many pest ant species including *L. humile* and *Paratrechina* spp. are not attracted to lipids. Commercial baits that use this matrix, such as Amdro®, are ineffective at controlling these species. However, the Amdro® Lawn and Garden bait has a matrix (protein and carbohydrate) that differs from the 'normal' Amdro® matrix and is more attractive to *L. humile* (Klotz *et al*. 2000b, in Stanley 2004)).

Fipronil can be formulated either as a bait or as a granular contact insecticide, both of which can be broadcast (Williams *et al*. 2001, in Stanley 2004). Fipronil baits have been used effectively to control ant species such as *S. invicta*, *L. humile* and *Anoplolepis gracilipes* (Barr and Best 2002, Harris 2002, Green *et al*. 2004, in Stanley 2004). Xstinguish® (fipronil) (protein and sucrose bait matrix) appears to be highly effective at controlling *L. humile* and the protein-based matrices of these baits make them highly attractive to species previously thought difficult to attract with baits. Fipronil appears to be more effective in controlling *L. humile* colonies than hydramethylnon and previously trialled toxins (Hooper-Bui and Rust 2000, Harris 2002, in Stanley 2004). Stanley (2004) recommends using Xstinguish® against *L. humile* in New Zealand as it is already registered and available and is attractive to and effective at controlling *L. humile*.

While the more recent neurotoxins imidacloprid and thiamethoxam show promise, very low concentrations must be used to prevent rapid intoxication and mortality of workers (Klotz and Reid 1993, in Stanley 2004). Rust *et al*. (2004) found that very low (0.0005 to 0.005%) concentrations of imidacloprid and extremely low concentrations of thiamethoxam (< 0.0001%) in sucrose solution had delayed toxicity in *L. humile* laboratory colonies. Thiamethoxam presents a low/slight toxicity risk to the environment and human health, a much lower risk than imidacloprid (in Stanley 2004).

3.0 Integrated Management

The potential of certain invasive ant species to reach high densities is particularly great in anthropomorphic (or human-modified) ecosystems. This may become particularly evident on land that is used intensively for primary production. *L. humile* reaches high densities in agricultural systems such as citrus orchards (which host mutualistic honeydew producing insects) (Armbrecht and Ulloa-Chacón 2003; Holway et al. 2002). Improved land management, including a reduction in monoculture and an increase in the efficiency of primary production, may help prevent population explosions of invasive ants and reduce the size of source populations which ants could spread from.

4.0 Research

4.1 Biosecurity New Zealand

Biosecurity New Zealand, the branch of government responsible for managing invasive species, has responded to a series of incursions of exotic invasive ant species by relying heavily on a small number of baits and toxins. The absence of a wide variety of effective baits may compromise the success of incursion responses. As a first step to ensuring effective incursion response, Biosecurity New Zealand commissioned Landcare Research to research and review international literature about the baits and toxins used for ant control (see Stanley 2004). The next step will be testing the most promising of these against a selected group of high-risk invasive ant species.

4.2 Bait and Toxin Research

Maxforce® Granular Insect Bait (hydramethylnon) has been used to contain the ant and prevent colony expansion of a supercolony in experimental plots in Haleakala National Park on Maui (Hawaii). This was found to consistently reduce the number of foraging ants by over 90% (Krushelnycky *et al*. 2004).

Research into alternatives to Maxforce® Granular Insect Bait and toxicant combinations for the purpose of Argentine ant eradication has included the toxicants fipronil, abamectin and the insect growth regulator methoprene in various bait carriers (W. Haines, P. Krushelnycky and E. Van Gelder unpubl. data., in Krushelnycky Loope and Reimer 2005).

Stanley (2004) suggests that future research on *L. humile* focus on:

- Testing the attractiveness of Presto® to *L. humile*
- Investigating the development of an aerially broadcast Xstinguish® bait
- Investigating the potential for indoxacarb (reduced risk pesticide) as a toxin to control *L. humile* colonies
- Further investigating the potential of IGR baits to control and attract *L. humile*

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