# WORLD'S WORST INSECT INVADERS: SOCIAL HYMENOPTERA

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The Invasive Insects: Risks and Pathways project has found that the world's environmentally harmful invasive insect species are dominated by just one insect order – that of ants, bees and wasps (Hymenoptera)[1]. This order accounts for 16 of the 17 insect invaders known to be causing environmental harm in Australia. Why are ants, bees and wasps so successful and so harmful?

One answer is that they are habitual and versatile world travellers. Of the dozen main pathways by which invasive insects reach new countries, Hymenoptera use them all and frequently so[1].

Another clue is that most invasive Hymenoptera are social, and the most harmful of them – typically ants – tend to live in extremely large societies, which can be more populous than the biggest human megapolises.

Western yellowjackets, invasive in Hawaii, are aggressive hunters.
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## DOMINANT INSECT INVADERS

Of the world's 24 insect orders, the Hymenoptera accounts for half the species in the assessment pool of the Invasive Insects: Risks and Pathways project (made up of species for which there is evidence of environmental harm somewhere in the world)[1]. The leading invaders are ants (all social), accounting for more than one in eight species assessed – three times as many as any other insect family. Bees, most of which are social, and parasitoid wasps, which are not, are also common invaders.

Of Australia's 17 insect invaders known to be causing environmental harm, 16 are Hymenoptera (9 ants, 3 wasps, 3 bees) and 1 is a beetle (Table 1)[1]. Three have been recorded in Australia for the first time just this century. As one indicator of the harm caused by social hymenopteran species, Australia is currently spending over $60 million a year on eradication programs for five ant species – seeking national eradication of red imported fire ants, electric ants and browsing ants, and partial eradication of yellow crazy ants (Wet Tropics) and Argentine ants (Norfolk Island).

In their invasive range, European fire ants reach extremely high densities, displacing nearly all other ants.
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The impacts of social hymenopteran species are complex, brought about mainly by predation, competition, and interaction with other exotic species[1]. Yellow crazy ants on Christmas Island demonstrate all these mechanisms. Capable of achieving extremely high population densities (more than 2000 a square metre), they aggressively displace most other animals from their invasive range[2,3]. The ants benefit enormously by 'farming' an invasive scale insect from which they gain honeydew. They have killed tens of millions of red land crabs by spraying their eyes and mouthparts with formic acid. Because the crabs eat leaf litter, seeds and seedlings, their absence has drastically altered the structure and composition of invaded forests, and the forest canopy is suffering dieback due to the outbreaks of invasive scale insects protected by the crazy ants and from sooty mould caused by honeydew[4]. The loss of crabs also enables the spread of another invasive species, the giant African land snail[5].

## WHAT WE MUST KEEP OUT OF AUSTRALIA

Of the 27 social hymenopteran species assessed so far in the Invasive Insects: Risks and Pathways project, 24 have been rated as 'of concern' or 'of substantial concern' (15 ants, 5 wasps, 4 bees)[1]. Of these, more than half (7 ants, 3 bees and 3 wasps) are already established in Australia. It is important to stop more introductions of these species – to



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## Table 1: Invasive insect species for which there is evidence of environmental harm in Australia

| Order | Family | Species | Common name | Date of first detection or mention | First state or territory record |
|---|---|---|---|---|---|
| Hymenoptera | Apidae | *Apis mellifera* | European honey bee | 1820 | Queensland |
| Hymenoptera | Formicidae | *Solenopsis geminata* | Tropical fire ant | 1863 | ? |
| Hymenoptera | Formicidae | *Paratrechina longicornis* | Black crazy ant | 1886 | Queensland |
| Hymenoptera | Formicidae | *Monomorium floricola* | Floral ant | 1910 | Queensland |
| Hymenoptera | Formicidae | *Monomorium destructor* | Singapore ant | 1910 | Queensland |
| Hymenoptera | Formicidae | *Pheidole megacephala* | African big-headed ant | 1911 | Queensland |
| Coleoptera | Scarabaeidae | *Heteronychus arator* | African black beetle | 1920 | South Australia |
| Hymenoptera | Formicidae | *Linepithema humile* | Argentine ant | 1939 | Victoria |
| Hymenoptera | Vespidae | *Vespula vulgaris* | Common wasp | 1959 | Victoria |
| Hymenoptera | Vespidae | *Vespula germanica* | European wasp | 1959 | Tasmania |
| Hymenoptera | Formicidae | *Anoplolepis gracilipes* | Yellow crazy ant | 1975 | Northern Territory |
| Hymenoptera | Vespidae | *Polistes chinensis* | Asian paper wasp | 1979 | New South Wales |
| Hymenoptera | Megachilinae | *Megachile rotundata* | Leafcutting bee | 1987 | New South Wales |
| Hymenoptera | Apidae | *Bombus terrestris* | Large earth bumblebee | 1992 | Tasmania |
| Hymenoptera | Formicidae | *Solenopsis invicta* | Red imported fire ant | 2001 | Queensland |
| Hymenoptera | Formicidae | *Wasmannia auropunctata* | Electric ant | 2006 | Queensland |
| Hymenoptera | Apidae | *Apis cerana* | Asian honey bee | 2007 | Queensland |

prevent re-invasion of those being eradicated and new areas being invaded, and to stop new genetic material from boosting their invasiveness. This leaves at least 11 additional species that are likely to be a high priority to keep out of Australia (subject to Australia-specific risk assessment), including 8 ants, 2 wasps and 1 bee (see Table 2). There are likely to be other priority species once 28 additional Hymenoptera in the assessment pool have been assessed.

## WHY ANTS ARE SUCH SUCCESSFUL INVADERS

The Hymenoptera is one of, if not the largest of, insect orders, abundant everywhere except in polar regions and ecologically highly influential. A major reason for their success is the nutritious food they provide to their offspring[6]. Parental care in this order has been taken to a new level with the evolution of sociality, which has occurred several times, being the case for some bee and vespid wasp species and for all ants. Social structures enable dozens to millions of individuals to work cooperatively to exploit resources, build nests, care for young, and maintain strong defences.

## Table 2: The invasive social Hymenoptera not established in Australia that are of concern or substantial concern due to environmental impacts elsewhere in the world

| Family | Species | Common name |
|---|---|---|
| Apidae | *Apis mellifera scutellata* | East African lowland honey bee |
| Formicidae | *Myrmica rubra* | European fire ant |
| Formicidae | *Pachycondyla chinensis* | Asian needle ant |
| Formicidae | *Paratrechina fulva* | tawny crazy ant |
| Formicidae | *Solenopsis richteri* | black imported fire ant |
| Formicidae | *Technomyrmex albipes* | white-footed ant |
| Formicidae | *Lasius neglectus* | invasive garden ant |
| Formicidae | *Tapinoma melanocephalum* | ghost ant |
| Formicidae | *Solenopsis papuana* | Papuan thief ant |
| Vespidae | *Vespula pensylvanica* | western yellowjacket |
| Vespidae | *Vespa velutina* | Asian hornet |

The most successful invasive Hymenoptera are the ants – which achieve an extreme form of sociality. A typical ant colony has one queen attended by her sterile daughters, who aggressively defend their territory, particularly against members of their own species[7]. But many invasive ants

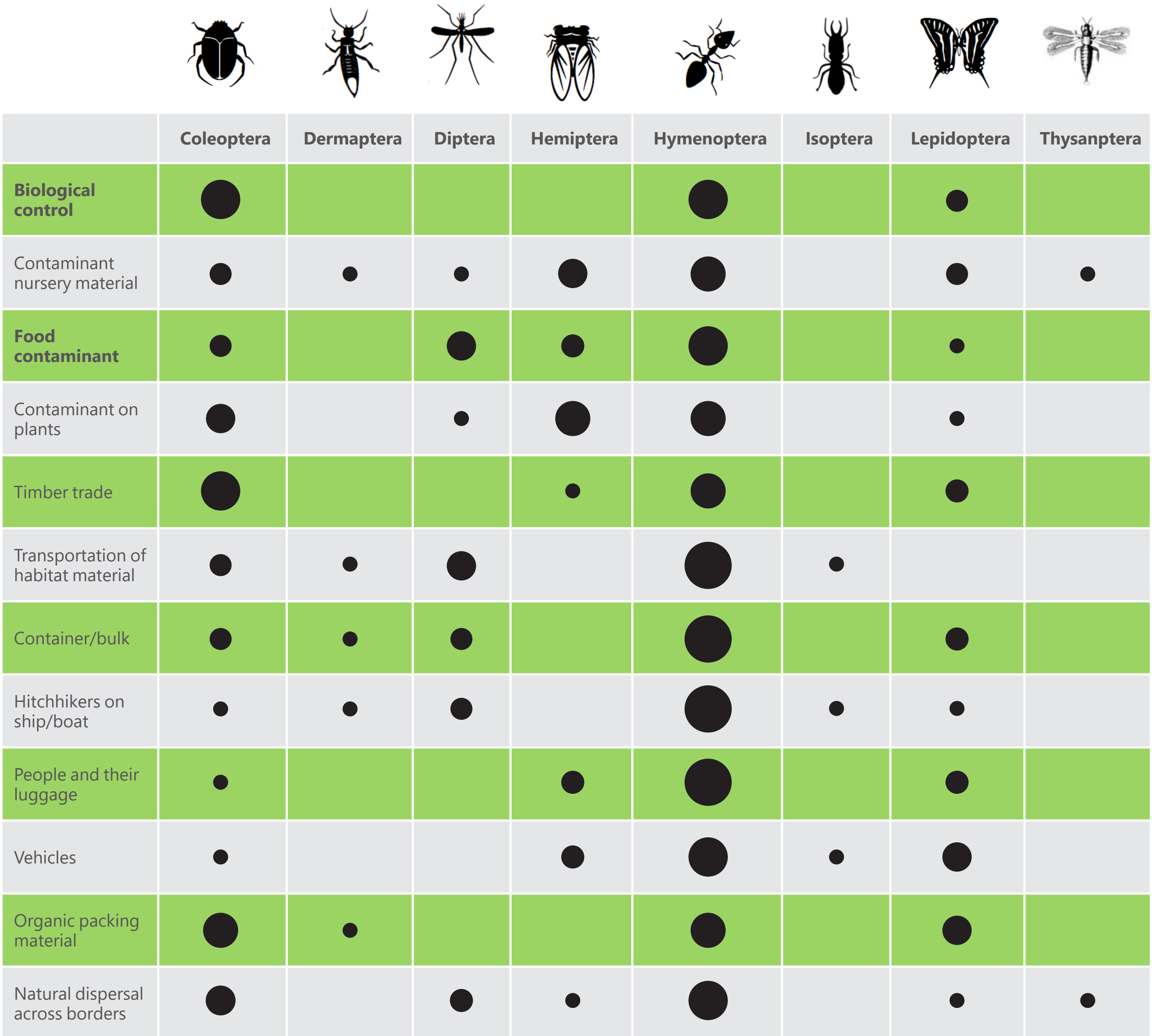


**Figure 1: The use of introduction pathways by invasive insect orders. Only the most prevalent pathways and insect orders are shown. Circles and their sizes represent the relative contribution (%) of each insect order to the number of species using a particular pathway. Circle sizes (from smallest to largest) represent 1-10%, 11-20%, 21-30%, 31-40%, 41-50%, 51-60%.**

form supercolonies, with many queens and many interconnected nests. The individuals from different nests behave amicably rather than aggressively towards each other and can move freely between nests. 'Thus, the cooperation that promotes the success of social insects generally appears to be exaggerated in many invasive ants'[8].

The largest known supercolonies are those of the Argentine ant (Linepithema humile). In its native range, it usually forms colonies with small territories that are aggressively defended against other Argentine ants, and lives among many other native ant species[8]. Sometimes it forms supercolonies spanning hundreds of metres, although these endure for only a few years, probably due to competition with other supercolonies and other ant species[9]. But their supercolonies in invaded areas can cover hundreds of kilometres, and some are more than a century old. One colony along the Mediterranean coast extends more than 6000 km, and one in Australia spans 2800 km[9]. These and several other supercolonies have their origins in just one ancestral supercolony from Argentina, and represent 'the most populous known animal society'[10].

Normally, low genetic diversity is thought to be harmful but, for ants, by reducing their aggression towards their own kind, it frees up a lot of extra energy for colony growth, foraging, defence and competing with other species[7, 8]. Extremely high ant densities can be achieved, allowing domination over other species. Over 1 million Argentine ant queens and 4.4 cubic metres of workers and brood were captured from one 8-hectare orchard in the United States (cited in 10).

Ants also have flexible diets (as omnivores), easy-to-fulfil nesting requirements, and an association with humans that allows them to travel around the world in traded products and as stowaways on ships. The Invasive Insects Risks and Pathways project found they travel frequently on all 10 of the most prevalent unintentional pathways for insect introductions (see Figure 1).

Asian needle ant. Photo: © Matt Bertone

# IMPLICATIONS FOR BIOSECURITY

The prevalence and harmfulness of the invasive hymenopteran species, particularly ants, means they should be a top biosecurity priority in Australia. As tiny, tough and versatile travellers, they are also very challenging for biosecurity. We must strive to prevent new introductions, including of the species already here, eradicate those we can, and protect Australian biodiversity from their impacts.

## Recommendation 1

**Fully implement Australia's invasive ant biosecurity plan[11].** This plan was adopted in mid 2019 by all national, state and territory governments but has no targeted funding for implementation. One particularly important action, essential for coordination and motivation, is to establish a 'permanent national body to coordinate national actions on invasive ants.' This is consistent with the seriousness of both existing and potential threats to the Australian environment, as well as human amenity and the economy.

## Recommendation 2

**Develop a biosecurity plan (or plans) for other social Hymenoptera.** With the potential for invasive bees and wasps to disrupt pollination communities, and the predatory efficiency of invasive wasps, they can have profound ecological impacts.

## Recommendation 3

**As a high biosecurity priority, reduce the risks of unintentional introduction pathways for the Hymenoptera.** Given their flexible travel habits – with ants in particular common on all 10 of the most prevalent unintentional pathways worldwide for invasive insects – the only feasible way to prevent new invasive hymenopteran species is to reduce the frequency by which they travel with traded products and as stowaways on ships and planes. This requires assessing the risks of each of these pathways, imposing import conditions to reduce the risks and improving inspection and diagnostic protocols.

## Recommendation 4

**As a high biosecurity priority, improve Australia's preparedness to respond to incursions of social Hymenoptera.** This requires developing effective surveillance programs and being ready to efficiently eradicate new incursions. Hymenopteran surveillance in Australia can be boosted by supporting citizen science programs.

# SOURCES


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# ABOUT THIS PROJECT

The Invasive Insects: Risks and Pathways Project is a partnership between Monash University and the Invasive Species Council. To find out more visit invasives.org.au/risks-and-pathways.

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