INVASIVE INSECTS

Risks and Pathways Project

Preliminary results and biosecurity implications, June 2019

Australia can't afford to allow in any more colonists of the likes of red fire ants, electric ants, browsing ants, yellow crazy ants, Argentine ants, African big-headed ants, Asian honey bees, large earth bumblebees and German wasps. These invasive insects are costing both the Australian environment and economy dearly.

Given the difficulties and costliness of eradicating or controlling invasive insects, one over-riding priority for Australian biosecurity must be to prevent more harmful species arriving and establishing. To do this, biosecurity authorities need to know which insects overseas represent the greatest invasive risks for Australia and how they are likely to arrive here. They already know which insects are the prevention priorities for agriculture, but there is no such list of insect prevention priorities for the Australian environment.

In 2017, with funding from the Ian Potter Foundation, the Invasive Species Council and the McGeoch Research Group of Monash University embarked on a project to fill that gap. Additional funding came from the Australian Government and the Queensland Government.

Our first objective was to identify high-priority potential insect invaders to Australia that could harm the natural environment, and their likely impacts and pathways of arrival. A second objective was to establish a best-practice process (comprehensive, robust, transparent, repeatable, updateable) for identifying environmental biosecurity priorities (high-risk species and pathways) for all species groups.

The first step was to synthesise the scientific knowledge of invasive insect species causing environmental harm anywhere in the world. Evidence of harm elsewhere is the most reliable way to predict potential invasive species. For each of the invasive insects for which there is sufficient evidence in the scientific literature of their environmental impacts, we described and rated the severity of these impacts based on a scheme developed by the International Union for the Conservation of Nature (IUCN) – the Environmental Impact Classification of Alien Taxa (EICAT)[1,2] – and identified the pathways by which they have spread. This detailed literature review and assessment work was done by a dozen insect and biosecurity risk experts from Monash University and other research institutions. The results will be published as peer-reviewed scientific papers and in an open source information platform that enables updates as more information becomes available.

INVASIVE INSECTS CAUSING ENVIRONMENTAL HARM

Insects are the world's most diverse class of animals and have a profound ecological influence (whether as native or non-native species) including as predators, plant-eaters, pollinators, parasites and disease carriers. Their abundance and diversity as well as small size, rapid reproduction and multiple life stages make them a very important, but very challenging, group of animals for biosecurity.

In contrast to the mountain of studies on the agricultural impacts of invasive insects, there was until recently very little work on their ecological impacts. Of the world's estimated 4 to 6 million insect species – of which only 1 million have been described – we found reports of more than 2800 having some sort of an environmental impact outside their native range (Figure 1). There is evidence of adverse environmental impacts for over 500 species, and sufficient evidence (from multiple sources) for about half of these (247 species) to allocate them to a priority assessment pool. So far, we have assessed about 100 of the priority species for their global impacts (by the EICAT method).

Of these, about three-quarters have had concerning impacts on biodiversity somewhere in the world:

- 29% are 'of substantial concern' (based on being rated as massive or major in the EICAT assessment).
- 47% are 'of concern' (based on being rated as 'moderate' or 'minor' in the EICAT assessment).

The most common mechanisms by which they cause harm to other species are

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Figure 1: The process for refining the global species pool of invasive insect species.

competition, herbivory, predation and transmission of disease.

A very few insect groups dominate the assessment pool of 247 harmful invaders. Of the world's 24 orders of insects, only 10 are represented in this pool and only 6 are represented by more than 1 species (Figure 2). By far the most dominant group are the ants, bees and wasps (order Hymenoptera), accounting for half of the pool species. Most of these invasive hymenopteran species are sociable, living in colonies, and their sociality – often extreme in invasive ants – helps explain their invasion success and the immense harm they cause. The next most common invaders are beetles (order Coleoptera, about one-sixth of the assessment pool) and sap-sucking insects (order Hemiptera, about one-seventh).

PATHWAYS BY WHICH INVASIVE INSECTS TRAVEL

In this age of globalisation, with more than 50,000 merchant ships plying the seas[3] carrying some 10 billion tonnes of goods a year[4,5], there are many ways for insects to travel to new countries. They can be introduced intentionally (for biological control, for example), unintentionally as contaminants of traded goods (such as flowers or timber) or as stowaways on ships or planes, or by natural dispersal from another invaded country.

In this project we recorded all the pathways by which the assessment pool of 247 insects have spread around the world, using a scheme adopted by the Convention on Biological Diversity that encompasses 44 different pathways. Most (85%) of the harmful insect invaders for which there is information about pathways have been introduced unintentionally. This is the opposite of the situation for invasive plants and vertebrate animals, most of which have been spread intentionally[6,8]. However, the pathways for close to half the harmful insect invaders are unknown.

The unintentional spread of invasive insects makes it difficult to predict which species will arrive, so there should be a strong biosecurity focus on identifying the high-risk pathways and minimising those risks[1]. This offers the potential to prevent a large number of new species arriving, including those whose invasion risks are unknown.

Our assessment found that 10 unintentional pathways are commonly used by invasive insects (Figure 3). The top three pathways are contamination of imported plants and nursery material and the timber trade. The ants, wasps and bees (Hymenoptera) and beetles (Coleoptora) use all 12 of the most prevalent pathways, indicating that their flexible travel habits (through their association with a wide range of traded products and ability to endure adverse conditions during travel) are a major reason for their high level of invasiveness.

RECOMMENDATIONS

The assessment work for the project is ongoing, including completing all EICAT assessments and assessing the potential ecological consequences for Australia of certain priority invasive insects. The next steps are to work with Australia's biosecurity agency and other stakeholders to (a) incorporate the results of the project into Australia's biosecurity system, (b) apply the process

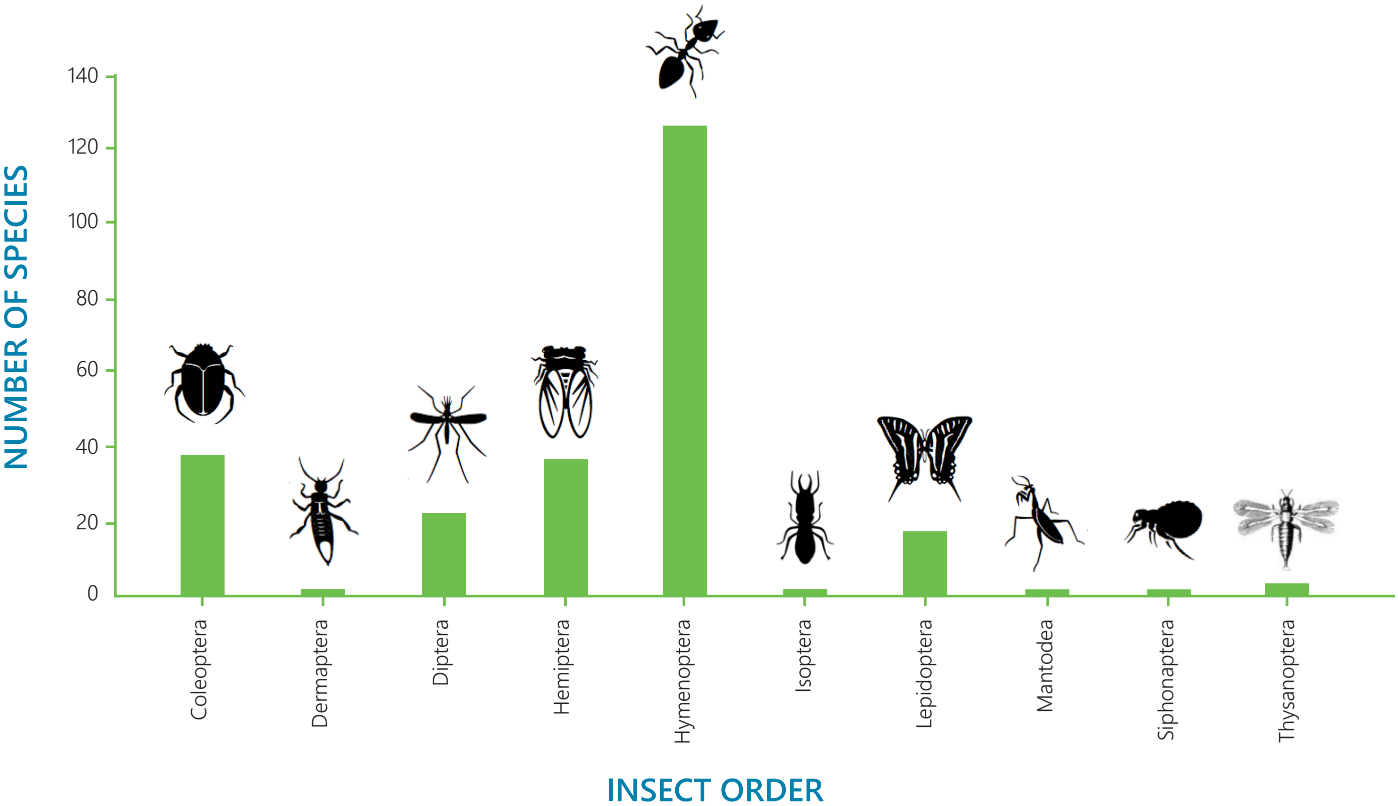

Figure 2: The insect orders with the highest numbers of environmentally harmful invasive insect species worldwide.

to other species groups and (c) establish a sustainable and publicly accessible data platform to maintain and regularly update information on potential invasive risks for the Australian environment. The Invasive Species Council and Monash University are seeking funds to undertake a similar assessment for invasive fungi.

Preventing insect invasions into Australia

Priority species: Invasive insect species of environmental concern not already in Australia should be incorporated into Australia's biosecurity system – including by assessing all 'of concern' insect taxa for their specific risks to the Australian environment, reviewing the adequacy of biosecurity protocols to detect and prevent these species, and developing contingency plans for all high-risk species.

Introduction pathways: Because most insect introductions are unintentional and there are likely to be many more harmful insect invaders than are documented, there should be a strong focus on reducing the risks of insect spread via the 10 most prevalent pathways for unintentional introductions. This includes assessing the Australian-specific environmental risks of these pathways and imposing import conditions to reduce the risks of high-risk pathways.

Social Hymenoptera: Because of the prevalence of social Hymenopteran species, particularly ants, as invaders, their harmful impacts on biodiversity, and their wide and versatile use of introduction pathways, reducing the risks of hymenopteran introductions should be a top priority for biosecurity. The national invasive ant biosecurity plan should be fully implemented and Australia's preparedness to respond to new incursions should be strengthened.

Applying best practice processes for prioritising potential environmental invaders

Other species groups: The methods used in this project to identify high-priority invasive insect species and pathways globally are robust, transparent and repeatable, and provides a comprehensive base of information from which to determine Australian-specific biosecurity priorities. A similar process should be applied to other species groups as the basis for determining priorities for Australian environmental biosecurity.

Sustaining the process with an accessible data platform

Database: A national public exotic and invasive species data platform is needed that:

- provides comprehensive, up-to-date information to support risk assessments;
- is updateable, repeatable and accessible to all, except for restricted data;
- is sustainable, with resources allocated for regularly updating the information and quality control.

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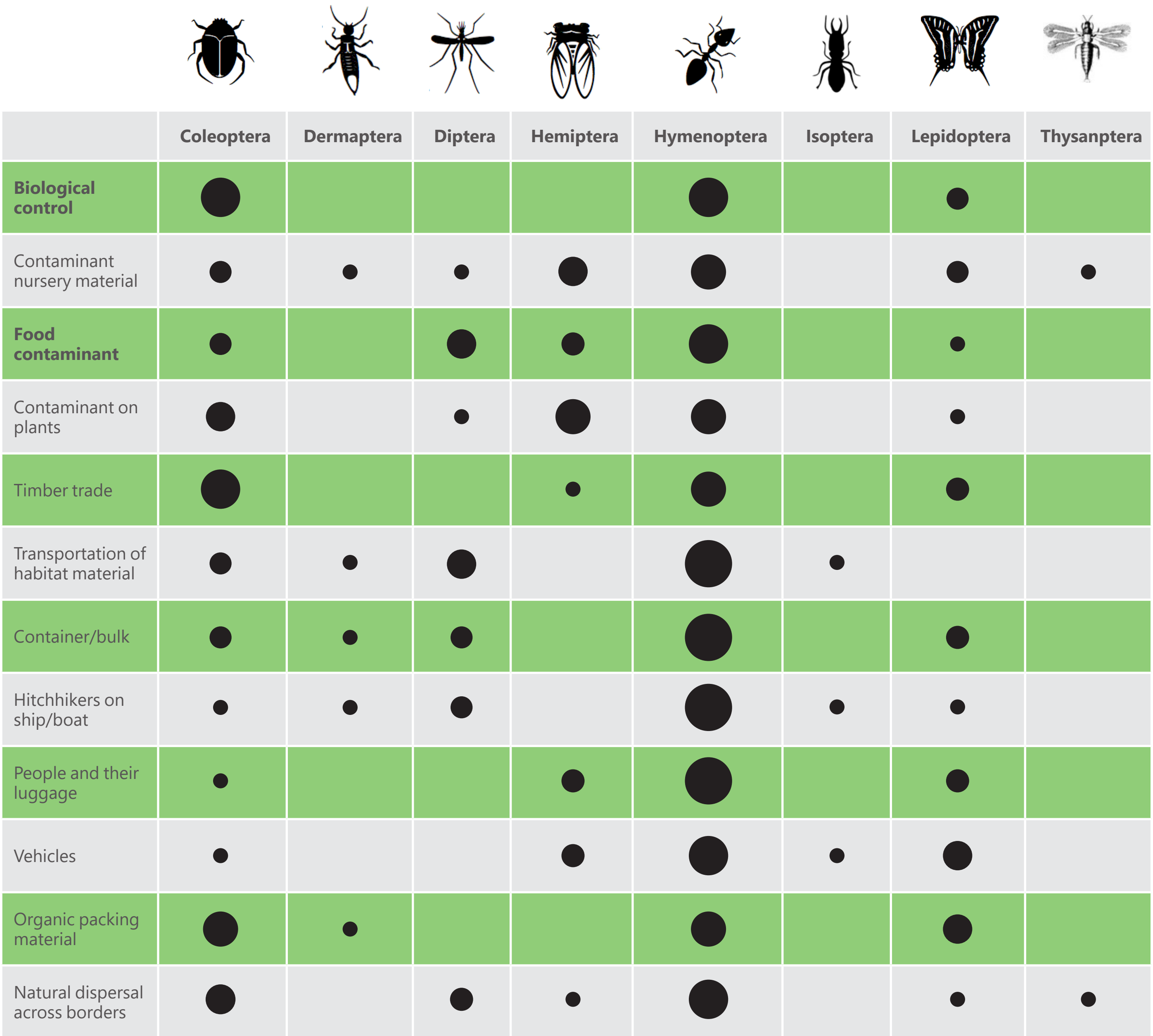

Figure 3: The use of introduction pathways by invasive insect orders. Only the most prevalent pathways and insect orders are shown. Circles and their sizes represent the relative contribution (%) of each insect order to the number of species using a particular pathway. Circle sizes (from smallest to largest) represent 1–10%, 11–20%, and so on up to 60%.

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