Editorial: Honey Pie - Are pollinators getting their fair slice?

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For some time, regular reports have appeared describing declines in pollinating insects over a global scale, with wild species exhibiting reduced abundance and shrinking biogeographic range and managed honeybees suffering from colony collapse. Current thinking suggests this pollinator deterioration is being caused by combination of environmental drivers: exposure to chemical pollutants and pesticides, loss of suitable habitat and floral resources, spread of virulent pests and pathogens, and climate change scenarios involving extreme weather events and loss of seasonal integrity (Potts *et al.* 2010; Mayer *et al.* 2011).

Because of the huge ecosystem service provided by pollinators, their disappearance has been readily linked to a potential deterioration in the quantity, quality and diversity of the human diet. A 2016 report by the Food and Agriculture Organization of the United Nations suggested around 75% of the world's food crops were dependent at least in part on animal pollination, with an annual value of somewhere between US$235 billion–US$577 billion. From a more ecological point of view, the authors estimated that 90% of wild flowering plants are dependent on animal pollination, but that over 40% of invertebrate pollinator species, particularly bees and butterflies, were currently facing extinction.

Alleviating the plight of bees and other pollinators seems to appeal to the wider social conscience and has led to the initiation of several pollinator promotion and monitoring schemes. Ecological organisations such as Friends of the Earth (The Bee Cause: Help Save the Bees;) and Greenpeace (Save the Bees) provide advice on planting bee-friendly gardens, avoiding use of bee-toxic chemicals and even sell kits containing pamphlets, identification charts and packets of seeds to help with all of this. In the UK, The Centre for Ecology and Hydrology (CEH) has initiated the UK Pollinator Monitoring Scheme, which utilizes citizen science volunteers to collect data using standardized counts. On the other side of the Irish Sea, The All-Ireland Pollinator Plan provides guidelines for farmers, businesses, and communities on how to encourage insect pollinators and monitor the

results of planting initiatives. In New Zealand, Landcare Research/ Manaaki Whenua have a series of web pages dedicated to the Community Pollination Project, with information on the groups of insects that visit flowers in NZ, and guidance and suggestions for study projects for the general public, schools, and scientists.

The concern felt for pollinators and the services they provide has reached policy makers and associated government departments, which has led in turn to some considerable funding schemes for scientific research. For example, as part of the EU Horizon 2020 program, €9 million has been awarded to the PoshBee program ("Pan-European Assessment, Monitoring and Mitigation of Stressors on the Health of Bees") which involves scientists, beekeepers, farmers, and government agencies from 42 institutions in 14 European countries. PoshBee plans to carry out a series of laboratory and semi-field experiments, in addition to an 8 country/ 128 site field study, measuring multiple response variables (e.g. bee pathogens and pests, larval development, colony strength, bee proteomics) and multiple explanatory factors (e.g. habitat complexity, floral resources, nutrient content of pollen, chemical contamination) to examine how exposure to multiple hazards effects the 'health' and performance of honeybees, bumblebees and solitary mason bees.

In New Zealand, insect pollinators have been widely researched due to their importance to the horticultural sector, the use of clover as animal forage and the multimillion-dollar mānuka honey industry (Newstrom-Lloyd 2013). Thus, it was pleasing to see in the recent New Zealand Entomological Society Newsletter (December 2017) that two new projects on bee ecology and behaviour have received substantial funding. Lisa Evans of Plant and Food Research has been awarded a Marsden Fund Fast-Start grant for research into how bumblebee learning behaviour is influenced by floral diversity and environmental stability. This work is timely, as studies have shown that exposure to agrichemicals can detrimentally affect learning behaviour of bees (Stanley *et al.* 2015), but that bees may not avoid floral resources or diets where these chemicals occur (Kessler *et al.* 2015). Steve Wratten at Lincoln University has been awarded a James Cook Research Fellowship to examine how honeybee nutrition is related to bee health and performance. By examining the mineral composition of different pollens consumed by honeybees, it is planned to develop a bee supplement containing a balanced mix of minerals that will promote bee health.

When it comes to pollinators, people clearly have their favourites (e.g. Sumner *et al.* 2018) and the two new studies described above, like many in New Zealand, are focussed on the performance of non-native pollinators, primarily bees in the genera *Apis* and *Bombus*, which reflects the agricultural basis of the research and the importance of these species in terms of food production (e.g. Howlett *et al.* 2018). Of course, pollination is important to wild plants as well as those supplying food to humans and domestic animals, and there are many other groups of insects, both native and exotic, that are responsible for pollination services (e.g. Rader *et al.* 2016). These issues are also being addressed in a New Zealand context: for example, Buxton et al. (2018) reported on the role of New Zealand moths as pollinators and Stavert *et al.* (2018) described how Diptera can maintain pollination levels in situations where native New Zealand pollinators are in decline.

Other recent New Zealand work has focussed on the ecology of wild rather than managed pollinators, both in terms of detailed studies of ecology and foraging behaviour (e.g. Hart 2016; Bennett *et al.* 2018) and the responses of pollinators to landscape features such as field boundaries (Macdonald *et al.* 2018). The latter study demonstrated that conservation initiatives involving the planting of native New Zealand species along field margins could increase the numbers of native bee species in otherwise functional pasture-based farmland. Similar work is described by Curtis *et al.* (2019) where plantings of native species in the corners of dairy paddocks also increased numbers of native bees (as well as honeybees).

The use of floral subsides in and around field crops or horticultural land in order to attract and maintain pollinators is a well-established method (e.g. Sprague *et al.* 2016). In terms of wider species conservation, however, seemingly well-meaning initiatives to attract and promote the success honeybees can have contradictory results for other pollinator species (Geldmann & Gonzalez-Varo 2018). Increases in the density or abundance of exotic honeybees can lead to declines in native pollinator species and interfere with pollination networks involving native plants and insects (Donovan 1980; Lindström *et al.* 2016). The vast quantities of mānuka and 'bush' honey produced every year by honeybees in New Zealand suggests that pollination of these native plant species is now performed primarily by this exotic bee species. One wonders what the effect of this 'pollination domination' has been on the native insect species that presumably pollinated

these plants perfectly well for the 1000s of years prior to honeybee introduction to New Zealand in the mid-1800s. In contrast to the latter scenario, Iwasaki *et al.* (2018) examined interspecific interactions between introduced and native bees occurring in alpine grassland near Queenstown. The authors reported that bee species overlapped more in terms of the floral resources they within each group than they did between these two main groups, and thus suggested that introduced and native bees may not compete excessively in this ecological setting.

The results of Iwasaki *et al.* (2018) also allude to another conservation issue: that of native pollinating insects utilizing introduced plant species outside of an agricultural setting where the flowers are being used as a resource subsidy. For example, Hodge *et al.* (2017) described how 20 endemic species of New Zealand invertebrates were found on the flowers of the introduced ice plant, *Carpobrotus edulis*, in the highly modified sand dune system at New Brighton, near Christchurch. The literature can provide numerous other cases of introduced, often invasive, plant species providing shelter, pollen or nectar for native insects, and this phenomenon extends the discussion as to whether these plants are having a negative impact by disrupting the indigenous pollinator networks or actually providing a useful ecological conservation tool.

This last example leads onto a final point: although, overall, research into both 'pure and applied' New Zealand pollinator systems appears to be in good health, and covers a wide range of taxa, one component that appears lacking is the analysis of whole insect-plant pollinator networks. This is possibly because researchers trying to fathom all species-specific insect-plant pollinator interactions would encounter problems with insect identification, either because the group is difficult (e.g. native bees) or due to a lack of completeness in the described New Zealand fauna (e.g. syrphids, tachinids, muscids; Janice Lord *pers. comm*.). Even with all the current financial and conservation initiatives now available for pollination research, it seems likely that the immediate focus will remain on *Apis* and other managed bees of agricultural importance. For our native insect-plant pollinator networks to be studied in more detail, however, the less 'populist' insect groups cannot be forgotten, and it would be hoped that even a small piece of the vast funding pie on offer for pollination research might somehow find its way to the plate of a grateful taxonomist.

Webpages

All-Ireland Pollinator Plan: pollinators.ie/
CEH: www.ceh.ac.uk/our-science/projects/pollinator-monitoring
EU: ec.europa.eu/environment/nature/conservation/species/pollinators/
FAO Pollinator report: www.fao.org/news/story/en/item/384726/icode/
Friends of the Earth: www.friendsoftheearth.uk/bees/
Greenpeace: www.greenpeace.org/international/act/save-the-bees/
Landcare: www.landcareresearch.co.nz/science/plants-animals-fungi/plants/pollination/community-pollination-project/
PoshBee: poshbee.eu

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