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JAMES COOK UNIVERSITY
AUSTRALIA

The provision of pollination services to agroecosystems by a diverse assemblage of wild, unmanaged insect taxa

Thesis submitted by
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in July 2010

For the degree of Doctor of Philosophy
in the School of Marine & Tropical Biology
James Cook University
Cairns

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Abstract

The current global pollination crisis highlights the advantages of the provision of pollination services by a suite of core pollinators. Recent declines in honeybee populations have focused attention on the potential for unmanaged insects to replace them as pollinators of global food crops. The ability of unmanaged pollinators to replace services currently provided by honeybees requires understanding of their efficiency as pollinators as well as the spatial and temporal variability of their services, yet few quantitative assessments currently exist. In order to understand if unmanaged pollinator taxa are capable of providing equivalent pollination services to the honeybee I compared the pollination services provided by unmanaged taxa to the honeybee within a *Brassica rapa* mass flowering crop in a highly modified New Zealand agricultural landscape. First, I examined four functional traits of insect flower visitors in order to compare the pollination services provided: per visit pollen deposition, the probability of stigmatic contact, visitation rate, and capacity to transport pollen over distance. Second, I investigated how these traits vary between unmanaged pollinators and the honeybee both in space (between field locations) and time (within a day and between years) to examine whether unmanaged pollinators are capable of providing consistent, stable pollination services to a *B. rapa* mass flowering agricultural crop.

I observed a total of 41 managed and unmanaged taxa visiting flowers of *B. rapa*. In addition to *A. mellifera,* seven insect species visited flowers frequently. These were three other bees: *Lasioglossum sordidum*, *Bombus terrestris* and *Leioproctus* sp.; and four flies: *Dilophus nigrostigma*, *Melanostoma fasciatum*, *Melangyna novae-*

*ze*landiae and *Eristalis tenax*. Two bee species, *Bombus terrestris* and *Leioproctus* sp. and one fly, *Eristalis tenax* were as efficient as the honeybee and as effective (in terms of rate of flower visitation). A higher honeybee abundance however, resulted in it being the more effective pollinator overall. All frequently visiting pollinators were consistent in their visits over a four year period, even though individually visit frequencies varied between taxa. The pooled services of the unmanaged taxa were equal to or better than the honeybee in three of the four years.

Pollinators were active at different times of the day. Most unmanaged fly taxa were most active early in the morning and late in the afternoon/evening. Managed and unmanaged bee taxa and one fly (*D. nigrostigma*) were more active in the middle of the day. Overall visitation rate did not differ significantly between the hours within a day, indicating that changing taxonomic composition in assemblage structure was not accompanied by changes in potential pollination services. The contributions to visitation rate provided by fly taxa outside of standard survey hours resulted in a higher visitation rate at the end of the day.

Both managed and unmanaged pollinators transported viable pollen outside of a *B. rapa* crop. These consisted of three species from two bee families (Hymenoptera: Apidae and Halictidae), and seven species from four fly families (Diptera: Bibiondae, Stratiomyidae, Syrphidae and Tachinidae). Pollen viability varied between insect families and declined with distance from the crop but was nonetheless carried to at least 300m outside of the crop.

The results of this study suggest alternative pollinator taxa are capable of performing pollination services in a mass flowering crop equal to or better than the managed European honeybee. Alternative land management practices that increase the population sizes of unmanaged pollinator taxa to levels resulting in visitation frequencies as high as *A. mellifera,* have the potential to replace services provided by the honeybee. At the time of this study the *Varroa* sp. mite had not been recorded in the Canterbury region of New Zealand, where this study was conducted. It has since been recorded in this area, representing a significant possible threat to pollination services and hence crop production. My results have direct application suggesting that pollination services historically provided by managed honeybees might be replaced by those provided by other existing unmanaged pollinator taxa. Evidence from my study suggests that increases in the abundances of these alternative taxa should translate into greater pollination services.

To increase the population sizes of unmanaged pollinator taxa, I suggest “in-situ” management. This will require a change in land management practices in order to ensure year round refuge, feeding, nesting and other resource requirements of pollinator taxa are met.