The following is an example of a scientific report for the Let's Bee Scientists research, created by Japhy Ong and Julie-Ann Henninger

Let's BEE Scientists: Using citizen science and artificial flowers to research pollinators and pollinator preferences in the Blue Mountains

Abstract

Pollinators are vital to the planet's ecosystem so it's important to study and learn more about their behaviour. This study used citizen science and artificial flowers to research pollinators and pollinator preferences in the Blue Mountains. Families gathered data in their own gardens surveying flowers and pollinators present and setting up an artificial flower circle. The artificial flowers were used to compare pollinator attraction to traits like colour, complexity and construction material. Although this study has a small sample size it shows artificial flowers are successful survey tools in field settings and have the potential to gather useful information about pollinator preferences. Further citizen science studies with easier methods of data return and larger sample sizes are recommended. Paper artificial flowers are preferable to plastic artificial flowers in further pollinator research.

Introduction

Pollinators are vital to our ecosystem and are currently in danger. Between AUD$342.44 billion and AUD$840.80 of global food production per year relies on direct contributions by pollinators. 90% of all wild flowering plants rely on some amount of animal pollination. Most pollinators have not been assessed at a global level, however regional and national assessments indicate high levels of threat for butterflies and bees in particular. 40% of these pollinators are threatened (Food and Agriculture Organization of the United Nations, 2019).

Understanding the way pollinators utilize and interact with resources across different habitats can teach us to better our ways of agriculture and planting tactics in order to strengthen them, and help protect against environmental change (Nordström et al., 2017).

Studies into the co-evolution of bees and flowers have led to general understandings of bee preferences. Bees tend to show preferences for showing brightly colored petals (blue and yellow in particular). Flowers may also have nectar guides which are guides to show the bee/pollinator where the nectar is, usually in UV light (Raven, Evert & Eichhorn,1999).

Artificial flowers have been used to understand pollinator preferences, and have provided useful information particularly in laboratory settings (Russell & Papaj, 2016). Artificial flowers were used by Nordström et al. (2017) in the field working with hoverflies. Apart from this there is very little research done into artificial flowers in the field.

Citizen science helps provide benefits for researchers and participants and aids in conservation efforts. Citizen science is useful to participants because it helps them develop more knowledge about the world around them as well as providing them with useful scientific tools. It is useful for researchers as it helps them gather more data then they would be able

to without the contribution of the citizen scientists. (Ellwood, Crimmins & Miller-Rushing, 2017)

Some research into pollinators has been done in the Sydney region (Makinson,Threlfall, & Latty, 2016). However there is little to none that has been done in the Blue Mountains.

This study used citizen science and artificial flowers to research pollinators and pollinator preferences in Darug and Gundungurra Country, the Blue Mountains. We looked at the following hypotheses:

(1) Artificial flowers provide information on pollinator preferences in a field setting.

(2) Complex artificial flowers are more appealing to pollinators than simple types.

(3) Yellow artificial flowers receive more attention from pollinators than blue or black artificial flowers.

(4) Paper flowers are more attractive to pollinators than plastic.

Methods

Experiment packs were handed out to around 30 families in the Blue Mountains region. The packs contained artificial flowers, a bingo sheet of native insects and instructions on how to use them. Families gathered data in their own gardens. They filmed/looked around their gardens for all flowering plants, either their whole garden or up to two tennis courts worth. They were also given a checklist with many pollinating insects to tick off their checklist and to film to see how many were in their garden at that time. Once those activities were completed they set up eight artificial flowers in a circle with an 160cm diameter. Once completed families created a fake nectar to attract the flies and bees. To do this they dissolved caster sugar in warm water in a 50:50 split (half sugar, half water) Once the sugar was dissolved they filled the Eppendorf tubes positioned at the center of the artificial flower with the artificial nectar. Then they filmed the artificial flower circle and kept track of which flowers got the most attention from the bees and flies. They did this for ten minutes. Once this information was gathered families were invited to submit their data. See Appendix A for experiment pack instructions. Participants also collaborated in many science communication projects including the Let's Bee Scientists website (Let's Bee Scientists, 2019).

Figure 1: Artificial flower types.

Results

Ten fully completed surveys were collected. In every survey pollinators visited the artificial flowers. There were forty nine insect interactions with artificial flowers in total. Three of those insects drank from the artificial nectar. Figure two shows the number of insects that visited each flower type. Flower type A (Fancy mostly yellow) received the most visits. The error bars show this is a valid result. Flower G (black plastic) received zero visits.

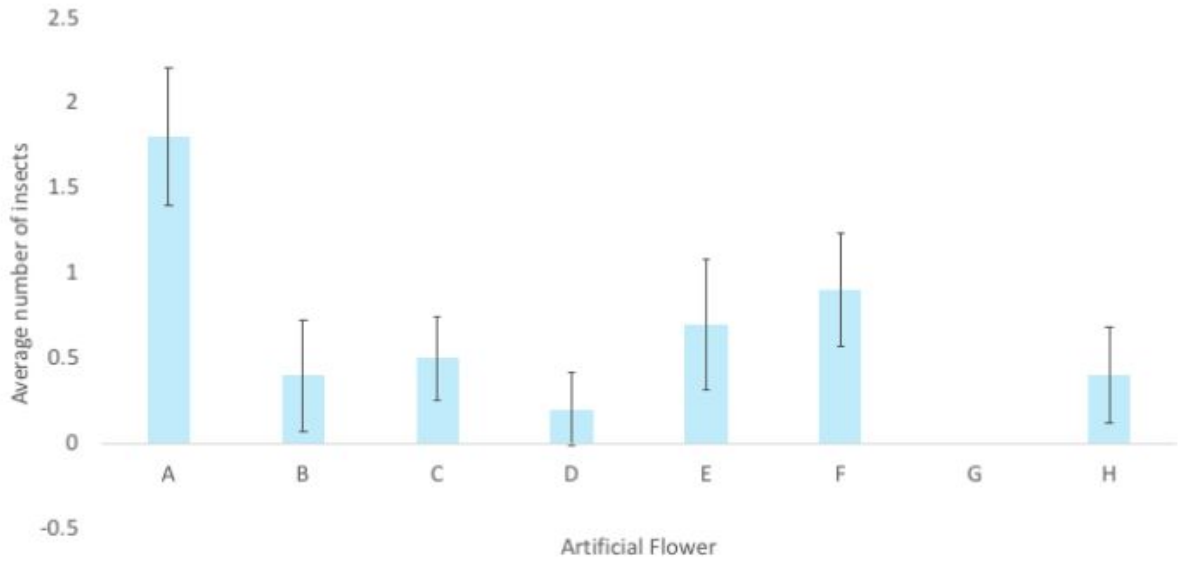

Figure two: Average number of insects interacting with artificial flowers.

The yellow artificial flowers received the most attention from insects and pollinators, gathering more than twice as much attention as the blue flowers, and almost three times as much as the black flowers.

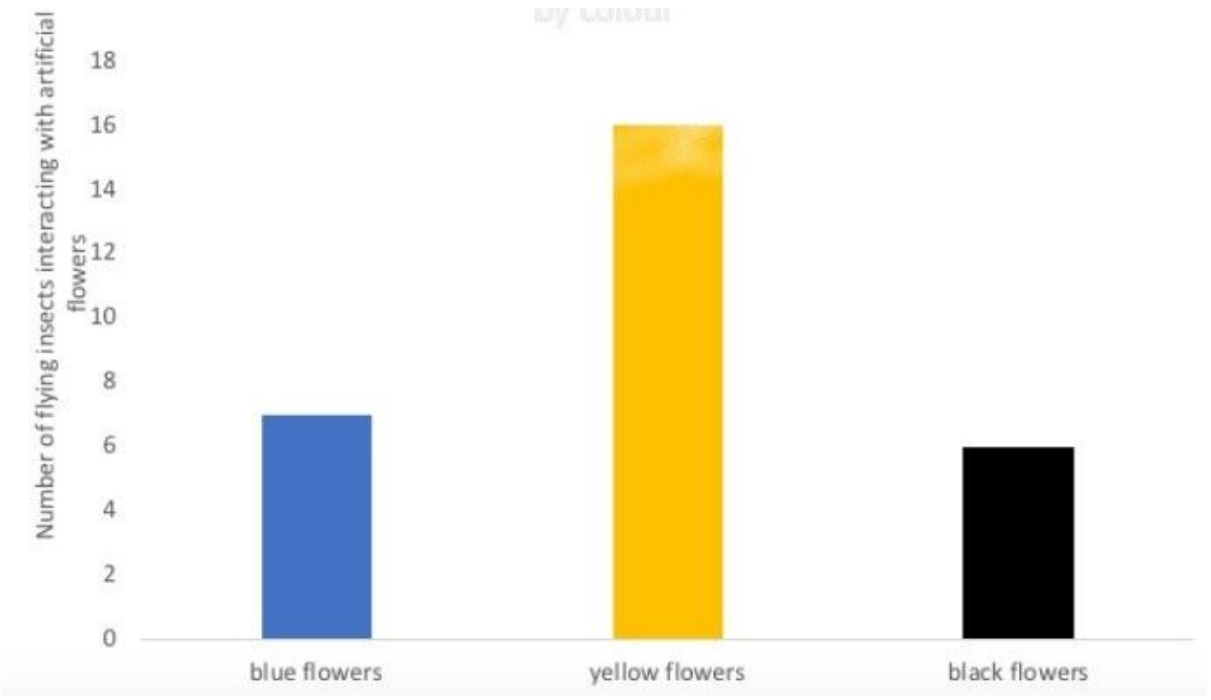

Figure three: Total number of pollinator interactions with artificial flowers by colour.

The bingo exercise showed the diversity and abundance of pollinators observed in gardens. Of the identified insects;. Honey bees, Grey fly and Hover flies were the most common insects seen in people's gardens.

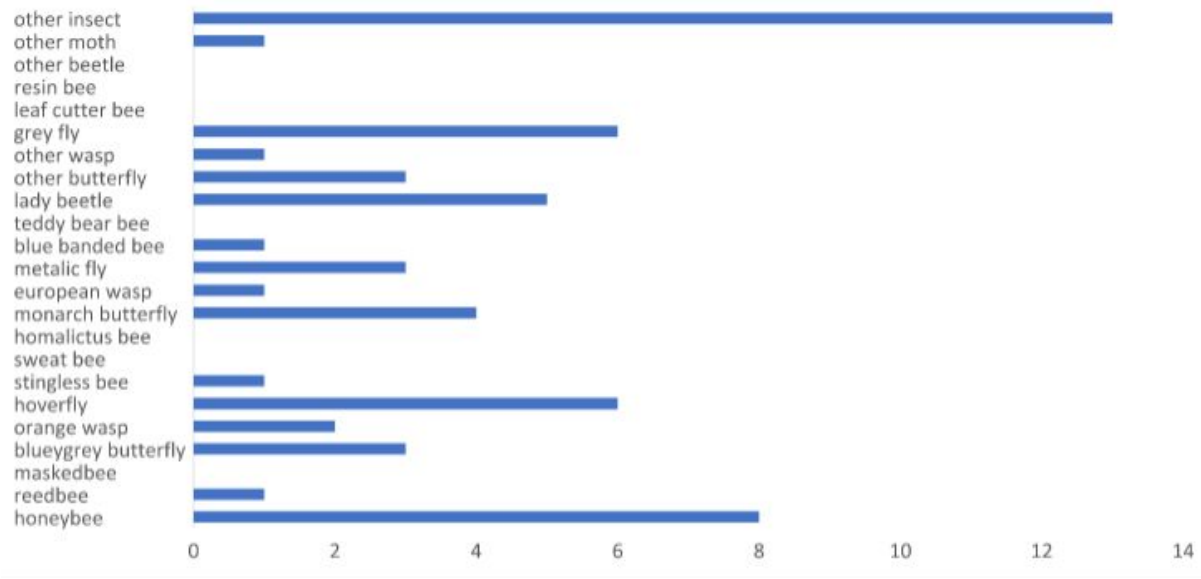

Figure four: Total number of insects seen during bingo in all gardens

Grey flies and bees were the most common insects identified interacting with the artificial flowers.

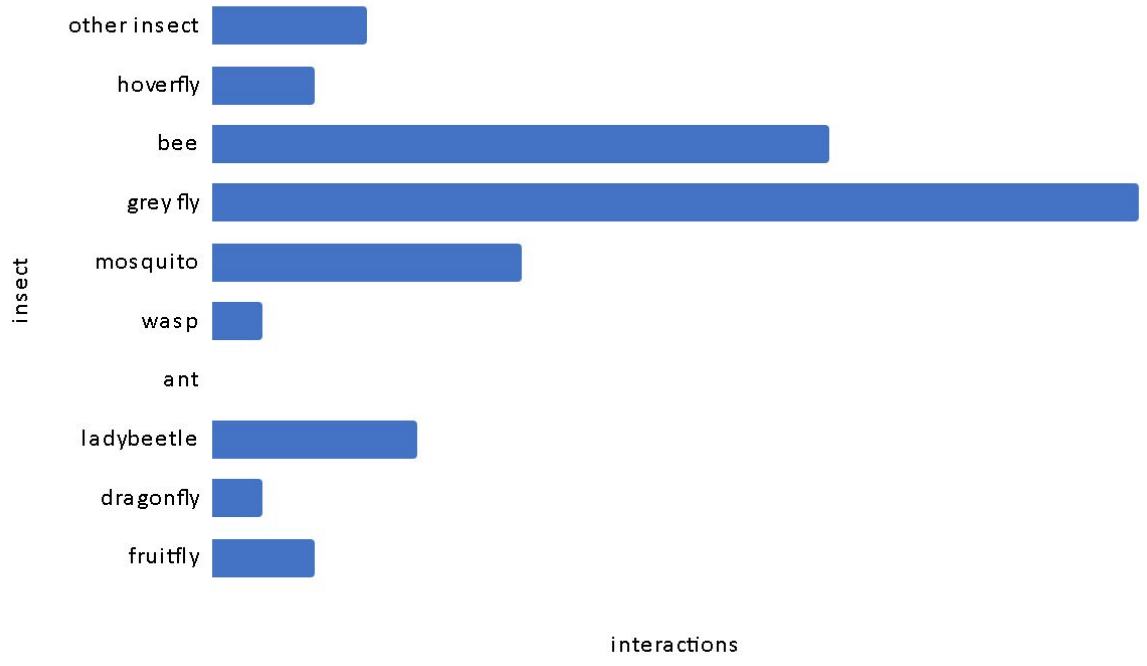

Figure five: Total number of insect interactions with artificial flowers

In our results paper flowers received fifteen visits in total were plastic received twelve. We did not receive enough data to perform statistical analysis.

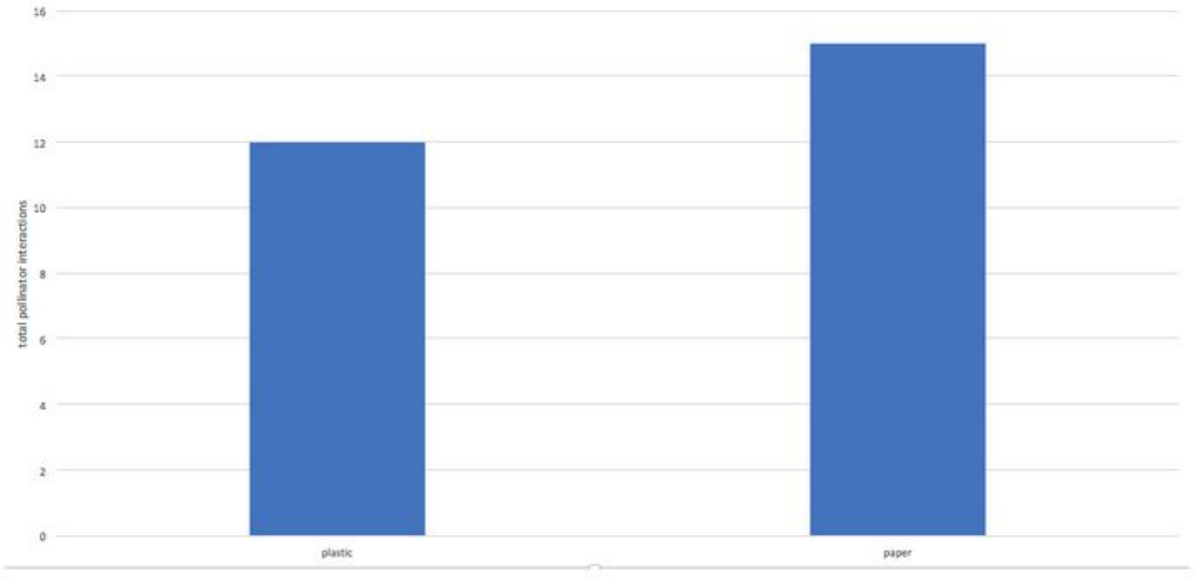

Figure five: Total pollinator interactions with simple plastic and paper flowers.

Discussion

While this study has a very small sample size it provides some useful preliminary data towards our hypotheses. The number of pollinator visits to the artificial flowers supports our first hypothesis that artificial flowers would provide information on pollinator preferences in a field setting (Hypothesis 1). The small sample size limited statistical analysis and the scientific weight of the findings. However using standard error we can observe that the complex flower A was most attractive to local pollinators which supports our hypothesis that complex flowers are more attractive than simple ones (Hypothesis 2).The shape of flower A also has petals which makes it look a lot more like a non artificial flower. It also contains both blue and yellow, with the blue at the centre similar to flowers with nectar guides. We can see that our hypothesis receives support from our findings demonstrating better attraction to complex looking flowers opposed to simplistic flower design. Further study is required to confirm which were the factors that most heavily influence Flower A's attractiveness.
The fact that flower A was also predominantly yellow, and the fully yellow flowers (flowers E and F) received more pollinator visits than other colours provides preliminary support to hypothesis (3) that yellow artificial flowers receive the most attention from pollinators. A larger sample size is needed to confirm if this can be confirmed as a statistically significant result.
The construction material of the artificial flowers also seemed to affect the level of attraction with paper flowers receiving more visits than plastic flowers like we expected to be the case in hypothesis (4). Again a larger sample size is needed for statistically supported results.

The main issue this study encountered was a small sample size from collecting smaller number of data sheets than anticipated. We believe we made it too difficult to return/submit the data participants gathered. For example, study participants were asked to submit photos and videos of their findings which made it more difficult, with video being harder to submit due to large file sizes. Participants were also concerned about low photo quality and did not submit results due to these concerns (personal communication). The survey conducted at a busy time of year for families (at the end of the year) which could have influenced their availability.

Another issue is the question of relying on data from citizen science.
Issues that could have occurred from this is a potential lack of knowledge and ability to discern insects from one another. However this citizen science project provided enough valuable information and citizen science has such a diversity of benefits (Ellwood et al, 2017) that we recommend further studies maximise the use of citizen science. We concur with Ellwood et al (2017) that with appropriate training and selection of tasks, citizen scientists are extremely valuable contributors to science and conservation. Future work is recommended to study how to maximise the effectiveness of citizen science: how to maximize data quality and quality and support efficient data collection. Ellwood et al. also

recommends that citizen science be coordinated and communicated as widely as possible (Ellwood et al, 2017). While this project worked on the science communication aspect (Let's Bee Scientists, 2019), the coordination aspect could be improved to expand sample sizes and cover a wider geographical area.

While we think this study was valuable in determining the usefulness of artificial flowers in a field setting there's still much work we'd like to see done in the future. For example, we recommend further citizen science performed on a larger scale with a larger sample size, supported by easier methods of data submission. Further study could be done into what makes Flower A appealing to pollinators. The majority of pollinators did not drink from the sugar water so a study could be designed to test whether removing it has an effect on the attractiveness of the artificial flowers. We recommend paper flowers be used in future studies as they were at least equally effective as plastic (if not more effective) and are more environmentally friendly (in that they are biodegradable and can be more sustainably sourced).

Conclusion: The sample size for this study was too small, despite this the study showed artificial flowers are useful in a field environment and artificial flowers are a good resource in learning more about pollinator behaviour. In the future it would be beneficial to make data submission easier for citizen scientist participants. We conclude paper artificial flowers are preferable to plastic artificial flowers in pollinator research.

Acknowledgements

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