



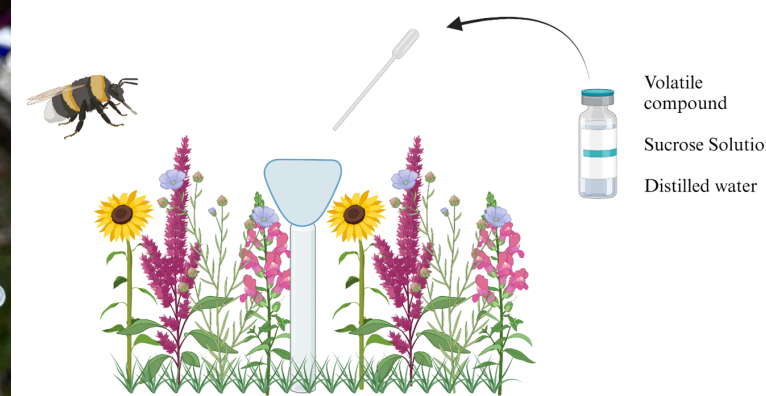
The Impact of Colour and Olfactory Features of Artificial Flowers on Their Attraction to Bumble Bees

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Introduction

The widespread use of *Bombus terrestris* for commercial pollination in the UK has raised concerns about biodiversity and competition with native species. To address these issues, it is crucial to understand the preferences of various bee species for different floral properties. This study investigates how colour and scent influence bumblebee attraction to artificial flowers, hypothesising that bees prefer floral blends over singular compounds and that both scent concentration and flower colour significantly impact their behaviour. The findings aim to support targeted plant selection to enhance bee populations, improve crop yields, and promote biodiversity.

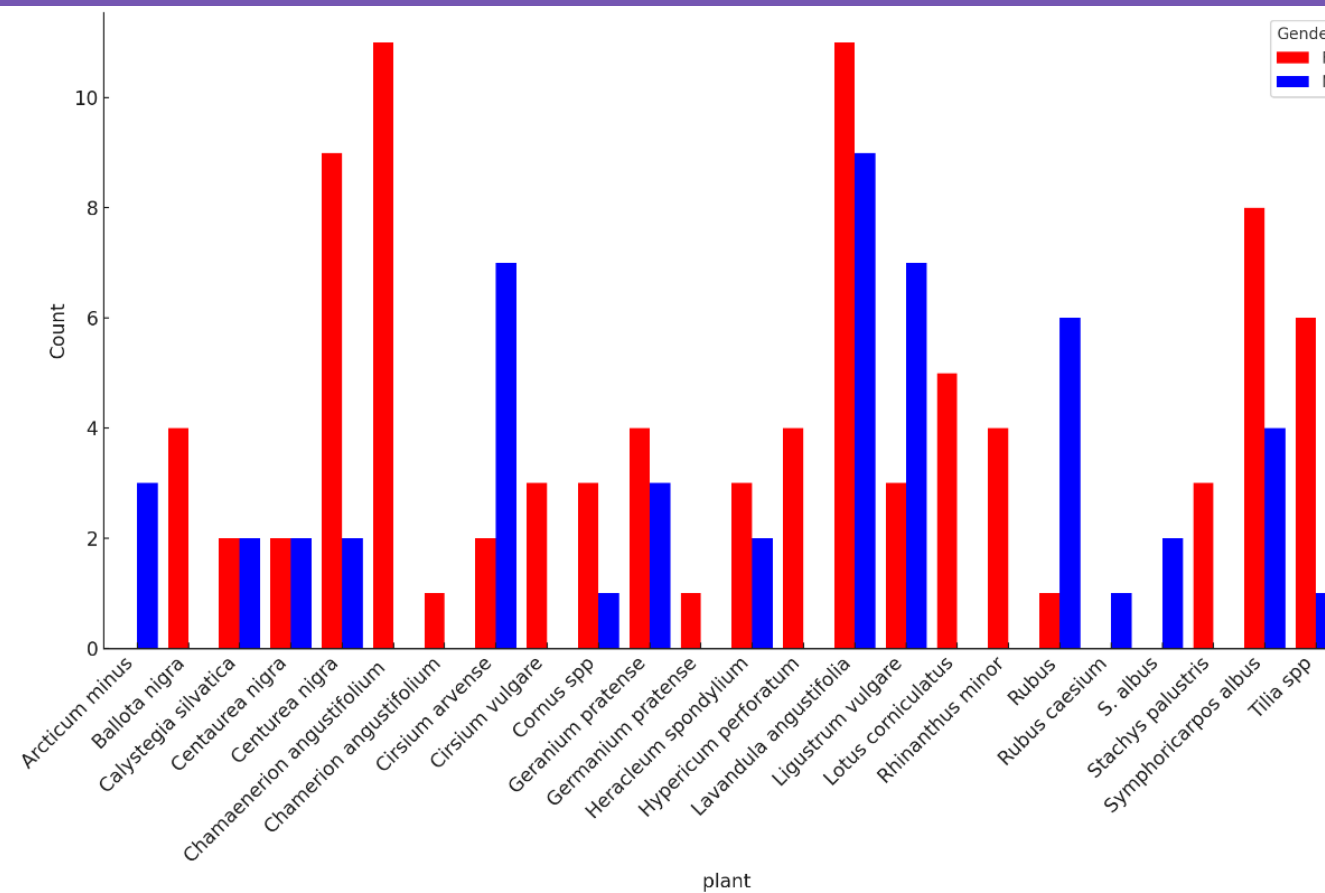
Methods



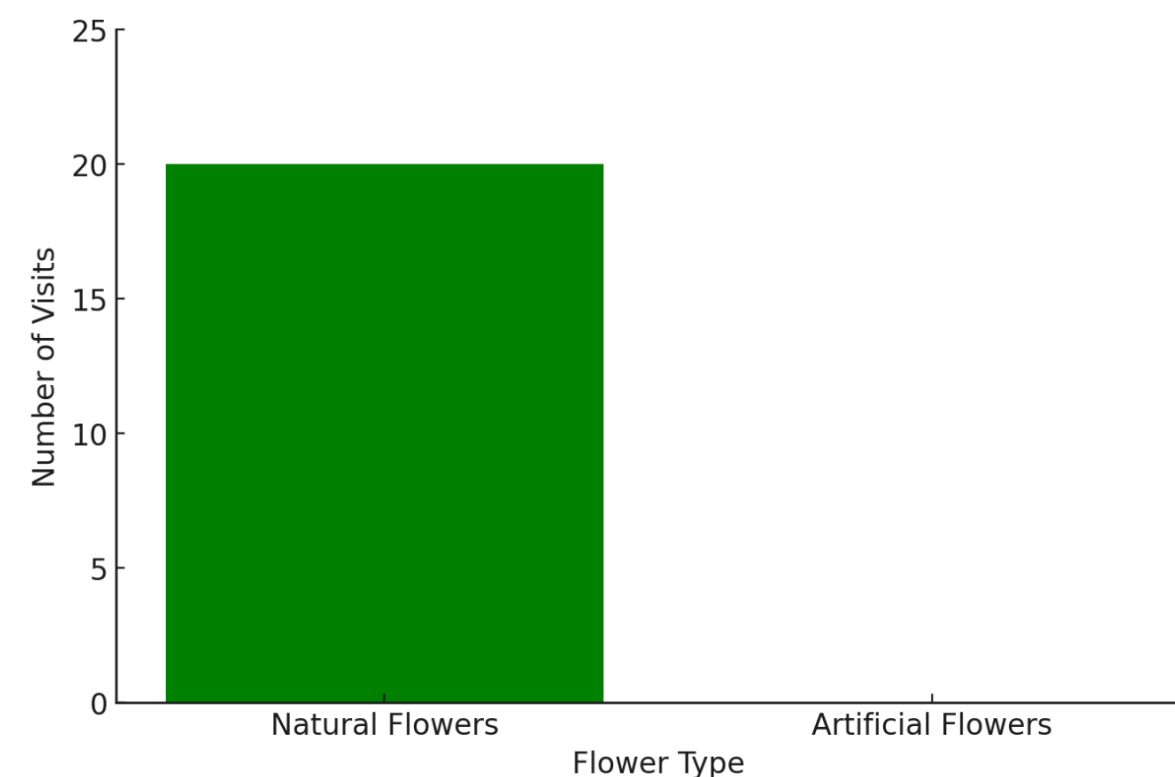
Foraging Experiments: Bee foraging was observed across various sites in Durham, including wildflower meadows and artificial beds. Native and non-native flowers were sampled, with a preference for native species noted. Bees were collected, euthanised ethically, and identified. Plant volatiles were extracted using plastic bags and analysed for chemical composition.

Behavioural Experiments: Artificial flowers with varying scents were created using plastic and paper. Scents included d-limonene, alpha-pinene, and methyl-salicylate in different concentrations. Bee interactions were observed in a mesh tent and among natural flowers. Responses such as visitation frequency and time spent were recorded. Floral blends and controls were tested to assess bee preferences.

Results



This bar chart illustrates the distribution of male and female bees across various plant species. Each bar represents the total count of male (blue) and female (red) bees observed visiting each plant species. The data highlights the different visitation patterns, with some plant species being more frequently visited by one sex over the other. For instance, *Lavandula angustifolia* and *Chamaenerion angustifolium* show a significant preference by females, while other plants like *Centaurea spp* were visited relatively equally by both sexes. Understanding these patterns can provide insights into the floral preferences and foraging behaviours of male and female bees and further exploration can link this to species differences.



Bees did visit the artificial flowers and did not respond to single scent compounds in vials, showing no preference between scented and unscented artificial flowers. Adding a sucrose reward (1 g in 20 ml water) did not increase attraction, suggesting the concentration was too high compared to natural flowers. Flower colour, shape, and material (paper or plastic) variation also had no effect. Other insects, such as flies, visited the flowers, indicating some attractiveness unrelated to bee-specific preferences.

Discussion

Bees showed a clear preference for natural flowers over artificial ones, indicating that multiple sensory cues, such as scent, colour, and texture, influence their foraging behaviour. Female bees, with higher energy needs due to their role in hive maintenance, were more selective and visited early-blooming flowers more frequently, possibly due to higher pollen availability or volatile compounds produced. The absence of pollen and floral cues in artificial flowers likely reduced visitation rates. Differences in male and female bee preferences align with their distinct nutritional needs.

The study's limitations include a small sample size, short duration, and focus on one region, suggesting that results may not apply to all *Bombus* species. Overall, with further investigation and study, this investigation could help us to identify which aspects of plants the bees were most attracted to, including the notations from our study such as pollen and texture, to help to identify the best natural plants for attracting bees and increasing populations.

Future Work

Future studies should focus on identifying specific plant volatiles and their impact on bee preferences by species and sex. Investigations into the wavelength of reflected light and training bees to respond to various scents could improve artificial flower design. Exploring the effects of floral blends versus single compounds on bee behaviour would provide insight into multimodal attraction. Enhancements to artificial flowers, such as replicating natural humidity, texture, and possibly adding pollen, could help identify key factors influencing bee visitation.

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