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The Crucial Role of Bumble Bees in Pollination: Ecological Impact and Conservation Perspectives

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Bee pollinators are vital contributors to global crop production, with one-third of the world's food supply depending on their pollination services. While honeybees are commonly recognized for this role, wild pollinators like bumblebees are equally important yet often overlooked. Bumblebees are particularly suited to high altitudes and cold environments, pollinating large number of fruits and vegetable crops. However, bumblebee populations have been declining over the past 60 years because of many reasons. Protecting bumblebees through these strategies is essential for sustaining their role in global pollination and crop production.

Introduction

Bee pollinators are one of the major contributors to an increase in the production and productivity of crops across the world. It is also known that one-third of the world's food production directly and indirectly depends on bee pollination. Pollination by honeybees is the most common but there are many unsung heroes such as wild bees are there for pollination. Bumble bees are one of the important species of pollination among the wild species and are called as teddy bear of insects. Bumble bees are robust insects with a yellow and black coloration that is known to pollinate a wide variety of crops that are unable to pollinate by honeybees. For instance, in the field bean and red clover have long corolla, and pollination occurs only when bumble bees visit. Similarly, pollination in tomatoes demands a vibration to fall pollen from the stigma and bumble bees effectively do that. Further many other crops like cucumber, cotton, watermelon, pepper, strawberry, kiwifruit, and many fruits and vegetable crops more efficiently. Interestingly, the bumble bees have a wide range of flower choices and are found to have a long fly season in comparison to the honeybees. Moreover, the bumble bees are well known for their unique way of visiting a flower, as they leave scent marks on the flowers to prevent them from revisiting the same flower (Wahengbam *et. al.*, 2019). The term used to describe the pollination by bumblebees is called myophily.

Bumblebees are eusocial insects and foraging behaviour varies according to the environmental conditions. The foraging ability is upto 2 km with an average speed of 54km/h (Nayak *et. al.*, 2020). They are abundantly present in higher altitudes and latitudes and often remain active at very low temperatures which is difficult for other bee species to survive and forage. Their survival in extreme cold conditions is facilitated by regulating body temperature through mechanisms such as solar radiation absorption and an internal cooling process known as heterothermy. Additionally, they adapt to high altitudes by increasing their wing stroke amplitude (Dillon and Dudley, 2014). Different species of bumble bees are distributed all throughout the world but no traces of their presence in Australia. Unfortunately, these beautiful creatures are declining over the past 60 years and the major reasons include a

decline in flora diversity and abundance, habitat loss, intensification of agriculture, loss of nesting sites, hazaradous pesticides, and invasion of nonnative species (Abrol *et. al.,* 2021).

Proposed measures include strict regulation of commercial bumblebee use and the implementation of targeted, environmentally compatible practices to enhance floral diversity in agricultural landscapes. Agri environment schemes like replanting hedgerows, sowing wildflower strips, leaving land fallow, and restoring rich flower grassland. Adopting the cultural practices that are safe for bumble bees. On more natural lands, the management practices should focus on diverse maintenance of indigenous flora that can be available throughout the season. Observations of nest failures caused by food shortages emphasize the importance of a consistent supply of nectar and pollen during the active period of bumblebees, which lasts from spring through late summer. In both natural and human-altered habitats, a variety of nectar plants with overlapping bloom periods are typically necessary to meet this requirement. Moreover, tongue length variation among bumblebee species leads to differences in their flower preferences. Therefore, maintaining a plentiful and diverse array of plants, both in terms of their phenology and morphology, is a wise management strategy. Some bumblebees nest underground, while others nest above ground. Reducing tillage or leaving unplowed strips of vegetation can generally enhance the availability of nesting habitats for ground-nesting species. Pesticide use diminishes bumblebee pollination and can potentially drive them out of agricultural areas entirely. The most effective way to prevent the negative effects of pesticides on bumblebees is to avoid applying insecticides to flower patches that attract them. When pesticide use is necessary, dosage and application methods impact toxicity to bees. To minimize harm, pesticides should be applied from the ground during calm winds, with either solutions or soluble powders instead of dust. Avoid spraying crops in bloom, as bumblebees may still be active even when honeybees are not. Pesticides lose toxicity faster in warm, dewless conditions, making this the ideal time for application. Alternatively, use of insecticides that are safe to bumblebees can be adopted (Schweitzer *et. al.,* 2012)

Conclusion

Bee pollinators, especially bumblebees, are crucial for increasing crop production globally. Bumblebees, known for their unique pollination abilities and adaptability to various environmental conditions, play a vital role in pollinating crops that honeybees cannot. Despite their importance, bumblebee populations have been declining due to habitat loss, pesticide use, and reduced floral diversity. To support their survival, it is essential to enhance floral diversity, implement environmentally friendly practices, and manage pesticide use carefully. Adopting these measures will help ensure the continued contribution of bumblebees to agricultural productivity and ecosystem health.

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