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Honeybees as Pollinators and their Conservation: A review

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Abstract

Pollination is a critical mechanism for maintaining and conserving biodiversity, with pollinator diversity playing a major role for the enhancement of food security and livelihoods. Pollinators provide the essential service of enabling plants to produce fruits and seeds in our ecosystems. These pollinators come from many groups within the kingdom Animala, including insects, birds, bats and reptiles. Among them, arthropods, especially honey bees, are pivotal In delivering pollination services to flowering plants. Additional important pollinators include halictids, carpenter bees, bumblebees, megachilids, andrenids, syrphids etc. Bees visit plants to obtain their food, nectar and pollen and also attracted by nectars rich in sugar content and pollens with higher nutritive values. Four important species of honey bees (Hymenoptera: Apidae) found in India: Apis cerana, Apis dorsata, Apis florae and Apis andreniformes. The two most common pollinators of vegetables and horticultural crops are the Indian hive bee, Apis cerana, and the rock bee, Apis dorsata. Declines of pollinator population are a serious global issue that has attracted the attention of experts, decision-makers and the general public. Nevertheless, parasitic mites, diseases of honey bees and the less survival of honey bees to unfavourable weather conditions are some of the difficulties that affect modern beekeeping. To effectively implement initiatives for pollinator conservation and habitat restoration there should be collaboration among governments, legislators, corporations, scientists, farmers and citizens globally. These difficulties jeopardise honeybees' overall value as pollinators. As a result, safeguarding honey bee biodiversity and wild pollinators is vital for maximising the potential yields of varied agricultural and horticultural products, developing hybrid seeds, growing crops in poly-houses, and preserving the country's rare and distinctive species.

Keywords: Pollination, beekeeping, pollinators, honey bees, conservation

INTRODUCTION

A wide range of environmental functions, including pollination and nutrient recycling, are mostly provided by insects. Insect pollination is a vital ecological service that is necessary for the production of crops. Animal pollination is necessary for the development of fruit, vegetables and food crops worldwide [9]. According to [17] The worth of insect pollination to the world's agricultural output was estimated to be 9.5% of the total worth of agricultural production used to feed humans.

In India, pollination by insects benefits the greatest number of crop plants. The benefits provided by pollinators to nature and humanity are immense.

During the co-evolution of insects and angiosperms, specific plant-pollinator relationships have developed, with particular species of

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pollinators playing a crucial role in conserving rare orchid species. Additionally, our diverse landscapes which include pastures, mountains, forests, uncultivated lands, ponds, rivers and lakes are like a home to a rich array of vegetation and floral plants. Such diversity in flower shapes demands a comparable diversity of pollinators to ensure effective and efficient pollination.

The necessity for intensification and diversification to sustain agriculture and horticultural fulfil the needs of a growing population. For the increase of crop productivity in both natural and agro-ecosystems, the services of pollinators become pivotal. Even in cultivated fields, where maximum numbers of crops rely on insect pollination. Research conducted by many scientists demonstrates that honey bee pollination boosts not only the fruit set but also enhances fruit quality, and reduces fruit drop in apple, peach, plum, citrus, kiwi, and strawberry [6,7,13]. Moreover, bee pollination has been associated with increased fruit juice and sugar content in citrus fruits, while in strawberries, there was reduction in the numbers of fruits having change in shape [13,14].

Bees as Pollinator

In India, there are four important species of honey bees i.*e Apis cerana, A. dorsata, A. florae* and *A. andreniformes* which act as important pollinators in numbers of agricultural and fruits crops. Among these, *Apis cerana* also called as the Indian hive bee and rock bee, *Apis dorsata.* are predominant. The primary economic function of honeybees in natural ecosystems is to facilitate the pollination of flowering plants, ensuring the quantity and quality of seed production. Flowering plants and honeybees share a symbiotic relationship, essential for their respective biological processes and life cycles. *Apis mellifera,* commonly known as the Western honeybee, holds a dominant position in commercial pollination worldwide due to its highly social nature. However, wild bee species also play a crucial role as pollinators. Unfortunately, their contribution has often been underestimated, partly due to our limited understanding of their nesting behaviours. Another factor is our heavy reliance on the easily managed honeybee, which not only facilitates pollination but also provides valuable by products. Nevertheless, modern beekeeping faces numerous challenges, including infestations by parasitic mites, diseases affecting honeybee populations, and their limited ability to function in low temperatures and adverse climatic conditions (Torchio, 1990). These obstacles jeopardize the honeybee's efficacy as an agricultural pollinator, raising concerns among beekeepers, crop growers, and policymakers. The phenomenon of Colony Collapse Disorder (CCD) exemplifies the widespread decline in honeybee populations in recent years.

In addressing these challenges, it's essential to recognize the complementary role of wild and domesticated non-Apis bees in agricultural pollination. Various species, such as bumblebees for greenhouse tomato pollination, solitary bees like Nomia and Osmia for orchard crops, Megachile for alfalfa pollination, and social stingless bees for coffee and other crops, are managed effectively to enhance crop pollination. This diversified approach to pollination management not only mitigates the risks associated with honeybee decline but also contributes to the resilience and sustainability of agricultural ecosystems [18]. clearly demonstrated the superior pollination efficiency of the alfalfa leaf-cutting bee, *Megachile rotunda* (F.), compared to honeybees for alfalfa cultivation. He observed a significant increase in alfalfa seed yield, from 50 kg/ha to 350 kg/ha, with the introduction of Megachile bees. Through more careful handling, this yield could potentially be further raised to 1000 kg/ha.

It's interesting to note that honeybees, or *Apis mellifera,* are not native to North America; instead, they were brought for agricultural purposes from Africa, eastern Europe, or western Europe. While most North American honeybee colonies are maintained for pollination, others may roam the wild in quest of new places to build hives. When these controlled bees start colonies in the wild, they are categorized as feral. Consequently, agricultural studies typically compare commercial honeybees with other native species rather than their feral counterparts. Because there is a dearth of scientific information about honey bees, debates about their behavior and preferences tend to focus on managed colonies. According to [4], honeybees and bumblebees are expected to play an important role in pollination in the UK, both for glasshouse crops like tomatoes and sweet peppers and outdoor crops like rape, beans, tree fruit, and soft fruit.

Bumblebees, prevalent in the Northeast, are among the largest bee species in the region, varying from medium to very large in size. Their distinguishing feature is their full coverage in hair, setting them apart from other large bee species like carpenter bees [11]. Sporting distinct fuzzy black and yellow striped patterns, they primarily inhabit cooler climates across North America and Europe [11]. However, bumblebees face various challenges, including diseases, parasites, and predators such as mice, skunks, badgers, birds, as well as human-induced issues like pesticide use and habitat destruction. To enhance their beneficial presence, growers or communities can take proactive measures. Providing suitable nesting sites and areas conducive to their habitat can encourage their presence. Controlling their predators and being cautious with herbicide and insecticide use are additional steps. Moreover, cultivating crops or promoting wildflowers can offer them foraging opportunities during periods of food scarcity.

Osmia bees, like *Osmia cornifrons*, can be managed to pollinate crops effectively [3]. reviewed Osmia pollination methods, noting the successful apple pollination management in northern and central Honshu, Japan, since 1958. Growers capture the bees away from treated fields, transporting them to orchards during apple bloom. They start flying about two weeks before apple bloom, enduring temperatures as low as 45 degrees F, 20 degrees lower than honeybees flight threshold [10]. successfully induced *Osmia lignaria* to nest in specially prepared tubes and rearing them less efficiently on bee-collected pollen compared to Osmia-collected pollen. *Meliponula beccarii* (“Damuu”) is a notable species in Ethiopia, living in perennial colonies by constructing nests underground. These nests serve as breeding grounds and storage for honey and pollen materials [16].

Mass Multiplication and Conservation of Bees

The successful mass propagation and conservation of honeybee colonies hinge upon understanding the genetic diversity within bee populations and their capacity to adapt to various regional environmental factors, such as climate, vegetation, prevalent diseases, and other locally significant aspects [2]. Proposed several measures to bolster wild bee populations, particularly in the eastern half of the United States:

- Clearing forested areas to create more hospitable conditions for bees.
- Constructing highways, which can concentrate moisture along road verges, providing favourable habitats for bees.
- Introducing "weeds" that serve as foraging resources for bees.
- Cultivating diverse crops that offer ample foraging opportunities for bees.
- Stimulating blooming in desert regions through irrigation, thus expanding foraging options for wild bees.

Furthermore, efforts are made to establish and safeguard plantings that serve as foraging or nesting sites for wild bees, shielding them from potential threats such as fires, floods, overgrazing, or exposure to insecticides. However, our understanding of effectively managing the global scientific community has prioritized the conservation of pollinators like the honeybee, emphasizing the importance of species conservation planning and a comprehensive understanding of the phylogenetic relationships among these species [5,8]. This focus on conservation is driven by the desire to preserve biodiversity in its broadest sense. Several crucial factors must be taken into account and given careful attention in order to maintain, define and use pollinator genetic resources effectively:

a. Characterization of indigenous Indian honeybee species, such as *Apis cerana*, across various ecological regions of the country. This involves studying their genetic diversity, behaviour, and ecological preferences. Furthermore, breeding and mass queen raising of enhanced stock of the European honey bee species, *A. mellifera* and *A. cerana*, should be prioritized.
b. Understanding the diversity and characteristics of non-Apis species, such as *Trigona iridipennis* and other native bee species. This entails studying their biology, behaviour, and ecological roles to assess their potential contributions to pollination and ecosystem health.

c. Conducting genomic studies on native honeybee species and leveraging information from sequenced genomes for trait improvement is essential. By analysing the genetic makeup of these species, researchers can identify genes associated with desirable traits and use this knowledge to enhance breeding programs and develop superior bee strains.
d. Identifying favourable traits in *A. cerana*, such as pest and disease resistance, high honey yield, efficient brood rearing, hygienic behaviour, reduced swarming, gentleness, and effective long-distance foraging, is crucial. These traits can be sourced from diverse populations across different regions of the country to create resilient and productive bee colonies.
e. Enhancing the genetic quality of *A. cerana* by combining multiple positive traits can lead to increased bee product yields, including honey, wax, propolis, pollen, royal jelly and bee venom. Moreover, improving their pollination efficiency in various agroecosystems can significantly benefit crop production.
f. A thorough understanding of the genetic, biochemical, physiological, molecular, and morphological factors driving desirable features in honeybees is essential.This knowledge forms the basis for breeding programs aimed at improving bee stocks and enhancing their performance in pollination and hive product production.
g. Developing molecular markers to assess honeybee diversity and identify desirable traits such as disease resistance and pollination efficiency can facilitate targeted breeding efforts and conservation initiatives.

By addressing these aspects, researchers and conservationists can make informed decisions and implement effective strategies to conserve and sustainably utilize pollinator genetic resources.

Relying solely on a few intensively managed honeybee species may pose challenges in managing pollination services effectively. A diverse community of functionally distinct pollinator species offers greater benefits. Research has shown that higher pollinator diversity leads to improved pollination outcomes, highlighting the importance of conserving functional diversity and maintaining biodiversity in agricultural landscapes [1]. Developed procedures for observing the behaviour and social organisation of stingless bees using a customised hive. Pollination should not be viewed as a free ecological service but rather recognized as a resource that demands investment in terms of food, shelter, and ecological support for pollinators [19]. worked on the approaches employing a specific hive to observe stingless bee behaviour and social organisation.

It is crucial to reassess agricultural strategies such as clean cultivation, multiple cropping, farming systems, and forest conservation to better support pollinator populations and enhance crop production while conserving biodiversity. Addressing these challenges requires renewed efforts in taxonomic and biological research to identify key native pollinator species and their roles in specific crop pollination across different regions. Reshaping strategies to prioritize pollination as an essential input for increasing crop productivity and conserving biodiversity is imperative.

CONCLUSION

Horticultural output depends mainly on pollination and one of the most important aspects of pollination is the species and population of bee pollinators in the farms. When the bees are unable to pollinate crops, no fruit or seeds will emerge and even if farmers use high-yielding varieties, high-quality seeds and effective agronomic techniques like timely irrigation and fertilization. To enhance the living conditions of marginalised communities, it is critical to study every alternative for increasing agricultural productivity under sustainable farming methods [12,15]. Insufficient pollination is mostly caused by the lack of insect pollinators, especially bees. The important role that native pollinators play in crop productivity and agricultural profitability is something that many farmers are ignorant of. Even though the loss of pollinator populations is a serious threat to agricultural productivity. Furthermore, a lot of growers are not aware of how much natural pollinators contribute to crop productivity and farm profitability. To address these challenges, extension personnel and researchers will need to actively participate in honeybee raising for crop pollination.

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