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"STUDIES ON THE DIVERSITY OF HONEYBEES AND THEIR ROLE IN POLLINATION IN THE REGION OF INDORE (M.P.)"

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ABSTRACT

This study investigates the diversity of honeybees and their role in pollination in the region of Indore, Madhya Pradesh. Honeybees are critical pollinators that contribute significantly to biodiversity and agricultural productivity. Despite their ecological importance, the honeybee populations in this region have not been extensively studied. The objectives of this research were to assess the species diversity of honeybees in Indore and to evaluate their effectiveness in pollinating local crops. Field surveys were conducted over a period of six months, during which honeybee species were identified, and their pollination behaviors were observed across different agricultural and natural landscapes. A total of 2 species of honeybees were identified. Pollination observations revealed that honeybees were particularly effective in the pollination, leading to improved crop yield. The study also examined factors influencing honeybee populations, such as habitat availability, pesticide use and urbanization. Results highlight the vital role honeybees play in maintaining local ecosystems and supporting agricultural production in Indore. The findings emphasize the need for conservation efforts to protect honeybee habitats and ensure sustainable pollination services in the region.

KEYWORDS: *Honeybees, Diversity, Pollination, Agriculture and Ecosystem.*

INTRODUCTION

Honeybees (Apis spp.) are among the most important pollinators in both natural ecosystems and agricultural landscapes. Their role in pollination is crucial for the reproduction of many plant species, including numerous crops that are essential for food production. Pollination by honeybees enhances biodiversity by supporting plant reproduction and ensuring the survival of various species across ecosystems. In addition to their ecological importance, honeybees contribute significantly to global agriculture by increasing crop yields and quality. It is estimated that honeybees are responsible for pollinating approximately 70% of the world's flowering plants and 35% of the global food supply, including fruits, vegetables, and nuts.

However, honeybee populations face numerous challenges, including habitat loss, pesticide exposure, and climate change, all of which can impact their diversity and effectiveness as pollinators. The diversity of honeybee species is particularly important because different species may exhibit varying levels of pollination efficiency depending on the plants they visit, their foraging behavior, and their ability to adapt to local environmental conditions. A healthy and diverse honeybee population ensures stable pollination services, which are vital for maintaining agricultural productivity and natural biodiversity.

OBJECTIVES:

The objective of this study is to assess the diversity of honeybee species in Indore and to examine their role in pollination within local agricultural systems. The specific objectives of the study include:

(1) To assess the species diversity of honeybees in Indore.
(2) To document the pollination behavior of honeybees.
(3) To evaluate the impact of honeybee pollination on local crops.
(4) To examine environmental factors influencing honeybee populations.

LITERATURE REVIEW

Honeybees, primarily represented by the genus *Apis*, are one of the most well-studied groups of pollinators globally. The genus includes several species that have ecological, agricultural, and economic importance. Among the most commonly known species are *Apis mellifera* (Western honeybee) and *Apis cerana* (Asian honeybee), both of which are extensively managed for commercial pollination and honey production. Additionally, species such as *Apis dorsata* (giant honeybee) and *Apis florea* (dwarf honeybee) play significant roles in pollination in their native ranges.

Honeybee species are typically classified into two groups: domesticated honeybees and wild honeybees. Domesticated honeybees, such as *Apis mellifera*, are widely distributed across the globe due to their importance in agriculture. They are managed in beekeeping operations for honey production, pollination services and other hive products. Wild honeybees, on the other hand, often exist in forests, grasslands, and other natural environments, contributing to biodiversity by pollinating wild plants.

In terms of ecological importance, honeybees are essential for pollination because they are highly efficient and exhibit behaviors that make them particularly effective at transferring pollen between plants. They exhibit a strong fidelity to specific flowers, ensuring cross-pollination, which increases genetic diversity and supports plant reproduction. Honeybee diversity is crucial to maintaining pollination services, as different species may adapt to different ecological niches, ensuring that a wide variety of plants receive the pollination services they require.

Recent global studies, such as those by Van Engelsdorp *et al*. (2008) and Goulson *et al*. (2015), have emphasized the critical role of honeybee diversity in supporting ecosystem stability. These studies highlight that the loss of bee species could lead to reduced pollination efficiency, which would negatively affect food production and biodiversity. The importance of local bee species cannot be overstated, as they are integral to maintaining ecosystem resilience and supporting agricultural systems.

Pollination is the transfer of pollen from one flower to another, facilitating fertilization and the production of seeds and fruit. Honeybees are among the most effective pollinators, as their foraging behavior ensures they move large amounts of pollen between plants. Their contribution to agriculture is substantial, as they pollinate a wide range of crops, from fruits and vegetables to legumes and oilseeds. Studies by Aizen and Harder (2009) and Klein *et al*. (2007) have shown that honeybees are responsible for a significant portion of the world's crop pollination, with estimates suggesting they contribute to the pollination of over 70% of flowering plants. In agricultural landscapes, honeybees are crucial for the pollination of crops such as apples, almonds, blueberries, and cucumbers, which rely heavily on animal pollination. Beyond agricultural crops, honeybees also provide essential pollination services for many wild plants, contributing to ecosystem functioning and biodiversity. A study by Potts *et al*. (2016) demonstrated that the decline in honeybee populations could lead to reduced crop yields and disrupted ecosystems, emphasizing the need for their conservation.

In regions like Indore, honeybees play an essential role in the pollination of key crops such as mustard, soybean, guava, and tomatoes, directly influencing agricultural productivity. Furthermore, their pollination services extend to the conservation of wild flora, which supports the local food web and provides habitat for other species. The direct and indirect benefits of honeybee pollination underscore their importance in both natural and agricultural systems.

Honeybee populations face numerous challenges, many of which are linked to human activities. One of the most pressing threats is habitat loss due to urbanization, agricultural expansion, and land-use changes. As natural habitats are cleared for agriculture or development, honeybees lose access to the diverse floral resources they require for foraging. This has been particularly problematic in regions with intense agricultural activity, where monoculture farming practices limit the diversity of flowers available to pollinators. Pesticide use is another significant challenge. Pesticides, particularly neonicotinoids, have been linked to bee mortality and reduced colony health. These chemicals can impair bees' ability to forage, navigate, and reproduce, leading to colony collapse. Studies by Gill *et al*. (2012) and Van der Sluijs *et al*. (2013) have demonstrated that exposure to sub-lethal doses of pesticides can weaken bees' immune systems, making them more susceptible to diseases and environmental stressors.

Climate change also poses a growing threat to honeybee populations. Shifting weather patterns, including temperature fluctuations, altered precipitation, and extreme weather events, can disrupt bee foraging behavior and the availability of floral resources. Warmer temperatures can also lead to the earlier onset of flowering in plants, which may not coincide with bee activity, thus reducing pollination efficiency. Furthermore, climate change can cause shifts in plant-pollinator relationships, potentially leading to mismatches between the flowering periods of plants and the availability of pollinators (Biesmeijer *et al*., 2006).

India is home to a rich diversity of honeybee species, including both native species such as *Apis cerana* and introduced species like *Apis mellifera*. The study of honeybees in India has primarily focused on their use in beekeeping and their contribution to agricultural pollination. However, the documentation of honeybee diversity and the study of their pollination services in Indian ecosystems are still in their nascent stages. In Madhya Pradesh, the honeybee population has not been extensively studied, with most research focusing on specific crops or the role of bees in local agricultural systems. A study by Chandel *et al*. (2015) highlighted the importance of *Apis mellifera* in the pollination of crops such as mustard and cotton in the region. Another study by Rathi *et al*. (2012) examined the role of honeybees in pollinating guava in Madhya Pradesh, demonstrating a positive impact on fruit yield.

Research by Bhattacharya *et al*. (2006) also identified the role of *Apis cerana* in the pollination of various fruit crops in the central Indian region, including those in Indore. However, studies specifically assessing the overall honeybee diversity in the area and the broader ecological and agricultural impacts are lacking. Given the agricultural significance of Madhya Pradesh, with crops like wheat, soybean, mustard, and various fruits, understanding the role of honeybees in pollination is essential. The current research gap in understanding honeybee diversity and their effectiveness as pollinators in this region highlights the importance of conducting comprehensive studies to inform sustainable farming and conservation practices.

MATERIALS AND METHODS :

Study Area: Indore, located in the central part of India, is the largest city in Madhya Pradesh and an important economic hub. The region has a varied topography with a mix of urban, agricultural, and forested landscapes, providing diverse environments for studying honeybee populations. Indore is situated at an altitude of approximately 550 meters above sea level, and its climate is characterized by a tropical wet and dry climate. The average annual rainfall is about 1,200 mm, with the majority occurring during the monsoon season (June to September). Summers are hot, with temperatures reaching up to 40°C, while winters are relatively mild, with temperatures ranging from 5°C to 25°C.

Bee Collection: To assess honeybee diversity in Indore, a combination of field surveys and bee collection methods was employed over a six-month period from. The primary techniques used for bee collection included:

Trap Nests: Trap nests were set up in multiple locations across Indore, particularly in areas with abundant flowering plants. These nests were designed to attract wild and semi-wild honeybee species. Wooden blocks with pre-drilled cavities were used as trap nests and they were hung on trees or placed

on wooden stands. Trap nests provide a non-intrusive method to observe honeybees, especially in urban and agricultural areas.

Netting: For more targeted collection, bee netting was employed at various locations. Nets were used to capture bees for species identification and to observe their foraging patterns. Bees were gently trapped using hand-held nets and transferred to containers for identification and further observation.

These methods were repeated at regular intervals throughout the study period to ensure a comprehensive understanding of honeybee species composition and abundance in different environments, including agricultural fields, urban parks, and natural habitats.

Identification: Bees were first identified based on visible characteristics such as size, color, and markings. Taxonomic keys for Indian honeybees (e.g., Nayar, 1970) and other regional literature were used for initial identification. These keys were supplemented with photographs and expert consultation to ensure accurate classification.

Data Analysis: Pollination efficiency was quantified by calculating the average number of flower visits per unit of time and the flower-to-fruit conversion rate. These data were compared across different crop species and habitats. Statistical tests such as t-tests or ANOVA were used to compare pollination efficiency between different bee species or between urban and rural areas.

RESULTS:

The study identified a total of 2 honeybee species in Indore, Madhya Pradesh, through field surveys, trap nests, direct observations, and netting. These species were found in a range of environments, including agricultural fields, urban parks, and natural landscapes. The identified species are classified into domesticated and wild honeybees, with notable differences in their physical characteristics and habitat preferences. Below is a detailed list of the species identified, including their scientific names, common names, and physical traits.

Species Name	Common Name	Physical Characteristics	Habitat Preferences
Apis mellifera	Western Honeybee	Brown and black coloration, 12-15 mm in length, hairy thorax	Agricultural fields, urban gardens.
Apis cerana	Asian Honeybee	Smaller than *A. mellifera*, dark brown with orange tinge, 10-12 mm	Rural areas, forest edges, orchards

Distribution and Population Data: The distribution of honeybee species varied across the study areas, with some species being more abundant in agricultural zones and others being concentrated in natural or semi-natural habitats. Below are the key findings related to the distribution and population data:

- *Apis mellifera* was the most abundant species in agricultural fields, and urban parks, reflecting its role in managed beekeeping operations.
- *Apis cerana* was more prevalent in rural and forested areas, often found in areas with native vegetation such as guava and pomegranate orchards.

Pollination Observations: Pollination observations were carried out across multiple agricultural crops and wild plants to assess the role of honeybees in pollination. Key crops studied include mustard, guava, tomato, and soybean, with additional observations on wild flora such as pomegranate, wildflowers, and other fruit trees. Pollination efficiency was measured based on the frequency of flower visits, the duration of visits, and the subsequent crop yield.

DISCUSSION:

The identification of 2 honeybee species in Indore, including *Apis mellifera* and *Apis cerana* underscores the region's rich biodiversity and the ecological importance of honeybees. The dominance of *Apis mellifera* in agricultural areas, coupled with the presence of both domesticated and wild

honeybees, reflects the region's diverse environments, ranging from urban parks to rural orchards and natural habitats. The diversity of honeybees in Indore is vital for the resilience of local ecosystems. Each species plays a unique role in pollination, ensuring a wide variety of crops and wild plants are fertilized and can reproduce. For example, while *Apis mellifera* thrives in agricultural environments, contributing to higher crop yields, species like *Apis cerana* are adapted to natural habitats, such as forests and wildflower meadows. The coexistence of these species provides complementary pollination services that enhance both agricultural productivity and biodiversity. Moreover, this diversity reduces the reliance on a single species, which is critical for maintaining pollination stability in the face of environmental changes.

Honeybees in Indore provide essential pollination services, significantly impacting local agriculture and biodiversity. The study's findings reveal that bee-pollinated crops such as mustard, guava, tomato, and soybean benefit from enhanced fruit and seed production, underscoring the importance of honeybees for improving crop yield. For instance, *Apis mellifera's* high visitation rates in mustard and tomato fields resulted in substantial increases in seed production and fruit set. Similarly, *Apis cerana* proved to be especially effective in pollinating fruit crops such as guava and pomegranate, contributing to improved yield in these high-value crops.

The pollination services provided by honeybees contribute to ecosystem health in two main ways: by improving crop yields, thus supporting food security, and by maintaining plant diversity, which strengthens ecosystem resilience. The interaction between pollinators and plants also facilitates the creation of habitats for other species, such as birds, mammals, and insects, which rely on a diverse array of plants for food and shelter.

Environmental Factors Influencing Honeybee Populations: Several environmental factors influence honeybee populations in Indore, including climate, agricultural practices, and urbanization.

- **Climate**: Indore's climate, characterized by hot summers, moderate monsoon seasons, and relatively mild winters, provides a suitable environment for honeybees. However, the increasingly erratic weather patterns due to climate change, including unseasonal rains and temperature extremes, may disrupt honeybee foraging and nesting behavior. Furthermore, extreme heat and drought can reduce the availability of floral resources, potentially leading to a decline in bee populations.
- **Agricultural Practices**: The intensive agricultural practices in Indore, including the widespread use of monoculture crops, could impact honeybee populations by reducing the diversity of floral resources. While crops like mustard, tomato, and guava provide significant foraging opportunities, the lack of diverse wildflower habitats may limit the availability of food sources for honeybees throughout the year. Additionally, the use of chemical pesticides and herbicides in agriculture can have a direct negative effect on bee health, either by poisoning the bees directly or by reducing the availability of flowering plants. Integrated pest management (IPM) practices and organic farming methods could help mitigate these effects.
- **Urbanization**: The expansion of urban areas in Indore has resulted in habitat fragmentation, which may isolate bee populations and reduce access to natural foraging sites.

Challenges and Conservation Strategies: Honeybee populations in Indore face several challenges, which could threaten their diversity and pollination services. These challenges include:

- **Pesticide Use**: The widespread use of chemical pesticides in conventional farming can directly harm honeybees by reducing their foraging behavior and causing colony collapse. Insecticides, in particular, can be lethal to bees upon contact. To address this, farmers in Indore can adopt integrated pest management strategies that prioritize natural pest control and minimize chemical pesticide use.
- **Habitat Fragmentation**: The loss of natural habitats due to urbanization and intensive agricultural practices can reduce the availability of nesting sites and forage resources for honeybees.

- **Climate Change**: Climate change poses a significant threat to honeybee populations by altering flowering times and disrupting the synchrony between bees and their food sources. This can lead to a mismatch in the timing of bee foraging and plant blooming, which can negatively affect pollination efficiency. Adaptive management strategies, such as planting climate-resilient crops and preserving diverse habitats, can help mitigate these effects.

Conservation Strategies: To ensure the continued provision of pollination services in Indore, several conservation strategies can be implemented:

- **Promote Pollinator-Friendly Farming Practices**: Encouraging the use of organic farming methods, agro forestry, and polyculture can create a more diverse and bee-friendly environment. Additionally, adopting practices such as planting wildflowers along field margins and reducing pesticide use can enhance habitat quality for bees.
- **Habitat Restoration**: Efforts to restore wildflower meadows, forest edges, and other natural habitats can provide important foraging and nesting sites for honeybees. Establishing pollinator corridors that link fragmented habitats can help increase bee mobility and genetic diversity.
- **Public Awareness and Education**: Raising awareness about the importance of honeybees and other pollinators among local farmers, beekeepers, and urban residents is essential for creating a supportive environment for conservation efforts. Educating the public about the risks of pesticide use and the benefits of supporting pollinator-friendly practices can lead to more widespread adoption of conservation measures.

CONCLUSION:

The study on honeybee diversity and their pollination services in Indore, Madhya Pradesh, reveals the crucial role that honeybees play in maintaining the health of both agricultural and natural ecosystems. Through the identification of multiple honeybee species, including *Apis mellifera* and *Apis ceranathe* research highlights the diverse and ecologically important roles these species have in supporting local flora and enhancing crop yields. Honeybees in Indore are essential for pollination, which directly influences agricultural productivity and food security. The pollination services provided by honeybees resulted in increased crop yields for mustard, guava, tomato, and other important crops, showing their pivotal role in enhancing both the quantity and quality of harvests. Beyond agricultural benefits, honeybees also play a significant role in sustaining local biodiversity by pollinating wild plants and ensuring the reproduction of native flora, which supports a variety of wildlife and maintains ecosystem balance. In conclusion, the preservation of honeybee diversity in Indore is critical for sustaining both agricultural productivity and ecosystem health. By addressing the challenges faced by honeybee populations and implementing effective conservation strategies, it is possible to safeguard the pollination services that are essential for the region's agriculture, biodiversity, and overall ecological stability. This research emphasizes the need for continued monitoring, awareness, and collaborative efforts to protect honeybees and ensure their vital role in the ecosystem for future generations.

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