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Bee pollinators diversity of agroecosystem from Khultabad Taluka of Chhatrapati Sambhajinagar (Aurangabad) District, (M.S.), India

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Abstract
The current study aimed to document the bee pollinators diversity of agroecosystem in the Khultabad Taluka of Chhatrapati Sambhajinagar (Aurangabad) District. Study conducted between June 2022 to May 2023. A total of 23 bee species from 13 genera and 3 families were identified during the study. The family Apidae was the most represented, with notable species such as *Apis dorsata*, *Apis cerana*, *Apis florea* and managed bee species *Apis mellifera*. Other significant families included Megachilidae and Halictidae, with species such as *Megachile lanata*, *Nomia incerta*, and *Lasioglossum albescens*. The study highlights the rich diversity of bee pollinators in the region, which play a vital role in the pollination of local flora, contributing to the ecological balance and agricultural productivity of the area.

Keywords: Bee pollinators, honey bee, diversity, agroecosystem

Introduction
Bees are among the most critical pollinators in agricultural and natural ecosystems, facilitating the reproduction of many flowering plants, which in turn supports biodiversity and food security (Klein *et al*., 2007) [1]. The role of bees in pollination is vital for both ecological balance and agricultural productivity, with studies indicating that more than 75% of global food crops depend on animal pollination (Ollerton *et al*., 2011) [2]. As such, understanding the diversity and distribution of bee species within a given region is crucial for preserving ecosystem functions and ensuring sustainable agriculture.

The Khultabad Taluka of Chhatrapati Sambhajinagar (Aurangabad) District in Maharashtra, India, is known for its rich flora, which provides ample foraging resources for various bee species. In particular, the diversity of bee pollinators in this region can be attributed to the wide range of plant species, including cultivated and wild flora, that offer both nectar and pollen throughout the year. A diverse pollinator population is essential for effective pollination, as different bee species vary in their foraging behaviour, preferences, and efficiency (Garibaldi *et al*., 2013) [3].

Previous research has shown that areas with a rich diversity of bee species tend to have healthier ecosystems and higher crop yields (Goulson *et al*., 2015) [4]. In India, studies on bee diversity have emphasized the importance of conserving native bee populations, such as *Apis cerana* and *Megachile spp.*, which play a key role in maintaining agricultural productivity and biodiversity (Sihag, 2001; Partap & Verma, 2010) [5, 6]. However, habitat degradation and changes in land use patterns pose significant threats to pollinator populations worldwide, including in India (Potts *et al*., 2010) [7].

This study aims to document the diversity of bee pollinators in Khultabad Taluka over the course of a year (June 2022 to May 2023). By identifying the major bee species and understanding their distribution, this research seeks to contribute to the conservation of pollinators and support sustainable beekeeping practices in the region.

Materials and Methods
Study Area
The study was conducted in Khultabad Taluka, Aurangabad District, Maharashtra, from June 2022 to May 2023, Khultabad is situated at 20.05°N latitude and 75.18°E longitude.

Covering a diverse range of habitats, including agricultural fields and natural vegetation. The region's tropical climate provided seasonal variations in floral resources and pollinator activity.

Collection of Pollinator Bee Visitors

The documentation of bee visitors was conducted in agricultural fields every month in twice peak period of flowering visit to all study sites was made between the hours of 07:00–18:00 in the winter and monsoon and 07:00–18:30 in the summer. The study area was divided into four stations, Khultabad, Bajarsawangi, Sultanpur and Verul, where bee visitors on flowers were systematically collected using sweep insect nets. Collected bees were transferred to killing bottles for euthanization and preservation. Larger bees with a significant wing span were pinned and dry-preserved in insect boxes. In contrast, smaller bees were preserved in 70% alcohol for further analysis.

Identification of Specimen

Bees collected from each sampling plot were identified to the lowest possible taxonomic level, either species or genus, utilizing morphological keys and expert consultation. Detailed morphological characteristics were examined using reference works such as "The Bees of the World" by Michener (2007) [12] and published research article to ensure accurate identification. Expert taxonomists were consulted to confirm identifications, particularly for challenging specimens.

Results and Discussion

The study identified a total of 23 bee species across 13 genera and three families (Apidae, Megachilidae, Halictidae) in the Khultabad Taluka of Chhatrapati Sambhajinagar (Aurangabad) District from June 2022 to May 2023. Notable Four honeybee species include *Apis dorsata* (Fabricius, 1793), *A. florea* (Fabricius, 1787), *Apis mellifera* (Linnaeus, 1758, *Apis cerana indica* (Fabricius, 1798), and other Six Apidae species recorded *Amegilla thorogoodi* (Rayment, 1939), *Bombus fervidus* (Fabricius, 1798), *Tetragonulla bengalensis* (Cameron, 1897), *Ceratina binghami* (Cockerell, 1908), *Ceratina flavipes* (Smith, 1879) *and Nomada goodeniana* (Kirby 1802). Family Halictidae Seven species namely *Pseudapis diversipes* (Latreille, 1806), *Nomia incerta* (Gribodo, 1894), *Nomia westwoodi* (Gribodo, 1894), *Nomia crassipes* (Fabricius, 1789), *Nomia curvipes* (Fabricius, 1793), *Lasioglossum albescens* (Smith, 1853) and *Lipotriches flavoviridis* (Cockerell, 1905). Family Megachilidae Six species recorded *viz*. *Megachile lanata* (Fabricius, 1775), *Megachile nigriventris* (Schenck, 1870), *Megachile anthracina* (Smith, 1853), *Megachile melanophaea* (Smith, 1853), *Anthidium cingulatum* (Latreille, 1809) and *Coelioxys decipiens* (Spinola, 1838). These species represent a significant portion of the pollinators in the region, with the Apidae family being the most dominant, followed by Megachilidae and Halictidae. The species diversity is consistent across the Khultabad regions. In details showing the table no.1. Several researchers have also conducted similar investigations. According to Waykar and Baviskar, 22 bee species reported in Paithan taluka (M. S.) and these are observed Apidae family are dominant pollinators in these regions. Saini J. *et al*., diversity of bees recorded 49 species in Arunachal Pradesh. Rahman A. *et al*., these are 6 different species of stingless bees in India, but these are not found *Tetragonula bengalensis* species in Maharashtra. Satpute et. al., it was found in honeybee are dominant species in Warud tahsil Amravati (M. S.).

Table 1: Bee pollinators diversity of agricultural field from Khultabad region during study period June 2022 to May 2023.

Sr. No.	Name of Species	Family	Order
1	*Apis dorsata* (Fabricius, 1793)	Apidae	Hymenoptera
2	*Apis mellifera* (Linnaeus, 1758)	Apidae	Hymenoptera
3	*Apis cerana indica* (Fabricius, 1798)	Apidae	Hymenoptera
4	*Apis florea* (Fabricius, 1787)	Apidae	Hymenoptera
5	*Amegilla thorogoodi* (Rayment, 1939)	Apidae	Hymenoptera
6	*Bombus fervidus* (Fabricius, 1798)	Apidae	Hymenoptera
7	*Tetragonula bengalensis* (Cameron, 1897)	Apidae	Hymenoptera
8	*Ceratina binghami* (Cockerell, 1908)	Apidae	Hymenoptera
9	*Ceratina flavipes* (Smith, 1879)	Apidae	Hymenoptera
10	*Nomada goodeniana* (Kirby 1802)	Apidae	Hymenoptera
11	*Pseudapis diversipes* (Latreille, 1806)	Halictidae	Hymenoptera
12	*Nomia incerta* (Gribodo, 1894)	Halictidae	Hymenoptera
13	*Nomia westwoodi* (Gribodo, 1894)	Halictidae	Hymenoptera
14	*Nomia crassipes* (Fabricius, 1789)	Halictidae	Hymenoptera
15	*Nomia curvipes* (Fabricius, 1793)	Halictidae	Hymenoptera
16	*Lasioglossum albescens* (Smith, 1853)	Halictidae	Hymenoptera
17	*Lipotriches flavoviridis* (Cockerell, 1905)	Halictidae	Hymenoptera
18	*Megachile lanata* (Fabricius, 1775)	Megachilidae	Hymenoptera
19	*Megachile nigriventris* (Schenck, 1870)	Megachilidae	Hymenoptera
20	*Megachile anthracina* (Smith, 1853)	Megachilidae	Hymenoptera
21	*Megachile melanophaea* (Smith, 1853)	Megachilidae	Hymenoptera
22	*Anthidium cingulatum* (Latreille, 1809)	Megachilidae	Hymenoptera
23	*Coelioxys decipiens* (Spinola, 1838)	Megachilidae	Hymenoptera

Pollinator Diversity and Ecosystem Health

The moderate diversity of bee species in Khultabad Taluka highlights the region's potential for supporting diverse pollinator communities. The dominance of Apidae, particularly *Apis* species, aligns with their known importance in both natural and agricultural ecosystems as efficient pollinators. The presence of species from the Megachilidae and Halictidae families further enhances the ecological stability of the region, as these bees contribute to the pollination of different plant species.

Seasonal and Regional Variation

The consistency in species richness across seasons indicates that the region's floral resources are available throughout the year, although some seasonal shifts in species abundance were observed. Winter and Summer seasons showed slightly higher species richness and abundance, likely due to the flowering patterns of key forage plants during these periods. The lower species richness in Monsoon could be attributed to the reduced availability of certain floral resources during the rainy season.

Implications for Conservation and Agriculture

The high correlation between regions in species abundance suggests a relatively uniform distribution of bee species across Khultabad, Bajarsawangi, Sultanpur, and Verul, which could be beneficial for agricultural pollination services. However, the moderate diversity indices suggest that further efforts to conserve floral habitats could enhance pollinator diversity, particularly in areas with lower species evenness.

Conservation efforts should focus on maintaining the diverse floral resources that sustain bee populations year-round. Preserving native plants and minimizing habitat destruction are critical to ensuring the continued availability of forage resources for pollinators. Additionally, the results of this study could be used to inform local farmers and beekeepers about the importance of maintaining diverse habitats to support both wild and managed bee populations, thereby improving crop yields and ecosystem health.

Conclusion

The study in Khultabad Taluka identified 23 bee species from three families, with the Apidae family being the major dominant. Species richness remained consistent across regions and seasons, indicating stable pollinator populations. While the diversity indices suggest moderate diversity, the need for conservation efforts remains important to support the local bee populations and ensure continued ecosystem health. Preserving diverse floral resources and habitats is essential for sustaining pollinators, which are critical for agriculture and biodiversity in the region.

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