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DIVERSITY, DISTRIBUTION AND MANAGEMENT OF HONEY BEE IN MAHARASHTRA, INDIA: A REVIEW

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Keywords	Abstract
<i>Honey bees,</i> <i>Maharashtra,</i> <i>Apiculture,</i> <i>Bee pests,</i> <i>Bee predators,</i> <i>Integrated Pest Management,</i> <i>Pollination,</i> <i>Apis cerana,</i> <i>Apis mellifera.</i>	Honey bees play a vital role in sustaining agricultural productivity, biodiversity conservation, and ecosystem stability through pollination services. In India, beekeeping has emerged as an important subsidiary occupation contributing to rural livelihoods, nutritional security, and agricultural development. Maharashtra possesses diverse agro-climatic regions ranging from the humid Konkan coast to the semi-arid Deccan plateau and forested areas of Vidarbha and the Western Ghats, making it highly suitable for apiculture. The state supports several honey bee species, including <i>Apis dorsata</i>, <i>Apis cerana indica</i>, <i>Apis florea</i>, <i>Apis mellifera</i>, and various stingless bees. However, honey production and colony survival are adversely affected by numerous pests and predators. Wax moths, <i>Varroa destructor</i>, <i>Tropilaelaps</i> mites, ants, termites, small hive beetles, hornets, wasps, bee-eater birds, spiders, reptiles, and mammals collectively reduce colony strength, brood survival, and honey yield. The diversity and distribution of these pests vary across different ecological zones of Maharashtra due to climatic conditions, vegetation, management practices, and seasonal changes. Effective management requires integrated approaches combining cultural, mechanical, biological, botanical, and chemical methods while minimizing adverse effects on bees and the environment. Although several studies have documented individual pests and predators, comprehensive reviews focusing on Maharashtra remain limited. This



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	review synthesizes available literature published up to 2018 regarding the diversity, geographical distribution, biology, damage symptoms, and management of honey bee pests and predators in Maharashtra. It also identifies research gaps and proposes future directions for strengthening sustainable apiculture through integrated pest management, improved surveillance, and region-specific management strategies.
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1. Introduction

Honey bees are among the most ecologically and economically important insects because of their indispensable role in pollination. Approximately one-third of global food production depends directly or indirectly on insect pollination, with honey bees contributing the largest share (*Roubik, 1989*). Besides increasing crop yields, pollination improves fruit quality, seed production, and biodiversity conservation. Consequently, honey bees are recognized as keystone species in both natural ecosystems and agricultural landscapes.

India has a long tradition of beekeeping dating back several centuries. Modern scientific apiculture gained momentum during the twentieth century through research institutions, agricultural universities, and government development programmes (*Morse & Calderone, 2000*). The country harbours rich honey bee diversity because of its varied climatic conditions, diverse floral resources, and extensive forest ecosystems. Indigenous species such as *Apis cerana indica*, *Apis dorsata*, *Apis florea*, and stingless bees coexist with the introduced European honey bee *Apis mellifera*, each contributing differently to honey production and pollination (*Oldroyd & Wongsiri, 2006*).

Maharashtra is among India's most agriculturally significant states, extending over approximately 307,700 km². The state encompasses diverse ecological regions, including the Konkan coastal belt, Western Ghats, Western Maharashtra plateau, Marathwada, Khandesh, and Vidarbha. Climatic conditions range from humid tropical environments to semi-arid regions, resulting in exceptional floral diversity throughout the year. Major nectar and pollen sources include mango (*Mangifera indica*), jamun (*Syzygium cumini*), neem (*Azadirachta indica*), eucalyptus (*Eucalyptus* spp.), sunflower (*Helianthus annuus*), mustard (*Brassica juncea*), pigeon pea (*Cajanus cajan*), sesame (*Sesamum indicum*), cotton (*Gossypium* spp.), niger (*Guizotia abyssinica*), and numerous forest species.

Beekeeping in Maharashtra has become an important supplementary livelihood activity, particularly in tribal and rural areas. Various government agencies, including the *Khadi and Village Industries Commission (KVIC)*, *National Bee Board (NBB)*, *ICAR institutes*, agricultural universities, and the Maharashtra State Khadi and Village Industries Board, have promoted scientific apiculture through training, subsidies, and extension programmes. The introduction of *Apis mellifera* further enhanced commercial honey production, especially in migratory beekeeping systems.



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Despite favourable ecological conditions, the apiculture industry faces several biological constraints. Honey bee colonies are vulnerable to numerous pests and predators that attack brood, adults, wax combs, honey stores, and pollen reserves. Colony losses caused by these organisms can significantly reduce productivity and economic returns.

Among the most destructive pests are parasitic mites such as *Varroa destructor*, *Varroa jacobsoni*, *Tropilaelaps clareae*, and *Acarapis woodi*. These parasites weaken colonies by feeding on brood and adult bees while facilitating viral transmission (Rosenkranz et al., 2010). Wax moths (*Galleria mellonella* and *Achroia grisella*) damage combs and stored equipment, especially in weak colonies (Ellis & Munn, 2005). Ants, termites, beetles, and other opportunistic pests further compromise colony health under poor management conditions.

Predators also pose considerable threats to apiaries. Hornets (*Vespa* spp.), wasps (*Vespula* spp.), bee-eater birds (*Merops* spp.), dragonflies, praying mantids, spiders, reptiles such as lizards and geckos, and mammals including bears and monkeys prey upon bees or destroy colonies. Their incidence varies with habitat, season, and surrounding vegetation (Abrol, 2010).

Maharashtra's varied agro-climatic conditions influence the occurrence and abundance of pests and predators. High humidity in the Konkan region favours wax moth infestation, whereas dry regions experience increased pressure from ants and predatory wasps. Forest ecosystems harbour larger populations of hornets and bee-eater birds, while commercial apiaries are more susceptible to parasitic mite infestations because of colony movement and high stocking densities.

The impact of honey bee pests extends beyond honey production. Reduced colony strength decreases pollination efficiency, affecting crop productivity and biodiversity. Global concern over declining pollinator populations has highlighted the need to understand multiple stressors influencing bee health, including pests, pathogens, pesticides, habitat degradation, and climate variability (FAO, 2018). Integrated pest management (IPM) has therefore become the preferred strategy for maintaining healthy colonies while minimizing chemical residues in hive products.

Although considerable information exists on honey bee pests in India, studies are often fragmented, species-specific, or regionally confined. Comprehensive reviews integrating pest diversity, predator distribution, ecological characteristics, and management practices specifically for Maharashtra are scarce. Such synthesis is necessary for researchers, extension workers, policymakers, and beekeepers to develop sustainable management programmes tailored to local agro-ecological conditions.

2. Diversity of Honey Bees in Maharashtra

2.1 Overview

Maharashtra supports a rich diversity of honey bees owing to its varied topography, climatic gradients, and floral resources. The state's ecosystems include tropical evergreen forests of the



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Western Ghats, dry deciduous forests, agricultural plains, orchards, scrublands, and coastal vegetation. These habitats sustain both wild and managed honey bee populations.

The principal honey bee species recorded in Maharashtra include:

Scientific Name	Common Name	Status
<i>Apis dorsata</i>	Giant honey bee	Wild
<i>Apis cerana indica</i>	Indian hive bee	Domesticated & Wild
<i>Apis florea</i>	Dwarf honey bee	Wild
<i>Apis mellifera</i>	European honey bee	Introduced & Managed
<i>Tetragonula iridipennis</i>	Stingless bee	Wild & Semi-managed

These species differ in nesting behaviour, colony size, honey yield, migration, disease susceptibility, and pollination efficiency.

2.2 *Apis dorsata* (Giant Honey Bee)

Apis dorsata is the largest indigenous honey bee species in Maharashtra. It constructs a single large exposed comb on tall trees, cliffs, water towers, and occasionally buildings. Colonies are migratory and move seasonally according to floral availability.

Apis dorsata, commonly known as the giant honey bee, is the largest indigenous honey bee species found in Maharashtra. It constructs a single large exposed comb on tall trees, rocky cliffs, water towers, and occasionally on buildings. This species is highly migratory, moving seasonally in response to the availability of nectar and pollen resources. In Maharashtra, *A. dorsata* is widely distributed across the Western Ghats, Konkan forests, Vidarbha forests, Satpura ranges, Melghat Tiger Reserve, Gadchiroli, Chandrapur, Nandurbar, and the forested regions of Nashik. These areas provide abundant floral resources and suitable nesting sites that support large wild populations of the species. Although *A. dorsata* is capable of producing substantial quantities of honey, its domestication has not been successful because of its aggressive defensive behaviour, open-nesting habit, and seasonal migratory nature, making colony management under conventional beekeeping practices extremely difficult (Oldroyd & Wongsiri, 2006). Despite these limitations, the species plays a crucial ecological role as an efficient pollinator of both agricultural and forest ecosystems. It significantly contributes to the pollination of economically important crops such as mango (*Mangifera indica*), jamun (*Syzygium cumini*), cotton (*Gossypium* spp.), sunflower (*Helianthus annuus*), and pigeon pea (*Cajanus cajan*), in addition to numerous forest tree species. Through its extensive foraging activity, *A. dorsata* enhances crop productivity, promotes natural forest regeneration, and helps maintain biodiversity across diverse agro-climatic regions of Maharashtra.



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2.3 *Apis cerana indica* (Indian Hive Bee)

Apis cerana indica, commonly known as the Indian hive bee, is the traditional domesticated honey bee species of India and is naturally distributed throughout Maharashtra. It is well adapted to the tropical and subtropical climatic conditions of the state and has been reared by beekeepers for centuries using traditional as well as modern wooden hive boxes. The species is widely distributed across major apicultural regions, including Pune, Satara, Kolhapur, Nashik, Ahmednagar, Jalgaon, Dhule, Nandurbar, Amravati, and Nagpur, where diverse floral resources support its growth and productivity. Owing to its adaptability, *A. cerana indica* performs well under varied agro-climatic conditions and is particularly suitable for small-scale and rural beekeeping enterprises. Compared with exotic honey bee species, it exhibits better adaptation to local environmental conditions, efficiently utilizes scattered and seasonal floral resources, requires relatively lower colony management and maintenance costs, and demonstrates greater tolerance to several pests and diseases prevalent in tropical regions. These characteristics make it a preferred species for sustainable beekeeping among rural and tribal communities. However, despite its ecological adaptability and resilience, *A. cerana indica* generally produces lower honey yields than the introduced European honey bee, *Apis mellifera*, limiting its commercial profitability in large-scale migratory beekeeping operations. Nevertheless, its significant contribution to crop pollination, conservation of native biodiversity, and support for sustainable agricultural production underscores its importance in Maharashtra's apiculture sector.

2.4 *Apis mellifera* (European Honey Bee)

Apis mellifera, commonly known as the European or Western honey bee, was introduced into India to enhance commercial honey production due to its larger colony size, higher honey yield, and superior pollination efficiency. Since its introduction, the species has gained considerable importance in organized apiculture, particularly under migratory beekeeping systems. In Maharashtra, the adoption of *A. mellifera* expanded significantly during the 1990s with the promotion of scientific beekeeping by government agencies, agricultural universities, and the National Bee Board. Commercial apiaries rearing this species are primarily concentrated in the districts of Nashik, Pune, Ahmednagar, Sangli, Solapur, Satara, Kolhapur, and Jalgaon, where abundant nectar-producing crops such as sunflower, mustard, eucalyptus, cotton, and various horticultural crops provide favourable foraging conditions. The species offers several advantages over indigenous honey bees, including high honey production, large and robust colonies, excellent pollination efficiency, and suitability for migratory beekeeping, enabling beekeepers to exploit seasonal floral resources across different regions. These characteristics have made *A. mellifera* the preferred species for commercial honey production and large-scale pollination services in Maharashtra. However, despite its superior productivity, *A. mellifera* is comparatively more susceptible to parasitic mites, particularly *Varroa destructor*, as well as several brood diseases, including American foulbrood and European foulbrood.



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Consequently, successful management of this species requires regular colony inspection, effective disease surveillance, and the adoption of integrated pest and disease management practices to maintain colony health and sustain commercial productivity (Rosenkranz et al., 2010; Abrol, 2010).

2.5 *Apis florea* (Dwarf Honey Bee)

Apis florea, commonly known as the dwarf honey bee, is one of the indigenous honey bee species widely distributed throughout the dry and semi-arid regions of Maharashtra. Unlike cavity-nesting honey bees, *A. florea* constructs a single small exposed comb suspended from thin branches of shrubs, bushes, and low-growing trees. The species is commonly found in the Marathwada, Vidarbha, and Khandesh regions, as well as in the dry deciduous forests of the state, where it thrives under warm climatic conditions and utilizes a wide range of wild and cultivated floral resources. Although *A. florea* produces relatively small quantities of honey and is not commercially managed, it plays a significant ecological role as an efficient pollinator of numerous agricultural and wild plant species. It contributes substantially to the pollination of vegetables, oilseed crops, pulses, fruit plants, and naturally occurring flowering vegetation, thereby supporting agricultural productivity and maintaining ecosystem biodiversity. Owing to its adaptability to harsh environmental conditions and its ability to forage on scattered floral resources, *A. florea* remains an important component of Maharashtra's native pollinator fauna (Hepburn & Radloff, 2011; Oldroyd & Wongsiri, 2006).

***Tetragonula iridipennis* (Stingless Bee)**

Tetragonula iridipennis, commonly referred to as the stingless bee, is a small indigenous bee species widely distributed in the tropical and subtropical regions of Maharashtra. Unlike species of the genus *Apis*, stingless bees possess a vestigial sting and are therefore harmless to humans, making them suitable for meliponiculture and pollination in residential and protected cultivation systems. Their colonies are typically established in natural cavities such as hollow tree trunks, rock crevices, wall cavities, and occasionally in artificial nest boxes. In Maharashtra, *T. iridipennis* is predominantly distributed in the Konkan region, the Western Ghats, Sindhudurg, Ratnagiri, Kolhapur, and the forested areas of Chandrapur, where humid climatic conditions and rich floral diversity favour colony establishment and survival. Although these bees produce comparatively small quantities of honey, their honey is highly valued for its medicinal properties and commands a premium market price. More importantly, *T. iridipennis* is recognized as an exceptionally efficient pollinator of horticultural, vegetable, spice, medicinal, and wild flowering plants. Their ability to forage under low light intensity, cloudy weather, and confined conditions makes them particularly valuable for pollinating greenhouse crops and enhancing fruit set in various horticultural species. Consequently, stingless bees contribute significantly to biodiversity conservation, sustainable agriculture, and the maintenance of healthy ecosystems in Maharashtra (Hepburn & Radloff, 2011; Abrol, 2010).



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2.7 Distribution Across Agro-climatic Zones

Agro-climatic Zone	Dominant Honey Bee Species
Konkan	<i>Apis dorsata</i> , <i>Apis cerana</i> , Stingless bees
Western Maharashtra	<i>Apis mellifera</i> , <i>Apis cerana</i>
Marathwada	<i>Apis florea</i> , <i>Apis cerana</i>
Vidarbha	<i>Apis dorsata</i> , <i>Apis florea</i> , <i>Apis mellifera</i>
Khandesh	<i>Apis mellifera</i> , <i>Apis cerana</i> , <i>Apis florea</i>
Forest regions	<i>Apis dorsata</i> , Stingless bees

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CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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