# Rock Bee Colony Detection & Monitoring System

**AI-AppX Open App-a-thon 2025**

**Cmrit In collaboration with GKVK (University of Agricultural Sciences, Bengaluru)**

This research document presents an extensive and in-depth analysis of the ecological, technological, and institutional aspects involved in the development of a centralized, AI-assisted system for monitoring rock bee colonies (Apis dorsata). The focus of this work is to design a practical, scalable, and conservation-oriented solution that minimizes human–bee conflict while preserving ecological balance.

The app is not only designed for the users, but also for the research teams(like gkvk) to get real data for the conservation and effective production of honey from Rock Bee.

Table of Contents:

## 1. **Introduction**

Bees are indispensable agents of pollination and play a foundational role in sustaining both natural ecosystems and agricultural productivity. Their contribution extends beyond food production to maintaining biodiversity, stabilizing ecosystems, and supporting the survival of countless plant and animal species.

In recent decades, global reports have highlighted a decline in pollinator populations due to habitat loss, climate change, pesticide usage, and urban expansion. India, with its rapid infrastructural growth and expanding urban boundaries, has witnessed increasing overlap between human settlements and natural habitats of wild bee species.

This overlap has resulted in frequent encounters between humans and rock bees, particularly in institutional environments such as colleges, hostels, residential complexes, and construction sites. Addressing these encounters requires a balance between public safety and ecological responsibility.

This research proposes a centralized, AI-assisted monitoring system that enables structured reporting, intelligent validation, and authority-driven decision-making for rock bee colony management.

## 2. **Importance of Bees in Ecological and Agricultural Systems**

Bees are among the most effective pollinators, responsible for pollinating a large percentage of flowering plants and crops. Pollination enhances crop yield, improves fruit quality, and contributes to nutritional diversity in human diets.

Beyond agriculture, bees play a critical role in maintaining genetic diversity among plant species. This genetic diversity increases ecosystem resilience to environmental stressors such as drought, disease, and climate variability.

The decline of bee populations has been linked to reduced agricultural output, economic losses for farmers, and destabilization of natural ecosystems. Consequently, conservation of native bee species has become a priority for environmental agencies and research institutions.

Rock bees, despite being perceived as dangerous, are essential contributors to pollination, particularly in forested and semi-urban landscapes.

## 3. **Types of Honey Bees in India**

India hosts a diverse range of honey bee species adapted to different ecological conditions. Apis cerana, commonly known as the Indian honey bee, is semi-domesticated and widely used in traditional beekeeping due to its manageable behavior.

Apis mellifera, the European honey bee, has been introduced for commercial apiculture because of its high honey yield. However, it requires controlled environments and careful management.

Apis florea, the dwarf honey bee, builds small open nests on shrubs and tree branches and generally poses minimal threat to humans.

Apis dorsata, the rock bee, is the largest of all honey bee species in India and forms massive open colonies. Its ecological importance and aggressive defense behavior make it a critical subject for monitoring and research.

## 4. **Rock Bees (Apis dorsata): Biological Characteristics**

Rock bees are distinguished by their large body size, powerful flight, and highly organized social structure. Colonies often consist of tens of thousands of individuals working in coordinated roles.

One of the defining features of rock bees is their strong defensive behavior. When threatened, colonies can launch synchronized mass attacks, posing significant risk to humans and animals nearby.

Despite these risks, rock bees are highly efficient pollinators and contribute significantly to the health of forest ecosystems and agricultural landscapes. Their conservation is therefore of both ecological and economic importance.

## 5. **Open Nesting Behavior and Habitat Preference**

Open nesting refers to the construction of exposed honeycombs without any enclosing structure. Unlike cavity-nesting bees, rock bees build a single large comb that remains fully visible and accessible from the surrounding environment.

This nesting strategy allows for rapid colony expansion and effective ventilation, but also increases vulnerability to disturbance.

Rock bees prefer elevated nesting sites such as cliffs, tall trees, and increasingly, man-made structures like buildings and bridges. Urban environments inadvertently provide suitable nesting locations, increasing human–bee interactions.

## 1.Human bee conflict and public-safety

Human–bee conflict typically arises when rock bee colonies establish nests in close proximity to areas of frequent human activity. Noise, vibrations, and accidental disturbance can trigger defensive responses.

Mass stinging incidents can result in serious injuries, allergic reactions, and panic situations. Vulnerable populations such as children and the elderly are particularly at risk.

In the absence of proper awareness and guidance, communities may resort to unsafe methods of colony removal, leading to ecological damage and increased danger.

1. **Existing Monitoring and Management Practices**

Current approaches to managing rock bee colonies are largely reactive rather than preventive. These include emergency calls, manual inspections, and ad-hoc interventions.

Such methods lack standardization and are heavily dependent on individual expertise. Reports are often unverified, leading to inefficient use of resources.

There is no centralized digital platform to collect, validate, and analyze data over time, limiting the ability of authorities to plan long-term strategies.

## 2. **Problem Statement**

The absence of a centralized and intelligent monitoring system for rock bee colonies results in fragmented reporting, delayed responses, and unnecessary ecological damage.

Authorities and research institutions lack reliable, location-based data to assess risk levels, prioritize interventions, and design awareness programs.

A scalable, AI-assisted solution is required to support informed decision-making while ensuring public safety and ecological conservation.

## 3. **Proposed Centralized Monitoring Solution**

The proposed solution is a centralized mobile application designed specifically for institutional and research use. Students and staff act only as reporters when they incidentally encounter rock bee colonies.

Artificial intelligence is used to validate uploaded images, reducing false reports and improving the overall quality of collected data.

Verified information is securely stored in a backend system accessible only to authorized personnel and experts such as GKVK.

## 4. Artificial Intelligence and Machine Learning Framework

The AI framework employs a convolutional neural network for image classification. MobileNetV2 is selected due to its efficiency, low computational cost, and suitability for deployment on mobile devices.

The trained model is converted into TensorFlow Lite format, enabling on-device inference with reduced latency, lower power consumption, and improved privacy.

A secondary machine learning model performs contextual risk classification based on location type, colony size, and frequency of reports, assisting authorities in prioritizing responses.

## 5. System Architecture and Data Flow

The system architecture is composed of multiple layers, including the mobile application layer, the on-device AI inference layer, the backend data management layer, and the authority dashboard.

Data flows from the user device to the backend only after AI-based validation, ensuring data quality and reducing noise.

This layered architecture supports scalability, maintainability, and institutional governance while preserving user privacy.

## 6. Ethical, Privacy, and Sustainability Considerations

Ethical considerations are central to the system design. Sensitive location data is restricted to authorized users and is not exposed to the general public.

The system follows a human-in-the-loop approach, ensuring that artificial intelligence assists rather than replaces expert judgment.

By promoting awareness, structured monitoring, and conservation-oriented actions, the system supports long-term ecological sustainability.

## 7. Future Scope and Conclusion

Future enhancements include advanced species classification, heatmap-based colony density analysis, seasonal migration prediction, and automated alert systems for high-risk zones. In conclusion, this research demonstrates that a centralized, AI-assisted monitoring platform can effectively balance public safety with ecological conservation, offering a practical and deployable solution for institutions and authorities such as GKVK.

## References


1. FAO – Pollinators and Ecosystems
2. Indian Council of Agricultural Research – Apiculture Research
3. Scientific literature on Apis dorsata ecology and behavior
4. TensorFlow Lite Documentation
5. MobileNetV2: Efficient Convolutional Neural Networks for Mobile Vision Applications



TEAM leader:Nischal Adhikari(1CR24AD076)
Members:Alan Basnet(1CR24AD005)
Members:Ishan Joshi(1CR24AD45)