

Assessment of honeybee biodiversity in the agro-climatic zones of Uttarkashi of Garhwal Himalaya, Uttarakhand, India

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ABSTRACT: The richness and relative abundance of honeybee species were assessed from the Uttarkashi area in Uttarakhand, India. Surveys were conducted in twelve agroclimatic zones from March to May 2025 using the aerial netting technique for the collection of honeybees foraging on different floral resources. Of the total of 291 specimens, the representation included five honeybee species: *Apis cerana* F., *A. mellifera* L., *A. laboriosa* Smith, *A. florea* F. and *A. dorsata* F. Predominant one was *A. cerana*, representing 57.7 per cent of the total population, followed by *A. mellifera* (19.2%), *A. laboriosa* (11.6%), *A. florea* (5.8%) and *A. dorsata* (5.4%). These results indicate the predominance of both native and invasive species of honeybees in the area. Shannon (H2) and Simpson (1–D) diversity indices were highest for *A. cerana* (0.3172 and 0.333), indicative of its broad adaptability and even distribution of specimens across the habitats. © 2025 Association for Advancement of Entomology

KEY WORDS: *Apis* fauna, Shannon index, Simpson's index, relative abundance

As members of the Apoidea group, honeybees are important plant pollinators and frequent visitors to flowers in both natural and agricultural environments (Hristov *et al.*, 2020; Lupi *et al.*, 2025; Muñoz-Urias *et al.*, 2025). Honeybees, together with other wild pollinators, play a crucial role in preserving plant diversity and sustaining our food supply (Nouredine and Nizar, 2020). Honeybees are highly valued for their significant contributions to humanity, particularly for their crucial role in the pollination of agricultural and

horticultural crops (Chalapathy *et al.*, 2024). Approximately 80 percent of the world's major food crops rely on pollination by honeybees, underscoring their critical role in global food security (Klei *et al.*, 2007; Requier *et al.*, 2023; Richardson, 2023). Bees play an essential role in ecosystem maintenance since they are the most important and primary pollinators of many of our staple food crops (Raymann and Moran, 2018). A reduction in their diversity can indicate underlying environmental issues such as habitat destruction, excessive

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pesticide use, or the effects of climate change (Yang *et al.*, 2023; Ali *et al.*, 2025). Understanding honeybee diversity is essential for setting conservation priorities (Requier *et al.*, 2019). Certain species may be rare, unique to specific regions, or at risk of extinction (such as *Apis laboriosa* in the Himalayas), and without proper documentation, they could remain overlooked and vulnerable (Otis *et al.*, 2024). In Uttarakhand, *Apis cerana* and *A. mellifera* are key species supporting local apiculture (Tiwari *et al.*, 2013; Chauhan *et al.*, 2025; Ghosh *et al.*, 2025). However, limited documentation exists on honeybee diversity in Uttarkashi, which is vital for understanding ecological balance in Himalayan agroecosystems. This study aims to assess honeybee diversity and relative abundance across twelve agro-climatic zones of Uttarkashi district.

This study was conducted in different agro-climatic zones of Uttarkashi, which is present in one of the Himalayan states (Uttarakhand) of India. Uttarkashi district lies in the northwestern part of Uttarakhand state in India. It is bounded by North Latitudes 30° 27' 18" and 31° 27' 42" and East Longitudes 77° 48' 26" and 79° 24' 00". Twelve different locations were selected for the survey of *Apis* fauna. These were Mori, Purola, Sankri, Barkot, Harshl, Dharali, Jhala, Manpur, Kamad, Kumarkot, Dhanpur and Morem (Fig. 1). This study was conducted from 24th March 2025 to 19 May 2025. Sampling was done between 11 am to 3:00 pm when foraging activity was highest. At each site, 10 sweeps were performed using a 15-inch aerial net attached to a 3-meter pole. Collected specimens were preserved and identified using standard taxonomic keys. Relative abundance (%) was calculated as the number of individuals of a species divided by the total number of bees collected. Biodiversity was estimated using Shannon (H2) and Simpson (1-D) indices. Data analysis was performed using Python (v3.11) and Microsoft Excel 2021.

After pooling all the data, the relative abundance of different honeybee species was computed and expressed as a percentage using the following formula.

$$\text{Relative abundance} = \frac{\text{Number of individuals of species}}{\text{Total number of all honeybees}} \times 100$$

Shannon (H2) and Simpson's (1-D) Diversity Indices were used to measure species richness, evenness, and dominance, helping assess biodiversity levels and ecological balance across different habitats or study sites. After pooling all the data diversity (Shannon Diversity Index (H2)) of different honeybee species was computed and expressed as a formula: $H' = -\sum(pi \times \ln pi)$

Simpson's (1-D) diversity was expressed as a formula: $1-D = 1 - \sum(pi^2)$

Out of 291 honeybee specimens collected, five species, *A. cerana*, *A. mellifera*, *A. laboriosa*, *A. dorsata* and *A. florea* were recorded across twelve agro-climatic zones of Uttarkashi. Among them, *A. cerana* comprised the most abundant species (57.7%) followed by *A. mellifera* (19.2%), *A. laboriosa* (11.6%), *A. florea* (5.8%) and *A. dorsata* (5.4%) (Fig. 1). Shannon (H2) and Simpson (1-D) diversity indices were highest for *A. cerana* (0.3172 and 0.333), indicative of its broad adaptability and even distribution of specimens across the habitats (Table 1). *A. mellifera* had slightly lower diversity indices while exhibiting a preference for presence in a few managed apiary zones. *A. laboriosa* was largely encountered in higher altitude sites i.e. Sankri, confirming its preference for cooler high-altitude habitats. The low indices for *A. dorsata* and *A. florea* also reflect nesting preference ecology, with *A. dorsata* occupying higher taller trees and cliffs, while *A. florea* was commonly located in shrub landscapes near lower-altitude habitat zones. Its ecological adaptability to Himalayan agro-ecosystems and its

Table 1. Combined species count with Shannon and Simpson diversity indices

Species	Total	Shannon (H2)	Simpson (1-D)
<i>Apis cerana</i>	168	0.3172	0.333
<i>A. mellifera</i>	56	0.3171	0.037
<i>A. laboriosa</i>	34	0.2508	0.0137
<i>A. dorsata</i>	16	0.1595	0.003
<i>A. florea</i>	17	0.1659	0.0034

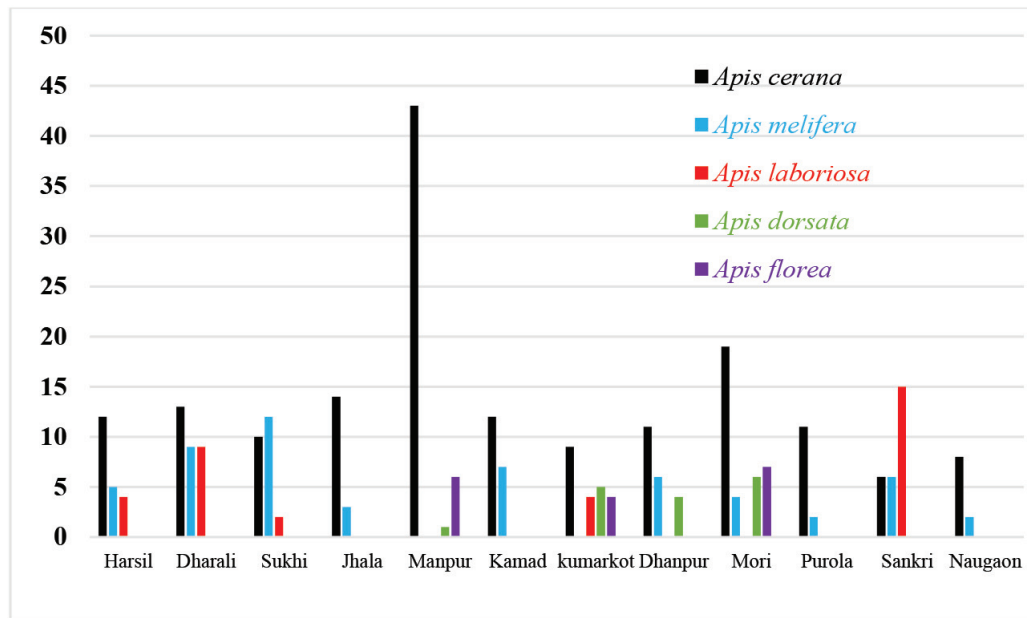


Fig.1 Relative abundance of different honeybees in Uttarkashi and its vicinity

significance for sustainable apiculture are highlighted by the prevalence of *A. cerana*, a local and traditionally managed bee. Despite its economic importance, *A. mellifera* seems less suited to higher elevations because of climate constraints. The study's overall findings demonstrate Uttarkashi's rich honeybee diversity, which is dominated by native species that have adapted to a variety of floral and climatic circumstances.

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