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# Survey of Native Bee Species in the Karni Mata Temple Region: Insights into Hymenopteran Diversity in Alwar

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**ABSTRACT:** The present study investigates the diversity of bee species around Karni Mata Mandir, a prominent semi-urban ecological niche in Alwar district, Rajasthan. Field surveys were conducted during March 2023 to October 2023 using sweep netting and direct observation methods. A total of twenty-two bee species belonging to four families (Apidae, Halictidae, Megachilidae, Andrenidae) were recorded. Eleven species from Apidae family, seven from Megachilidae family, three belongs to Halictidae family and one species from Andrenidae family were recorded. The most abundant family was Apidae, with *Apis dorsata* and *Apis cerana* as dominant species. The diversity indices shows high species richness and evenness, reflecting the ecological importance of the area as a foraging and nesting habitat. The findings highlight the need for habitat conservation and further monitoring to understand pollinator dynamics in temple-associated green zones. This baseline study serves as a foundation for future pollination and conservation ecology research in the region.

**KEYWORDS:** Alwar, diversity, family, pollination, Rajasthan

## I. INTRODUCTION

One of the most distinctive aspects of earth is its biodiversity, which includes a remarkable range of life forms, including differences in genes, species, functional characteristics, and habitats. (Cardinale *et al.*, 2012).

Natural resources and biodiversity are the foundation of all living systems. It provides economic and ecological stability for future generations, serves as the cornerstone of sustainable development, and is essential to the planet's environmental health. Walter and Rosen (1985) introduced the word "biodiversity," which is an abbreviation of the word biological diversity. The spectrum and heterogeneity of living organisms and the ecological complexity in which they reside are referred to as biological diversity. The world's living species are not evenly distributed. As one moves from the poles to the equator, the species richness increases. Global diversity, it is estimated that there are between 5-30 million different species of organisms on the planet. Among these are 3,00,000 green plant species, 8,00,000 fungal species, 40,00,000 insect species, 3,60,000 microorganism species, and numerous vertebrates and invertebrates. Many people think that the number of insects alone is more likely to be about 5 million, however other new estimates put it as high as 10 million. (Singh *et al.*, 2004). Insects stand out as some of the most fascinating and highly adaptable creatures among all animal groups.

They are more diverse than other animal groupings and can be found in nearly every kind of habitat. Eighty percent of insects are unique in India, one of the twelve countries with the highest biodiversity in the world. Insects play a crucial role in many ecological services, including pollination, decomposition, biological control, and the food chain. Insects contribute significantly to the biomass and species richness of terrestrial species and are essential to the health of ecosystems. Approximately 66% of all animals are insects (1,020,007 species under 39 orders), out of 1,552,319 worldwide known animal species. (Zhang, 2011). With an estimated 116,861 species out of a total of 1.5 million insect species, are the Hymenopterans.



The Greek terms Hymen (membranous) and Pteron (wings) are the roots of the name Hymenoptera. Two sets of membrane wings are present in species of this group. A set of tiny hooks known as "hamuli" that are located at the forward edge of the hind wings connect the fore and hind wings. (Hoell *et al.*, 1998). The Class Insecta including order Hymenoptera is significant because it includes species that are valuable for agriculture, the environment, and the economy. (Michener, 2003). Hymenoptera includes sawflies, wasps, bees, and ants. They serve as ecological indicators as well. (Dang and Doi, 2020). Bumble bees, honey bees, and ants are excellent pollinators. (Anbalagan *et al.*, 2015). It is known that the flower-foraging wasp, which recently abandoned its long-standing carnivorous propensity as shown in aculeate wasps, is the ancestor of bees belonging to the superfamily Apoidea of the order Hymenoptera of the class Insecta. (Michener, 2000). Apidae, Megachilidae, Halictidae, Andrenidae, Colletidae, Melittidae, and Stenotritidae (it is limited to the Australian region only) are the seven families into which the superfamily Apoidea has been further hierarchically divided. In all, about 20,000 species of bees have been recognized globally, with over 700 species found in India. Apidae (218 species), Megachilidae (237 species), Andrenidae (20 species), Halictidae (214 species), Colletidae (31 species), Melittidae (4 species), and Stenotritidae (0 species) are among the bee families found in India. (Ascher and Pickering, 2020). Since the Melittidae family is primarily found at higher elevations, only five bee families have been identified in Rajasthan, out of the six bee families that have been documented in India.

An essential component of the environment are bees. It has species that are valuable for agriculture, the environment, and the economy. Around the world, bees are well-known pollinators of a variety of wild and farmed crops. (Michener, 2003). When it comes to pollination services, bees are thought to be the most effective insect (Torchio, 1990; Free, 1993; Raj *et al.*, 2012; Thakur *et al.*, 2012). According to Garibaldi *et al.*, 2013, wild bees mainly contribute to maintain the integrity of natural ecosystems by pollinating native plants. Bee-pollinated plants provide around one-third of our total nutrients, either directly or indirectly. (Michener, 2007). They pollinate both natural and managed habitats, which is one of their vital ecological functions. (Gallai *et al.*, 2009). With the exception of the Trigona bee, which differs from other bees in that it uses carrion in place of pollen, bees gather pollen from blossoms as a source of protein to feed their larvae and maybe for ovarian expansion by egg-laying females. While serving as pollinators, they have a significant impact on floral variety, specialization, evolution, genetic variation in the plant community, ecological interactions, and ecosystem conservation and stability. In crops like strawberries, bees are essential for enhancing fruit quality, helping to produce traits like larger weight, lower sugar-acid ratios, firmer texture, fewer abnormalities, increased redness, and higher economic value. In addition to their economic importance in the production of honey and wax, bees also improve the yield and quality of agricultural crops through pollination services. About 35% of the world's crop production and 75% of blooming plants are fertilized by bees, making them one of the most efficient pollinators. (Klein *et al.*, 2007). Pollinated plants, notably trees and shrubs, are essential for sustaining the water cycle and lowering the emission of greenhouse gases. (Steffan - Dewenter *et al.*, 2005). A distinct type of intraspecific interactions known as eusocial and solitary behavior is exemplified by bees.

Biodiversity has been harmed far more quickly than in the past, which has detrimental effects on human lifestyle sustainability. (Turner *et al.*, 1990). The primary factor presently influencing biodiversity is habitat change, since farmland have replaced about 40% of forests and ice-free habitats. Global warming, invasive species, environmental damage, and over-exploitation are further factors. Since it may be applied in a number of areas to promote greater growth in the modern world, biodiversity is crucial for both ecological and economic reasons as well as for our day-to-day lives. The following are some significant areas where biodiversity is relevant:

**Relevance to Agriculture:** In the world of agriculture, biodiversity is crucial for creating new plant or crop varieties by altering their genetic characteristics. It also helps shield crops against diseases like coffee. It is also known as agricultural biodiversity.

**Relevance to Human Life:** Biodiversity is essential to human life because it helps produce a variety of valuable goods, including food, water, and various medications. Additionally, it involves dealing with many calamities. It manufactures a wide range of medicinal medicines that aid in healing.

**Relevance to Industry:** In the industrial sector, it is also utilized to create a variety of materials, including building materials, that are sourced from various biological resources and biodiversity. Fibers, dyes, oils, rubber, and other industrial goods are produced as a result of biodiversity.

Conservation of biodiversity requires research on faunal variety and distribution.

## II. MATERIAL AND METHODS

### Study area-

The current investigation was conducted at a site chosen in the Alwar district of Rajasthan. Geographically, Alwar district, located in northeastern Rajasthan, lies at 27.5545° N latitude and 76.6350° E longitude. On average, it is 271 meters (889 feet) above sea level. It is situated in the foothills of the Aravallis. Alwar experiences year-round high temperatures due to its semi-arid climate. The Karni Mata region of Alwar is where this study was carried out. It is a part of the Aravalli hill range, which greatly influences the topography and ecological aspects of the area. The coordinates of Karni Mata (Alwar District, Rajasthan) are 27.52°N, 76.61°E, and 300–400 meters above sea level. The area experiences high temperature summers and mild winters due to its semi-arid climate. Typically, soils range from rocky to sandy loam. *Acacia auriculiformis*, *Prosopis juliflora*, *Zizyphus*, and *Anogeissus* are among the most common species found in dry deciduous to thorn scrub forests. Diverse biodiversity is supported in the region.



Photoplate- Site Karni Mata region of Alwar district, Rajasthan, India.

### Insect Sampling-

The research was conducted from March to October of 2023. Collections and observation were done to learn about the diversity of bees in this region. The study utilized a random sampling method and normal 38 cm sweep nets. Samples were taken from the study site during each field visit between 7:00 a.m. and 4:00 p.m.

Bees that have been collected can be carefully evaluated, returned back into their natural environment and, if required, killed in a killing bottle made out of a cylindrical glass jar filled with ethyl acetate. The bees are spread out on a spreading board, pinned, and eventually put in an insect preservation box for more study.

### Identification-

With the aid of standard keys and existing literature, identification was accomplished by observing specific morphological distinctive characteristics of the species. Additionally, several internet resources were employed for identification.

### Diversity Indics and Data Analysis-

Using Microsoft Excel and PAST software (4.12b), the statistical analysis of the sampled species was conducted. Various indices such as Shannon Weiner Index for species diversity, Simpson Index for species dominance, Evenness Index and Margalef's Index for species richness were calculated.

### III. RESULT AND DISCUSSION-

The goal of the current study was to investigate the number and diversity of bees in the selected area of Alwar, Rajasthan. Study revealed bees belonging to four families, seven subfamilies, fourteen genera and twenty-two species.

Table 1. Record of bee species (Hymenoptera: Apoidea) reported from survey site.

Order	Superfamily	Family	Scientific Name	Common Name
Hymenoptera	Apoidea	Apidae	<i>Apis dorsata</i>	Rock bee
			<i>Apis cerana</i>	Eastern honey bee
			<i>Apis florea</i>	Dwarf honeybee
			<i>Amegilla zonata</i>	Blue banded bee
			<i>Tetragonula iridipennis</i>	Indian stingless bee
			<i>Thyreus species</i>	Dagger bee
			<i>Xylocopa fenestra</i>	Windowed carpenter bee
			<i>Xylocopa voilecea</i>	Voilet carpenter bee
			<i>Ceratina samargdula</i>	Dwarf bee
			<i>Nomada species</i>	Cuckoo bee
			<i>Bombus impatiens</i>	Common eastern bumble bee
		Megachilidae	<i>Megachile bicolor</i>	Leafcutter bee
			<i>Megachile disjuncta</i>	Resin bee
			<i>Anthidium species</i>	Wool carder bee
			<i>Megachile gathela</i>	Leafcutter bee
			<i>Megachile lanata</i>	Leafcutter bee
			<i>Megachile cephalotes</i>	Leafcutter bee
			<i>Coeliolix bee</i>	Cuckoo leafcutter bee
		Halictidae	<i>Nomia curviceps</i>	Sweat bee
			<i>Lassioglossum species</i>	Sweat bee
			<i>Nomia crassipes</i>	Sweat bee
		Andrenidae	<i>Andrena species</i>	Mining bee

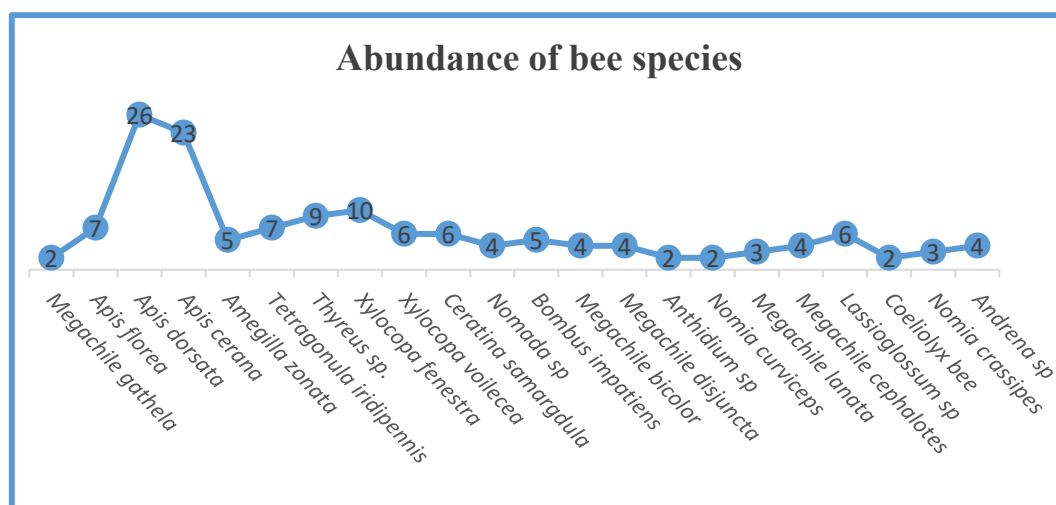


Figure 1. Graphical representation of abundance of bee species.

Apidae, Megachilidae, Halictidae, and Andrenidae are the four main families of bees based on observations. The Apidae family had eleven species. The family Megachilidae has seven species. There are three species in the Halictidae family, but just one species has been found in the Andrenidae family. The bee species identified were *Apis dorsata*, *Apis florea*, *Apis cerana*, *Amegilla zonata*, *Tetragonula iridipennis*, *Thyreus species*, *Xylocopa fenestra*, *Xylocopa voilecea*, *Ceratina samargdula*, *Nomada species*, *Nomada species*, *Megachile bicolor*, *Megachile disjuncta*, *Anthidium species*, *Megachile gathela*, *Megachile lanata*, *Megachile cephalotes*, *Coeliolix bee*, *Nomia curviceps*, *Lassioglossum species*, *Nomia crassipes* and *Andrena species*. It has been noticed that the species *Apis dorsata* and *Apis cerana* are the most abundant in the observed bee population, with the family Apidae appearing to be the most prevalent. According to the findings, *Apis dorsata* was the most abundant of all, followed by *Apis cerana*. However, the abundance of *Anthidium species*, *Megachile gathela*, and *Nomia curviceps* is low. Relative abundance recorded for *Apis dorsata* was 18.0555 and for *Apis cerana* value obtained was 15.9722. Relative abundance of *Anthidium species*, *Megachile gathela* and *Nomia curviceps* comes out to be 1.3888.

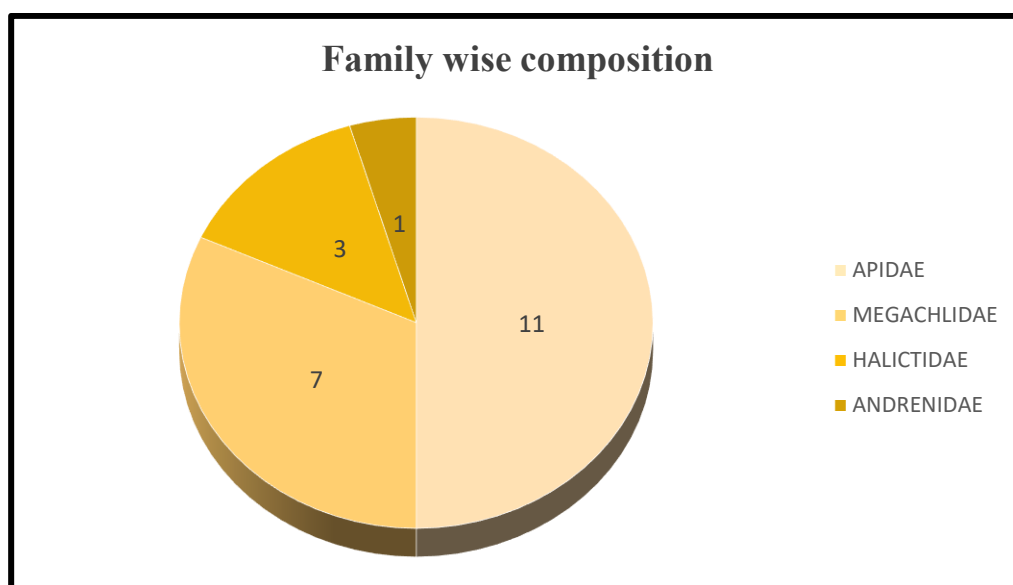


Figure 2. Family wise distribution pattern

By computing the several diversity indices, the site's diversity was ascertained. The values of the Shannon index (H) and Simpson index (D) were determined to be 2.757 and 0.08368, respectively. There is a high degree of diversity in the research area, as indicated by the Simpson index of diversity (1-D), which was also computed and determined to be 0.9163 (Table 2). In addition, species richness was computed using Margalef's index, which generated a value of 4.034.

According to the findings of the current study, there is a high level of rich diversity of bees at the chosen location. Temperature, humidity, rainfall, and daylight hours all contributed to the site's high level of diversity. A good degree of diversity is seen as a result of all these causes.

Table 2. Value of diversity indices.

Diversity indices	Value
Dominance_D	0.08368
Simpson_1-D	0.9163
Shannon_H	2.757
Evenness_e^H/S	0.7875
Margalef	4.034



Twenty Hymenopteran species from seven families were reported by Kumar *et al.* in 2019 from India's Nanda Devi Biosphere Reserve. With seven species, the Apidae family was the most prominent. The current study's findings are largely consistent.

Thirteen genera and eighteen species belonging to the Apidae, Halictidae, and Megachilidae families were recorded by Bhatta and Kumar, 2020 in their study of the variety and abundance of native bees in an urban green space in Bengaluru, India. Our current findings were also found to be supported by these findings.

Dang and Doi, 2020 conducted research on the hymenopteran fauna, which includes bees and wasps, at two specific locations in Kota: Herbal Park and the Government College Kota Campus. Eleven species of bees and wasps from six different families were found. Four of the eleven species found were bees, while the remaining seven were wasps. According to data from a college campus, the most prevalent species among wasps was *Polistes hebraeus*, whereas the most prevalent species among bees was Family Apidae, which had the most individuals and *Apis dorsata* Fabricius. This study confirmed our current findings as well.

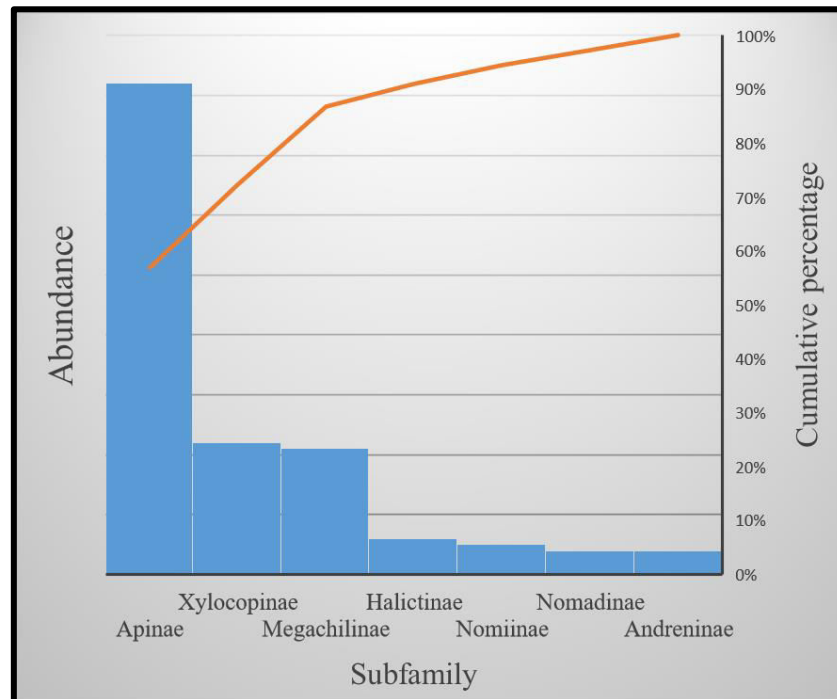


Figure. Pareto chart of bee subfamilies.

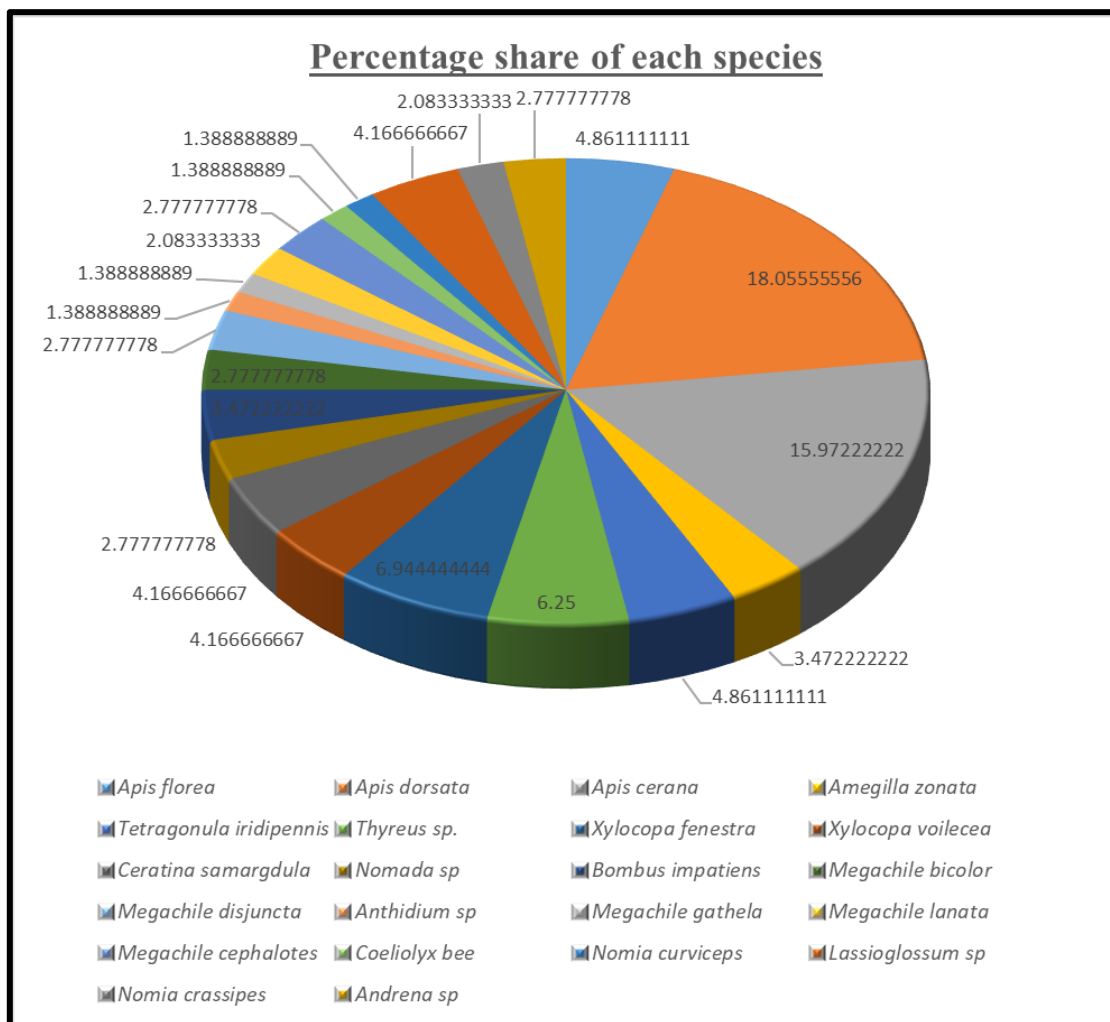


Figure . Graph representing relative abundance of different Apoidean bee species.

#### IV. CONCLUSION

From the results, it can be clearly noted that the study area has a high diversity of bee species recording twenty-two species identified from four families. Apidae was most abundant family that was recorded. Diversity indices show a good diversity is present over the site. This study highlights the critical importance of bee diversity in maintaining healthy ecosystems and supporting agricultural productivity. Through comprehensive sampling and analysis, we documented a rich variety of bee species, demonstrating the ecological complexity and resilience of pollinator communities. Our findings underscore the need for conservation strategies that protect both common and rare bee species, especially in the face of habitat loss, pesticide use, and climate change. Continued research and monitoring are essential to understand long-term trends in bee populations and to develop effective, evidence-based approaches to safeguard pollinator diversity. Our results also emphasize the importance of landscape heterogeneity and floral resource availability in maintaining healthy bee populations. By promoting habitat restoration, sustainable farming practices, and public awareness, we can ensure the survival of these indispensable pollinators and the vital ecosystem services they provide.



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