

Assessment of bees (Hymenoptera: Apoidea) diversity and distribution in Alwar, Rajasthan, India

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Abstract

Conservation of biodiversity requires research on the diversity and abundance of insect pollinators. As members of the order Hymenoptera's superfamily Apoidea, bees are essential pollinators for many wild and cultivated plants across the world. This paper presents a data of bee species found in Alwar district, located on the northern part of Rajasthan. Two sites from Alwar were chosen for this study. Site 1 was near by region of Umren and Site 2 was Agricultural land in Tijara, Alwar, Rajasthan, India during January 2023 to May 2023.

Of the six bee families present in India (Apidae, Megachilidae, Halictidae, Andrenidae, Colletidae, and Melittidae), five have been recorded in Rajasthan. During the investigation, a total of 14 bee species from four families were found at both locations. Based on field observations, species were also categorized as rare, occasional, and abundant. Two species were rare, four were occasional and eight were abundant. Apidae is the most diverse family in the region, with 8 species across five genera and three subfamilies. Megachilidae follows with 3 species in one genera, distributed across Megachilinae subfamily. Halictidae includes 2 species in two genera and two subfamilies. This research lays the groundwork for investigating bee-crop interactions in the Alwar region. The species data serves as a biodiversity index for the Apoidea superfamily, aiding in bee taxonomy studies and providing valuable microhabitat data for compiling a comprehensive fauna record of the area.

Keywords: Alwar, apidae, apoidea, bee diversity, hymenoptera

Introduction

In terrestrial ecosystems, insects are essential to a variety of ecological activities, including pollination, seed dispersal, nutrient cycling, predation/parasitism, and pest management. With more than 150,000 extant species, the enormous order of insects known as the Hymenoptera includes sawflies, wasps, bees, and ants (Dang and Doi, 2020) ^[5]. The flower-foraging wasp, which recently abandoned its long-standing carnivorous propensity as observed in aculeate wasps, is the ancestor of bees belonging to the superfamily Apoidea of the class Insecta, order Hymenoptera (Michener, 2000) ^[13]. Bees being part of the superfamily Apoidea, includes several families, the most well-known being Apidae, which contains honeybees, bumblebees, and stingless bees. Other important bee families include Andrenidae (miner bees), Halictidae (sweat bees), and Megachilidae (leafcutter bees), each of which exhibits unique characteristics. Apidae, Megachilidae, Halictidae, Andrenidae, Colletidae, Melittidae, and Stenotritidae (which is exclusive to Australia) are the seven families that comprise the superfamily Apoidea (Hooda and Jain, 2020) ^[8]. More than 20,000 species of bees have been documented worldwide, with over 700 of them species occurring in India (Ascher and Pickering, 2020) ^[11]. It has species that are valuable for agriculture, the environment, and the economy (Bishnoi and Dang, 2019) ^[3]. They serve as ecological markers as well. An essential component of the environment are bees. One of the most important services provided by bees, a fascinating group of insects with a wide range of distribution worldwide, is pollination (Free, 1993; Thakur and Dongarwar, 2012; Raj *et al.*, 2012) ^[6, 16]. Their importance in both wild and farmed field crops has been established, and as such, they have a direct impact on the system's sustainability and are necessary for the

survival of other species, including humans (Borneck and Merle, 1989; Gill, 1991; Robinson *et al.*, 1989; Southwick and Southwick, 1992) ^[4, 7, 18, 20]. Bees' preference for nectar with a greater sugar content and pollen with higher nutritional qualities accounts for their floral fidelity. For proper pollination, a large number of food crops in India need insect pollinators, primarily bees. Both social and solitary bees contribute to crop yield in both natural and managed environments (Nalwaya and Saxena, 2023) ^[14]. The plant is highly beneficial for increasing crop productivity by drawing in insect pollinators. Insects (entomophilous pollination) and wind (anemophilous pollination) both pollinate plants (McGregor SE, 1976) ^[12]. Bee populations around the world have been declining in recent years. This has been caused by a number of issues, such as the lack of food of excellent quality, actions by humans such as habitat loss and warming temperatures, and the excessive application of agricultural pesticides (Kremen *et al.*, 2002; Biesmeijer *et al.*, 2006; Potts *et al.*, 2010) ^[2, 10, 15]. The loss of these pollination services would have unfavourable effect on food production and no doubt for the preservation of biodiversity (Klein *et al.*, 2006) ^[11].

In conclusion, bee diversity is an essential aspect of global biodiversity, contributing to ecosystem health, agricultural productivity, and the survival of many plant species. Understanding and conserving this diversity is crucial for maintaining the health of our planet's ecosystems.

Materials and methods

Location of study area: Alwar is a city sited in the northern part of the Indian state of Rajasthan with geographical coordinates Latitude: 27.5545° N Longitude: 76.6350° E. It lies in the Aravalli Range, which stretches across northwestern India, and is situated at the foothills of the

Aravallis. The Aravalli Range, one of the oldest mountain ranges in the world, plays a significant role in shaping the region's landscape. Alwar has year-round high temperatures and a semi-arid climate. The climate is characterized by hot summers, moderate winters, and relatively low annual rainfall. Summers in Alwar are extremely hot, with temperatures often rising above 40°C in May and June and winters with temperature ranging 27°C to 10°C. Alwar's average annual rainfall is around 605.63 mm (Monsoon report, water Resource Department, Government of

Rajasthan, 2023). Due to its semi-arid climate, Alwar's vegetation is sparse, dominated by thorny shrubs, dry grasses, and hardy plants. In the foothills and river valleys, some agriculture is practiced, with crops like wheat, barley, millet, and mustard being grown. Horticulture is also practiced, with crops such as citrus fruits, guava, and pomegranates being cultivated.

To study the biodiversity of bees two sites of Alwar region were selected- Nearby region of Umren and Agricultural land in Tijara.



Photoplate 1: Site 1 (Umren region of Alwar district, Rajasthan)



Photoplate 2: Site 2 (Agricultural land in Tijara, Alwar, Rajasthan)

Survey, collection and Identification: The study and collection of bees took place between January 2023 and May 2023. The collection was carried out during the day. Sweep nets and hand-picking method were two active sampling strategies used to gather insects. Insects were immediately identified once the species were captured on camera in the field, and the undetermined species were taken to the college lab for identification. In the lab, the collected species were mounted and dry pinned. Identification was accomplished out using accepted and accessible literature.

Species abundance in two collection areas was determined independently with the help of below mentioned formula- (Number of individuals of a species/ total number of individuals) * 100

The following formulas were used to determine the diversity indices: -

1. Simpson's Index (D) = $\sum n(n-1)/N(N-1)$ Where, \sum = Summation
 n = Total number of individuals of a particular species in the sample.

N= Total number of individuals of all species present in the sample.

2. Shannon-Weiner Diversity Index (H) = $\sum [(pi) * \ln(pi)]$ Where,
 SUM = Summation
 Pi = Ratio of (n/N) of individuals.

Result and Discussion

From the present study of two surveyed sites of Alwar district of Rajasthan, 14 species of bees were collected during the study period and the collected individuals were identified belonging to four families and nine genera. Bees were divided into three major groups based on field observations and specimens' collection. First, rare that are few in number second, occasional that are distributed in some region and third is abundant which are frequently dispersed in the area.

From the total 14 species that were identified from the two sites, eight species were identified to be abundant, four species recorded were occasional and two species were found to be rare.

Table 1: Distribution pattern of bee species from two sites of Alwar, Rajasthan

Subfamily	Abundant	Ocassional	Rare
Apinae	√√√√√	√	
Xylocopinae	√		
Nomadinae		√	

Megachilinae	√√	√	
Halictinae		√	
Nominae			√
Andreninae			√
Total	8 species	4 species	2 species
Percentage	57%	29%	14%

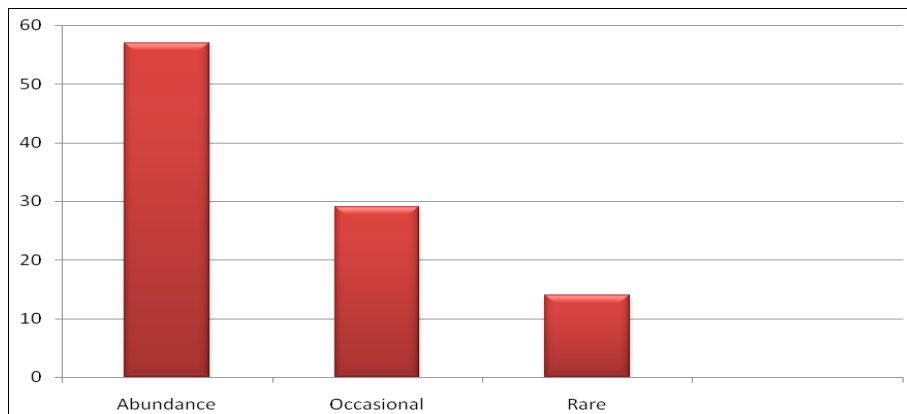


Fig 1: Bee species percentage distribution from two survey sites of Alwar district, Rajasthan

Table 2: Tabulated data of species of bees (Hymenoptera: Apoidea) identified from two survey sites of Alwar, Rajasthan

Name of the Family	Subfamily	Scientific name of Species	Common name of species	Collection site
Apidae	Apinae	<i>Apis dorsata</i>	Rock bee or Giant honey bee	Umren, Tijara
		<i>Apis florea</i>	Indian little bee	Umren, Tijara
		<i>Apis mellifera</i>	Honey bee	Umren, Tijara
		<i>Apis cerana</i>	Asian honey bee	Umren, Tijara
		<i>Amegilla zonata</i>	Blue-banded bee	Umren, Tijara
		<i>Thyreus species</i>	Dagger bee	Tijara
	Xylocopinae	<i>Xylocopa fenestrata</i>	Carpenter bee	Umren, Tijara
	Nomadinae	<i>Nomada species</i>	Cuckoo bees	Umren, Tijara
Megachilidae	Megachilinae	<i>Megachile bicolor</i>	Leaf cutter bee	Umren, Tijara
		<i>Megachila gathela</i>	Mason bees	Umren, Tijara
		<i>Megachile bingham</i>	Leaf cutter bee	Umren, Tijara
Halictidae	Halictinae	<i>Halictus lucidipennis</i>	Sweat bee	Umren, Tijara
	Nominae	<i>Nomia cerviceps</i>	Sweat bee	Tijara
Andrenidae	Andreninae	<i>Andrena species</i>	Mining bee	Tijara

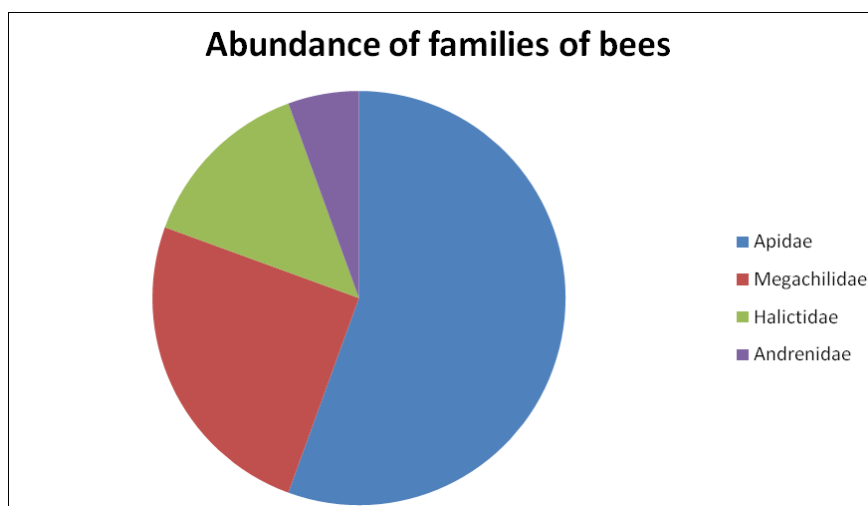


Fig 2: Abundance of families of bees from survey sites

Results from site 1, nearby region of Umren: Collection of bees from this site belongs to three families, six genera and eleven species. Species which were recorded from site 1 were namely *Apis dorsata*, *Apis florea*, *Apis mellifera*, *Apis cerana*, *Amegilla zonata*, *Xylocopa fenestrata*, *Nomada species*, *Megachile bicolor*, *Megachila species*, *Megachile bingham*, *Halictus lucidipennis*.

Apis dorsata is the bee species that was recorded in highest number.

Result of site 2, agricultural land in Tijara: The bee diversity from this site included four families, nine genera and fourteen species. The main family was Apidae, which was followed by Megachilidae family. Species that were

recorded from site 2 were namely *Apis dorsata*, *Apis florea*, *Apis mellifera*, *Apis cerana*, *Amegilla zonata*, *Thyreus* species, *Xylocopa fenestrata*, *Nomada* species, *Megachile bicolor*, *Megachile gathela*, *Megachile bingham*, *Halictus lucidipennis*, *Nomia cerviceps* and *Andrena* species.

According to the current study there is a significant bee population at the Alwar district Rajasthan survey location. The reason for this may be because of the fact that Alwar region has favourable climatic condition with extended daylight hour, suitable temperature and adequate amount of pollen resources. As an outcome of all these resources bee activity enhances explaining why they thrive here.

In the Vanaparvam Biodiversity Park in Kerala, India, Sheeja and Jobiraj (2017) ^[19] conducted a study on bee diversity. Out of 21 species that were collected, 18 species were identified, and they were divided into three families and nine genera. According to this survey, the Apidae family has the most number of species. The species with the highest recorded numbers were *Apis dorsata*, *Apis cerana*, and *Ctarina heiroglyphica*. Present study results show much of similar results. *Apis dorsata* is species that was recorded in maximum number from both the survey sites.

Rajpurohit *et al.* (2018) ^[17] conducted a study on bee diversity that visits *Ocimum basilicum* from eastern Rajasthan. The study showed that 16 species of a bees belonging to Apidae, Megachilidae, Halictidae and Andrenidae were present. Their findings also support the present study results.

Another study was carried out by Kachhawa *et al.* (2020) ^[9] on diversity and pollination probability of insect pollination of *Tagetes erecta* L. from Chomu Tehsil. Insects of 18 species from 9 families were tabulated and documented. Apidae family was seen as most abundant family. Results of this study also support present study.

Simpson Index of Diversity and Shannon-Weininger Index of Diversity of agricultural land in Tijara (0.87 and 2.09 respectively) are higher than that of nearby region of Umren (0.72 and 1.38 respectively) revealing high species evenness, species richness and evenhanded distribution of species over there.

Conclusion

In the present study 14 species of bees belonging to four families were identified. At site 1 Umren, 11 species of bees were reported. Number of bees were higher in agricultural land in Tijara because of availability of great amount of pollen and nectar contents due to presence of crop and flowering plants. In Umren, the site selected had less diversified feeding habitat due to colonisation that could be reason for variation in species. The social nesting behaviour of *Apis dorsata* led to its highest number presence. They build their nest in cavities such as tree hollows, buildings. At site 2, 14 species were identified belonging to four families. The abundance was higher in second site because of presence of open grassland, trees, flowers than in housing region of Umren. With the present study research work we have been able to form a diversity data from the site. It is obvious from study that Apoidea family is most diversified found in both sites. The analysis of bee diversity across experimental sites suggests that habitat quality, floral resource availability, and landscape structure play critical roles in supporting diverse bee populations. Bee diversity is influenced by a complex interplay of ecological, environmental, and anthropogenic factors. All these factors

shape the richness and abundance of bee species. Sites with varied vegetation, abundant wildflowers, and minimal pesticide use tended to have higher bee diversity, with a broader range of species present. In contrast, monoculture landscapes and areas with limited floral resources showed lower bee diversity, often dominated by a few generalist species. Future studies should focus on long-term monitoring to further understand the dynamics of bee communities in response to different environmental conditions and management practices.

References

- Ascher JS, Pickering J. Discover Life Bee Species Guide and World Checklist (Hymenoptera: Apoidea), 2020. Available: https://www.discoverlife.org/mp/20q?guide=apoidea_species&flags=HAS
- Biesmeijer JC, Roberts SP, Reemer M, Ohlemuller R, Edwards M, Peeters T, *et al.* Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. *Science*,2006;313:351–354.
- Bishnoi S, Dang K. Diversity of some hymenopteran insects in Kota, Rajasthan, India. *J Entomol Zool Stud*,2019;7(2):31-33.
- Borneck R, Merle B. Essai d'une évaluation de l'incidence économique de l'abeille pollinisatrice dans l'agriculture européenne. *Apiacta*,1989;24:33–38.
- Dang K, Doi D. Study on biodiversity of wasps and bees in Kota, Rajasthan, India. *J Entomol Zool Stud*,2020;8(6):807-810.
- Free JB. *Insect Pollination of Crops*, 2nd ed. Cambridge: Academic Press, 1993, 1-684.
- Gill RA. The value of honeybee pollination to society. *Acta Hort*,1991;288:62–68.
- Hooda S, Jain N. Diversity of Bees (Hymenoptera: Apoidea) in Kota, Rajasthan (India). *J Env Bio-Sci*,2020;34(1):65-68. Available: <https://connectjournals.com/03843.2020.34.65>.
- Kachhawa G, Charan SK, Choudhary R. Diversity and pollination probability of insect pollinators of *Tagetes Erecta* L. in the Chomu Tehsil, Rajasthan, India. *Int J Entomol Res*,2020;5(6):106-110. Available: <https://www.researchgate.net/publication/346561821>.
- Kremen C, Williams NM, Throp RW. Crop pollination from native bees at risk from agricultural intensification. *Proc Natl Acad Sci U S A*,2002;99:16812–16816.
- Klein AI, Steffan T, Tscharntke T. Rain forest promotes trophic interaction and diversity of trap-nesting Hymenoptera in adjacent agroforestry. *J Anim Ecol*,2006;75(2):315-323.
- McGregor SE. *Insect pollination of cultivated crop plants*. Agriculture Handbook No. 496. Washington, D.C.: USDA, ARS, 1976, 411.
- Michener CD. *The Bees of the World*. Baltimore, London: The John Hopkins University Press, 2000.
- Nalwaya S, Saxena K. Diversity and abundance of insect pollinators in urban landscapes of Meera Girls College, Udaipur, Rajasthan, India. *Indian J Appl Pure Bio*,2023;38:83–89.
- Potts SG, Biesmeijer JC, Kremen C, Neumann P, Schweiger O, Kuni WE. Global pollinator declines: Trends, impacts and drivers. *Trends Ecol Evol*,2010;25:345–353.

16. Raj H, Mattu VK, Thakur ML. Pollinator diversity and relative abundance of insect visitors on apple crops in Shimla hills of western Himalaya, India. *Int J Sci Nat*,2012;3:507–513.
17. Rajpurohit A, Pathan H, Patel D, Parmar H, Gupta RK. Species composition of Apoidea visitors on *Ocimum basilicum* L. in eastern Rajasthan. *Ann Entomol*, 2018, 36(1).
18. Robinson WS, Nowogrodski R, Morse AR. The value of honey bees as pollinators of US crops. *Am Bee J*,1989;129:411–423:477–487.
19. Sheeja K, Jobiraj T. The bee fauna of Vanaparvam biodiversity Park, Kerala, India (Hymenoptera: Apoidea). *Int J Agric Sci*,2017;7(7):1338-1341.
20. Southwick EE, Southwick L. Estimating the economic value of honey bees (Hymenoptera: Apidae), as agricultural pollinators in the United States. *J Econ Entomol*,1992;85:621–633.