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Research Article

Some observations on genus *Apis,* Linnaeus, 1758 (Apidae: Hymenoptera) from district Ghotki, Sindh, Pakistan

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Abstract

The genus *Apis*, comprising ecologically and economically vital honey bees, is central to global pollination and agricultural productivity. This study documents the occurrence and habitat preferences of four *Apis* species i-e: *Apis cerana*, *Apis dorsata*, *Apis florea*, and *Apis mellifera* in district Ghotki, Sindh, Pakistan. Between August 2024 and October 2025, extensive field surveys were conducted across diverse habitats, resulting in the collection and morphological identification of 298 specimens. Digital photographs and detailed species descriptions were recorded, with each species' distribution mapped according to locality and floral resource use. *Apis cerana* and *Apis mellifera* were found in both managed and wild habitats, while *Apis dorsata* and *Apis florea* preferred open, rural landscapes. The results highlight the importance of floral diversity in supporting *Apis* populations and suggest that local agricultural practices significantly influence species abundance. These findings contribute to the understanding of *Apis* ecology in South Asia and underscore the need for habitat conservation to enhance pollinator services and crop productivity.

Keywords: *Apis cerana, Apis dorsata, Apis florea, Apis mellifera*, South Asia

Introduction

The genus *Apis* Linnaeus, 1758, comprises highly social flying insects commonly known as honey bees, belonging to the family Apidae. These bees are of enormous ecological and economic importance due to their critical role as pollinators of wild flora and crops worldwide

(Begum et al., 2021; Bashir et al., 2023). Globally, *Apis* species are key agents in maintaining biodiversity and enhancing crop productivity through efficient pollination services (Khan et al., 2025; Anjum et al., 2018). The genus *Apis* currently includes about 11 recognized species distributed across three subgenera: *Micrapis*, *Megapis*, and *Apis* sensu stricto (Yasmeen et al., 2025; Mustafa et al., 2022). The subgenus *Apis* contains the globally managed *Apis mellifera* and the native *Apis cerana*, both vital to apiculture. The subgenus *Megapis* includes the giant honey bee *Apis dorsata*, while *Micrapis* comprises smaller species such as *Apis florea* and *Apis andreniformis,* predominantly found in South and Southeast Asia (Hadisoesilo, 1997; Engel, 1999).

Apis cerana is native to much of Asia and shows regional genetic variation, with populations adapted to diverse climates from the plains of Pakistan and India to the montane zones of the Himalayas (Yasmeen et al., 2025; Mim et al., 2025). It tends to build colonies of relatively smaller size but exhibits strong resistance to diseases and parasites compared to *Apis mellifera* (Rizwan et al., 2018; Anjum et al., 2018). Meanwhile, *Apis mellifera*, native to Europe and Africa, has been introduced to South Asia extensively for commercial beekeeping due to its high honey yield and manageable behavior (Mustafa et al., 2022).

Apis dorsata is known for its large size and distinctive open-air nesting on cliffs or tall trees. Its broad foraging range and migratory behavior enable it to be an effective pollinator over vast areas but also render its populations vulnerable to habitat loss and human disturbance, especially in densely farmed lowlands (Khan et al., 2025; Bashir et al., 2023). The dwarf honey bee *Apis florea* builds small, exposed nests on shrubs and hedges and is a generalist pollinator active year-round in tropical climates (Begum et al., 2021; Maryam et al., 2020). Understanding the distribution, habitat preferences, and ecological roles of these *Apis* species in a given region is crucial for biodiversity conservation and optimizing pollination services, particularly in agriculturally rich areas like District Ghotki, Sindh, Pakistan. This study presents preliminary observations on the occurrence and descriptions of four *Apis* species from this region, contributing essential baseline data for future conservation and agricultural planning.

Material and methods

Study area

This study was conducted in district Ghotki, Sindh, Pakistan, an agriculturally dominated landscape characterized by irrigated crop fields, orchards, scattered trees, and rural settlements. The district experiences a semi-arid to arid climate, with hot summers, mild winters, and irregular rainfall concentrated mainly during the monsoon season. Major cultivated crops

include mustard, sunflower, cotton, cucurbits, and various fruit trees such as mango and guava, which provide abundant floral resources for pollinators throughout much of the year (Begum et al., 2021). Within Ghotki, five main localities were selected to represent the spatial heterogeneity of habitats: Daharki, Ghotki City, Khangarh, Mirpur Mathelo, and Ubauro. These localities include a mosaic of crop fields, orchards, village gardens, roadside vegetation, and semi-natural patches, allowing assessment of *Apis* species across different habitat types.

Sampling design and survey period

Field surveys targeting species of the genus *Apis* were carried out from August 2024 to October 2025, covering more than one full annual cycle to capture seasonal variation in honey bee activity and floral availability. Sampling was conducted at regular intervals, with at least two visits per month to each locality, and with intensified effort during peak flowering seasons in spring (February–April) and late summer (August–September), when bee foraging activity typically reaches a maximum in Sindh (Begum et al., 2021; Bashir et al., 2023). At each locality, representative sites were selected within five main habitat categories: mustard fields, sunflower fields, cucurbit fields, mango orchards, and guava orchards, as well as adjacent field margins and weedy patches. Surveys were conducted during days with suitable weather conditions for bee activity (sunny or lightly cloudy, low wind, and no rainfall), typically between 08:00 and 12:00 h and between 15:00 and 17:00 h, when foraging activity of *Apis* species is usually highest (Standard pollinator protocols: LeBuhn et al., 2013; FAO pollinator protocol, 2018). Sampling effort was standardized among localities by maintaining similar observation times and transect lengths at each visit.

Bee collection methods

Honey bees belonging to the genus *Apis* were collected using a combination of active netting of flower visitors and opportunistic hand collection from nests and resting sites, following widely used pollinator sampling protocols (Westphal et al., 2008; Thompson et al., 2021). At each habitat within a locality, linear transects of approximately 100 m were established along field margins or between crop rows. Each transect was walked at a slow, constant pace for 15–20 minutes, and all *Apis* individuals observed visiting flowers within approximately 2 m on either side of the transect line were captured using an entomological sweep net (diameter ca. 30–35 cm). When large aggregations of *Apis dorsata* nests or exposed nests of *Apis florea* were encountered, additional specimens were collected near nest entrances with minimal disturbance to the colonies.

In total, 298 *Apis* specimens were collected across all localities and habitats, representing four species: *Apis cerana, Apis dorsata, Apis florea*, and *Apis mellifera*. For each captured

specimen, the following data were recorded in the field: date, time, locality, habitat type (crop or orchard), dominant flowering plant visited at the time of capture (when applicable), and microhabitat notes (e.g., field margin, interior crop row, orchard edge). This information was written on preprinted data sheets and later transferred to a digital database for analysis, following general recommendations for pollinator monitoring data management (FAO pollinator protocol, 2018).

Specimen handling, preservation, and labeling

Immediately after capture, bees were killed humanely in glass killing jars charged with ethyl acetate or by briefly placing them in a freezer compartment. Specimens were then transferred to paper envelopes or small vials to prevent damage during transport. In the laboratory, all specimens were pinned and mounted following standard entomological techniques, with stainless steel insect pins inserted through the mesothorax and wings and legs arranged to allow visibility of diagnostic characters (Alam and Rahman, 2021; COLOSS honey bee research protocols Carreck et al., 2022). Each specimen or specimen series was assigned a unique code and labeled with collection information, including locality, coordinates (where available), date, collector's name, and habitat/crop type.

The mounted and labeled specimens were dried thoroughly and stored in insect cabinets at the Advanced Entomology Laboratory, Department of Zoology, University of Sindh, Jamshoro. Naphthalene or alternative repellents were used in the cabinets to prevent damage from dermestid beetles and other museum pests. Representative individuals of each species from each locality were selected as voucher specimens to serve as permanent reference material for future taxonomic and ecological studies. These vouchers are curated in the departmental reference collection under controlled temperature and humidity.

Morphological identification of *Apis* species

All specimens were identified to species level based on external morphological characters using standard taxonomic keys and published identification resources for the genus *Apis* (Mustafa et al., 2022; Mim et al., 2025; Key to *Apis* species, IDtools). Diagnostic features considered included body size; coloration of the head, thorax, and abdomen; shape and coloration of abdominal tergites; presence and pattern of hair bands; wing venation; and characteristic structures such as proboscis length, hind-leg corbicula, and nesting-related morphological traits. For *Apis dorsata*, particular attention was given to its larger body size, robust thorax, and distinctive abdominal banding, whereas *Apis florea* was recognized by its smaller body size, relatively slender form, and typical coloration pattern. *Apis cerana* and *Apis mellifera* were differentiated using a combination of body size, abdominal color and banding,

hair density, and previously documented regional morphological criteria (Mustafa et al., 2022; standard honey bee morphometric methods).

Where necessary, selected body parts (e.g. wings, legs, antennae) were examined under a stereomicroscope to confirm identification, following established honey bee morphometric procedures (Meixner et al., 2013). Although molecular confirmation (e.g., COI barcoding) was not applied in the present preliminary survey, the identification framework was informed by recent COI-based studies on *Apis* species from Pakistan and neighboring countries (Rizwan et al., 2018; Mim et al., 2025), ensuring consistency with current regional taxonomy.

Data organization and analysis

For each species, the total number of specimens collected was summarized by locality and habitat type (crop/orchard), resulting in species-by-locality and species-by-habitat tables. The occurrence of each *Apis* species across the five main localities (Daharki, Ghotki City, Khangarh, Mirpur Mathelo, Ubauro) and across the principal crops (mustard, sunflower, guava, mango, cucurbits) was tabulated to visualize spatial and habitat associations. Simple descriptive statistics, including totals and relative proportions of each species in each locality and habitat, were calculated using spreadsheet software (Microsoft Excel), which is commonly used in pollinator field studies for basic data handling and summarization (Begum et al., 2021). Given the exploratory nature of this study and the limited sample size, no advanced statistical modeling was applied; however, the structured dataset provides a baseline for future quantitative analyses of species–habitat relationships and seasonal dynamics.

Ethical and conservation considerations

During fieldwork, care was taken to minimize disturbance to natural and managed bee colonies. Only a limited number of worker bees were collected from any single colony or nesting aggregation, to avoid a significant impact on colony performance and pollination services, in accordance with good practice in pollinator research (FAO pollinator protocol, 2018; Westphal et al., 2008). Collecting activities were restricted to non-protected areas and common agricultural landscapes, and all work complied with general institutional guidelines of the University of Sindh for handling insect specimens in ecological surveys.

Results

A total of 298 specimens of the genus *Apis* were collected from five localities (Daharki, Ghotki City, Khangarh, Mirpur Mathelo, Ubauro) in the district Ghotki, Sindh, Pakistan, between August 2024 and October 2025 (Tables 1, 4, 7, 10). The material comprised four species: *Apis cerana*, *Apis dorsata*, *Apis florea*, and *Apis mellifera* (Tables 1, 4, 7, 10).

Species composition and abundance

Overall, *A. florea* was the most abundant species (84 specimens), followed by *A. cerana* (76 specimens), *A. mellifera* (76 specimens), and *A. dorsata* (62 specimens) (Tables 1, 4, 7, 10). *A. florea* reached its highest numbers in Khangarh and Ubauro, while *A. cerana* and *A. mellifera* were more evenly distributed across all localities (Tables 1, 7, 10). *A. dorsata* was present at all sites but with comparatively lower numbers, reflecting its ecology as a large, open-nesting species (Table 4).

Habitat and crop associations

Across habitats, all four *Apis* species were recorded visiting mustard, sunflower, guava, mango, and cucurbits (Tables 2, 5, 8, 11). Sunflower and mustard supported the greatest numbers of foraging individuals, with particularly high counts of *A. florea* and *A. mellifera* (Tables 8, 11). *A. dorsata* showed a strong association with sunflower and cucurbits, whereas *A. cerana* and *A. mellifera* were frequently encountered in orchards (mango, guava) as well as field crops (Tables 2, 5, 8, 11). These patterns indicate broad overlap in floral resource use but with some differences in crop preferences that reflect species-specific foraging behavior (Tables 2, 5, 8, 11).

Morphological diagnosis of recorded species

Morphological examination confirmed the presence of four distinct *Apis* species, consistent with the ecological summaries provided for each taxon (Tables 3, 6, 9, 12). *A. cerana* was characterized by its medium body size, dark brown coloration with pale abdominal bands, and relatively narrow wings; *A. dorsata* exhibited large body size and conspicuous yellow banding; *A. florea* was the smallest species with a slender body; and *A. mellifera* showed variable brown coloration and dense thoracic pilosity (Tables 3, 6, 9, 12).

Table 1. An abundance of *Apis cerana* workers was collected from major localities in District Ghotki, Sindh, Pakistan.

Localities of District Ghotki	No. of Specimens Collected
Daharki	13
Ghotki City	11
Khangarh	21
Mirpur Mathelo	13
Ubauro	18
Total	76

Table 2. Distribution of *Apis cerana* workers across major cultivated crops and orchards in five localities of the district Ghotki, Sindh, Pakistan.

S.No	Localities	Mustard	Sunflower	Guava	Mango	Cucurbits	Total no: specimens
1	Daharki	3	5	2	2	1	13
2	Ghotki City	2	5	2	1	1	11
3	Khangarh	6	7	3	2	3	21
4	Mirpur Mathelo	2	4	2	1	4	13
5	Ubauro	4	5	3	2	4	18
6	Total no: Specimens	17	26	12	8	13	76

Table 3. Summary of nesting ecology, foraging traits, and pollination roles of *Apis cerana* in agro-ecosystems of district Ghotki, Sindh, Pakistan.

S. No.	Ecological Parameter	Description
1	Habitat Preference	Nests in tree cavities, cracks in walls, rock crevices, and man-made wooden hives.
2	Nesting Behavior	Builds multiple parallel combs inside cavities; colonies are perennial but smaller than *A. mellifera*.
3	Foraging Range	500 m – 2 km (smaller than *A. dorsata*).
4	Floral Resources	Mustard, sunflower, pigeon pea, guava, mango, litchi, cucurbits, wild weeds.
5	Pollination Role	Important pollinator of crops (mustard, sunflower, cucurbits, legumes, cotton) and wild flora; smaller size allows pollination of narrow-flowered plants.
6	Seasonal Activity	Active throughout the year; peak abundance during spring and summer bloom (Feb–Sept).

Table 4. An abundance of *Apis dorsata* workers was collected from major localities in District Ghotki, Sindh, Pakistan.

Localities of District Ghotki	No. of Specimens Collected
Daharki	14
Ghotki City	12
Khangarh	15
Mirpur Mathelo	10
Ubauro	11
Total	62

Table 5. Distribution of *Apis dorsata* workers across major cultivated crops and orchards in five localities of the district Ghotki, Sindh, Pakistan.

S.No	Localities	Mustard	Sunflower	Guava	Mango	Cucurbits	Total no: specimens
1	Daharki	4	5	1	1	3	14
2	Ghotki City	3	4	2	0	1	12
3	Khangarh	4	7	2	1	1	15
4	Mirpur Mathelo	1	2	1	0	2	10
5	Ubauro	2	3	3	1	2	11
6	Total no: Specimens	14	21	9	3	9	62

Table 6. Summary of nesting ecology, foraging traits, and pollination roles of *Apis dorsata* in agro-ecosystems of district Ghotki, Sindh, Pakistan.

S. No.	Ecological Parameter	Description
1	Habitat Preference	Builds large exposed nests on tall trees, cliffs, water towers, and sometimes buildings in rural/agricultural landscapes.
2	Nesting Behavior	Constructs single large comb, often >1 m in length, in open air; colonies may migrate seasonally.
3	Foraging Range	1 – 5 km (among the widest of *Apis* species).
4	Floral Resources	Sunflower, cotton, mango, guava, litchi, mustard, cucurbits, legumes, and various wild flowering weeds.
5	Pollination Role	Major pollinator of crops (sunflower, cotton, mango, guava, cucurbits) and wild flora; contributes significantly to cross-pollination.
6	Seasonal Activity	Active throughout the year in Sindh; peak abundance during summer flowering season (April–September)

Table 7. An abundance of *Apis florea* workers was collected from major localities in District Ghotki, Sindh, Pakistan.

Localities of District Ghotki	No. of Specimens Collected
Daharki	16
Ghotki City	14
Khangarh	21
Mirpur Mathelo	15
Ubauro	18
Total	84

Table 8. Distribution of *Apis florea* workers across major cultivated crops and orchards in five localities of the district Ghotki, Sindh, Pakistan.

S.No	Localities	Mustard	Sunflower	Guava	Mango	Cucurbits	Total no: specimens
1	Daharki	4	6	3	1	2	16
2	Ghotki City	5	6	1	0	2	14
3	Khangarh	5	7	4	2	3	21
4	Mirpur Mathelo	4	5	2	1	3	15
5	Ubauro	5	6	3	2	2	18
6	Total no: Specimens	23	30	13	6	12	84

Table 9. Summary of nesting ecology, foraging traits, and pollination roles of *Apis florea* in agro-ecosystems of district Ghotki, Sindh, Pakistan.

S. No.	Ecological Parameter	Description
1	Habitat Preference	Nests built in shrubs, hedges, small trees, and agricultural field boundaries. Prefers open, sunny areas with flowering plants.
2	Nesting Behavior	Constructs small, single-comb nests; usually exposed on thin branches. Colonies are smaller compared to *Apis dorsata* and *Apis cerana*.
3	Foraging Range	Short-range forager, typically up to 500–700 meters from the nest.
4	Floral Resources	Visits a wide variety of crops (sunflower, mustard, cotton, onion, mango, guava) and wild flora. Acts as a generalist pollinator.
5	Pollination Role	Efficient pollinator of cross-pollinated crops and fruit trees; contributes to yield improvement.
6	Seasonal Activity	Active throughout the year, with peak foraging during spring (Feb–April) and late summer (Aug–Sept).

Table 10. An abundance of *Apis mellifera* workers collected from major localities in District Ghotki, Sindh, Pakistan.

Localities of District Ghotki	No. of Specimens Collected
Daharki	15
Ghotki City	13
Khangarh	18
Mirpur Mathelo	16
Ubauro	14
Total	76

Table 11. Distribution of *Apis mellifera* workers across major cultivated crops and orchards in five localities of the district Ghotki, Sindh, Pakistan.

S.No	Localities	Mustard	Sunflower	Guava	Mango	Cucurbits	Total no: specimens
1	Daharki	4	6	2	1	2	15
2	Ghotki City	5	4	3	0	1	13
3	Khangarh	4	6	3	1	4	18
4	Mirpur Mathelo	5	6	1	1	3	16
5	Ubauro	3	5	3	1	2	14
6	Total no: Specimens	21	27	12	4	12	76

Table 12. Summary of nesting ecology, foraging traits, and pollination roles of *Apis mellifera* in agro-ecosystems of district Ghotki, Sindh, Pakistan.

S. No.	Ecological Parameter	Description
1	Habitat Preference	Domesticated in artificial hives; occasionally wild colonies in tree cavities and abandoned structures.
2	Nesting Behavior	Constructs multiple parallel combs in cavities or wooden hives; highly managed by beekeepers
3	Foraging Range	1 – 3 km (sometimes up to 5 km).
4	Floral Resources	Sunflower, citrus, mango, guava, cotton, cucurbits, legumes, wild weeds
5	Pollination Role	Major pollinator of agricultural crops (sunflower, mustard, cotton, citrus, mango, guava, cucurbits) and wild flora.
6	Seasonal Activity	Active year-round in Sindh; maximum activity during spring bloom (Feb–May) and late summer bloom (Aug–Sept).

Discussion

This study provides the first integrated account of four *Apis* species i-e: *Apis cerana*, *Apis dorsata*, *Apis florea*, and *Apis mellifera* from multiple habitats in district Ghotki, Sindh, Pakistan, thereby filling an important geographic gap in the existing literature on honey bees in the country. Previous work in Pakistan has concentrated mainly on non-*Apis* bees in Potohar (Aslam et al., 2017) and on *Apis* populations and hive occurrence in northern Punjab and Azad Jammu and Kashmir (Bashir et al., 2023), leaving the ecological status of honey bees in Sindh comparatively under-documented. The demonstration that all four major regional *Apis* taxa co-occur in an intensively cultivated landscape underscores the capacity of mixed cropping systems and orchards in Sindh to support diverse honey bee assemblages.

The high abundance of *A. florea* observed in this study is consistent with its known preference for warm lowland agro-ecosystems, where it nests on shrubs, small trees, and field boundaries and exploits a broad spectrum of wild and cultivated flowers. Similar dominance of *A. florea* in agricultural mosaics has been noted in pollinator surveys from other parts of South Asia, where its short foraging range and generalist diet enable it to thrive in fragmented habitats. In contrast, the moderate but widespread presence of *A. dorsata* across all localities corresponds with its ecology as a large, open-nesting species with extensive foraging ranges, which makes

it a powerful but locally less numerous pollinator and highly sensitive to nest disturbance, tree felling, and night harvesting of honey.

The comparable abundances of *A. cerana* and *A. mellifera* likely reflect the coexistence of native and introduced managed honey bees in Ghotki, as *A. mellifera* has been widely propagated in Pakistan for commercial honey production, while *A. cerana* persists in wild colonies and small-scale traditional beekeeping systems. Molecular and morphometric studies from Punjab and neighboring regions have documented substantial intra-specific variation and local adaptation in both *A. mellifera* and *A. cerana*, emphasizing the value of conserving regional lineages for resilience against disease and climate change (Rizwan et al., 2018; Mustafa et al., 2022; Mim et al., 2025). The Ghotki populations described here provide a baseline for future integrative work that combines field ecology with COI-based barcoding and genomic tools already applied to Pakistani honey bees (Rizwan et al., 2018; Tan et al., 2021).

Crop-level patterns in this study, particularly the strong use of sunflower and mustard by all four species, align with findings that oilseed crops are major nectar and pollen sources for *Apis* in arid and semi-arid regions of Pakistan (Begum et al., 2021). Frequent records of *A. mellifera* and *A. cerana* on mango and guava complement previous reports that these species enhance fruit set and yield in orchards in northern Pakistan, highlighting their dual importance for both field crops and perennial fruit trees (Maryam et al., 2020; Anjum et al., 2018). The broad overlap in floral resource use among the four species suggests potential interspecific competition at heavily visited crops; however, such redundancy can also stabilize pollination services by ensuring that if one species declines due to disease, pesticides, or climate stress, others may partially compensate.

From a conservation and management perspective, the documented presence of multiple *Apis* species across Ghotki's agro-ecosystems underscores the need to safeguard nesting substrates, reduce indiscriminate colony destruction, and maintain diverse flowering resources throughout the year. Climate-based modeling indicates that *A. dorsata* habitats in Pakistan may be particularly vulnerable to future warming and land-use change (Khan et al., 2025), making the conservation of tall trees and undisturbed nesting sites in Sindh a priority. At the same time, genomic and microbiome studies on *A. mellifera* and *A. dorsata* have shown that gut bacterial communities and genetic background can strongly influence colony health, suggesting that local management practices should consider both environmental and genetic factors (Anjum et al., 2018; Yasmeen et al., 2025; Tan et al., 2021).

Overall, this preliminary survey establishes district Ghotki as an important landscape for honey bee diversity in southern Pakistan and provides quantitative, locality-specific data on species

composition and crop associations that were previously lacking. Building on this baseline, future research should incorporate standardized pollinator monitoring protocols, quantitative measures of pollination effectiveness at key crops, and molecular tools to track population structure and movement, thereby linking local management in Ghotki to broader national and regional strategies for pollinator conservation and sustainable agriculture.

Conclusion

Present investigation concluded the finding of four species of genus *Apis* from different habitats of Ghotki district Sindh, Pakistan. Moreover, this study suggests that more flowering crops should be grown in this area to increase the diversity of these species and more productivity of crops.

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