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Soil Beetle Assemblages of Konkar Agricultural Fields, Sindh Province, Pakistan: Species Inventory and New Distributional Records

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Abstract

Beetles (Coleoptera) are among the most diverse insect groups and have important ecological roles in agricultural ecosystems, but their diversity is poorly documented in many regions of Pakistan. The diversity of crop-associated soil beetles in the Konkar area of Gadap Town, Karachi was explored in the present study during the 2025 growing season. A total of 23 species belonging to several beetle families were recorded, including predatory, phytophagous, and decomposer guilds typically associated with agricultural habitats. The collected specimens showed that the assemblage of coleopterans in the relatively small agricultural landscape of Konkar is diverse. Six species are reported for the first time from Pakistan: *Chlaenius* (*Achlaenius*) *amplipennis*; *Diplocheila* (*Isorembus*) *transcaspia* Semenov, 1891 (Carabidae); *Amblyrrhinus* *poricollis* Schoenherr, 1826 (Curculionidae); *Cyaneolytta* *violacea* Brandt & Ratzenburg, 1833 (Meloidae); *Pharaphodius* cf. *calo* Balthasar, 1971; and *Rhysemodes* *orientalis* Mulsant & Godart, 1875 (Scarabaeidae). The discovery of these new country records suggests that the beetle fauna of Pakistan remains under-recorded and underscores the importance of faunal surveys in previously unstudied agricultural habitats. This study provides baseline data on the taxonomic composition and diversity of soil beetles in southern Pakistan and is a contribution towards future biodiversity assessments, ecological monitoring and conservation planning in agricultural ecosystems.

Keywords: Faunistic, Coleoptera, New records, Sindh Prov, Pakistan.

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Introduction

Beetles (Insecta: Coleoptera) are the largest order of insects and among the most diverse groups of organisms on Earth. There are approximately 400,000 beetle species known in the world (Segura, 2012). However, many more species are believed to be discovered in less explored areas. Their overwhelming evolutionary success is explained by their ability to adapt to a wide variety of ecological circumstances, allowing them to occupy virtually any terrestrial and freshwater niche. Beetles are one of the most ecologically important groups of insects, with remarkable diversity in their morphology, behaviour, feeding and life histories.

Coleopterans are indispensable in maintaining the stability and functioning of ecosystems. Various groups of beetles have important ecological functions, such as decomposing organic matter, recycling nutrients, pollination, disseminating seeds, biological control of agricultural pests and regulation of populations of other insects. While many species provide important ecosystem services, others are known as serious pests of agriculture and stored products and can cause significant economic losses; 2. Hence, knowledge on beetle diversity is significant not only for biodiversity conservation but also for sustainable agricultural management, ecological monitoring, and environmental assessment.

Pakistan lies at the meeting point of the Oriental, Palaearctic and Afrotropical biogeographical regions and is, consequently, unique in its ecological and biological diversity. The country offers a variety of habitats from alpine forests in the Himalayas and Hindu Kush, arid deserts, riverine systems, coastal zones and the fertile agricultural plains of Sindh. This environmental heterogeneity results in a

rich and diverse insect fauna including many representatives of the order Coleoptera. Despite this potential richness, the beetle fauna of Pakistan is still poorly documented, with many areas having been subjected to little or no systematic entomological investigation. Many areas, especially small, isolated or rural agricultural localities, remain poorly surveyed, which results in large gaps in our knowledge of species distribution and biodiversity.

Konkar is a small village, an agricultural community, in Gadap Town in Karachi, at the foot of the Kirthar Range. The area's climate is semi-arid with high temperatures, low annual rainfall, and seasonal agricultural activities. The landscape is mainly cultivated crop fields with patches of native shrubs, scattered trees, and natural vegetation from the adjoining Kirthar foothills. This mosaic of cultivated and semi-natural habitats provides suitable conditions for a large number of insect species, including many beetle taxa with different ecological niches. However, despite its ecological importance, Konkar has attracted little scientific attention regarding its insect biodiversity, especially its Coleopteran fauna.

To address this knowledge gap, a large-scale field survey was conducted from spring to autumn 2025 to document beetle diversity associated with agricultural habitats in Konkar. The objectives of the present study were to prepare an inventory of the Coleoptera species occurring in and around cultivated fields, to record species which may represent new distributional records for Pakistan, and to contribute baseline faunal data for future ecological, taxonomic and conservation studies. The study provides valuable information on the diversity and distribution of beetles in

southern Pakistan by comparing collected specimens with previously published faunal inventories and adds to a broader understanding of the country's coleopteran fauna. The results also serve as a valuable reference for future biodiversity assessments, monitoring of agricultural pests, and planning for conservation in the region.

The order Coleoptera is the largest and one of the most diverse insect orders (Insecta: Coleoptera, ~400,000 known species worldwide, Segura, 2012). They have been remarkably successful evolutionarily, enabling them to colonize almost all terrestrial and freshwater habitats, where they perform a wide variety of ecological functions. Beetles play a critical role in ecosystem processes like decomposition, nutrient cycling, pollination, seed dispersal, biological control, and regulation of other invertebrate populations. Many groups of beetles are used widely as indicators of habitat quality and ecosystem health because of their ecological diversity and sensitivity to change in the environment. Pakistan has a unique biogeographical position at the junction of the Oriental, Palaearctic and Afrotropical regions and supports remarkable diversity of habitats ranging from the Himalayan forests in the north to the arid deserts, riverine ecosystems and the agricultural plains of Sindh in the south. This environmental heterogeneity offers favourable conditions for a rich insect fauna, with a diverse assemblage of coleopteran species. Despite this potential diversity, the beetle fauna of Pakistan is incompletely documented and many areas, particularly small or isolated agricultural landscapes, have received little systematic entomological attention.

One such place is Konkar, a small agricultural settlement in Gadap Town,

Karachi, at the foothills of the Kirthar Range. The local climate is semi-arid with high temperatures and seasonal rainfall that supports mainly warm-season agriculture. The site is surrounded by cultivated fields with native shrubs, scattered trees, and natural vegetation coming down from the Kirthar foothills. The mixture of cultivated and semi-natural habitats in this region provides a range of ecological niches, which could support diverse beetle communities, but the coleopteran fauna of the area has not been well studied.

Agricultural ecosystems harbor a rich beetle community which is important for ecosystem functioning and biodiversity conservation (Tscharntke et al., 2021). In recent studies, beetle communities have been shown to respond strongly to land-use practices, crop diversity, habitat heterogeneity, and environmental disturbance. Carabidae, a family of ground beetles, are widely known as important biological control agents. Scarabaeidae play a role in nutrient cycling and soil improvement through the decomposition of dung and processing of organic materials (Kotze et al., 2021; Nichols et al., 2022). Curculionidae and Tenebrionidae are also important parts of agricultural food webs and can indicate habitat quality. Recent studies have demonstrated that agricultural landscapes can be significant reservoirs of insect biodiversity if natural vegetation patches and sustainable farming practices are maintained. Therefore, local biodiversity inventories are required to understand species distributions and to develop effective conservation strategies in agroecosystems.

Monitoring of soil biodiversity has become an increasingly important component of ecosystem assessment and sustainable land management. One of the

most well-known bioindicators is soil insects, in particular beetles, which are characterized by a quick response to environmental changes and habitat disturbances (Rainio and Niemelä, 2021). Pitfall trapping techniques are widely used in monitoring programmes to assess species richness, community composition and temporal variation in arthropod assemblages (Work and Buddle, 2022). Recent ecological studies have also demonstrated the importance of long-term biodiversity monitoring to detect changes in species distribution, to evaluate the health of ecosystems and to assess the impacts of agricultural intensification. Thus, baseline inventories of soil fauna are necessary for future ecological monitoring and conservation planning, especially in regions where information on biodiversity is still scarce.

The beetle species richness, diversity, and abundance have been more and more reported in Pakistan and other parts of South Asia (Alam et al., 2024; Bektas and Tezcan, 2025; Kwon et al., 2026). However, many agricultural regions of Pakistan remain under-explored and deficient in large faunal inventories. The taxonomy and nomenclature of the collected specimens were checked against the Catalogue of Palaearctic Coleoptera and other authoritative taxonomic literature (Ahmed & Lalika, 2025; Ball, 1959; Darılmaz and Ahmed, 2015; Platia, 2015; Alonso-Zarazaga et al., 2017; Genier and Moretto, 2017; Iwan and Löbl, 2020; Löbl and Smetana, 2007; Löbl and Löbl, 2016; Löbl and Löbl (eds.), 2017) to ensure the accuracy of the identification and to validate distributional records. In this regard, the present study was conducted to document the coleopteran fauna associated with the agricultural landscapes of Konkar, Gadap Town, Karachi, to prepare a

baseline inventory of species occurring in the area, to identify potential new distributional records for Pakistan, and to contribute to the understanding of beetle diversity in southern Pakistan.

Data Collection

Materials and methods

The study was conducted at Khuda Bux Farm, Konkar, Gadap Town, Karachi, Pakistan (25.0659°N, 67.2727°E; elevation 176 m above sea level). Konkar is a peri-urban agricultural region characterized by a semi-arid climate, low and irregular rainfall, high temperatures, and year-round cultivation supported primarily by groundwater irrigation. The area comprises a mosaic of vegetable, fruit, and fodder crops, providing suitable habitats for a diverse assemblage of insect pests and beneficial insects. The study site was selected due to its agricultural importance, crop diversity, and frequent pest infestations.

It was done to investigate insect diversity and abundance in agricultural fields. Sampling was carried out across different crop species during pre-monsoon, monsoon, and post-monsoon seasons. Insects were collected using direct hand picking, sweep nets, yellow sticky traps, pheromone traps, and light traps to ensure comprehensive sampling of both diurnal and nocturnal species.

Collected specimens were preserved in 70% ethanol and identified to the lowest possible taxonomic level using standard taxonomic keys and morphological characteristics under a stereomicroscope. Environmental parameters, including temperature, humidity, rainfall, and wind speed, were recorded to assess their influence on insect populations.

Species diversity was evaluated using the Shannon–Wiener and Simpson diversity indices, while relationships

between insect communities and environmental variables were analyzed through Canonical Correspondence Analysis (CCA). Statistical analyses were performed using SPSS, Microsoft Excel, and RStudio.

Results

Taxonomic Composition and Diversity of Soil Beetles

A total of 23 species of beetles belonging to 9 families of the order Coleoptera were collected from the survey in the agricultural landscapes of Konkar, Gadap Town, Karachi. The collected specimens were a taxonomically diverse group of species occupying different ecological niches, usually associated with semi-arid agricultural ecosystems. The beetle fauna comprised predatory and phytophagous groups, and saprophagous and decomposer species contributing to nutrient cycling and the functioning of the soil ecosystem.

The families recorded were highly variable in terms of species richness and ecological roles. Cultivated fields and bordering natural vegetation were often inhabited by predatory beetles, especially those of the Carabidae and other predatory groups, indicating their participation in the regulation of other arthropod populations. Phytophagous beetles including representatives of Curculionidae, Chrysomelidae and related families were associated with cultivated crops and surrounding vegetation, while decomposer taxa including members of Scarabaeidae and Tenebrionidae were commonly collected from soil surfaces and organic debris. Together, these ecological guilds represent the functional diversity of beetle communities in the agricultural landscape of the study area.

This beetle species diversity observed in the survey is a reflection of the

heterogeneous nature of the Konkar agroecosystem, where cultivated fields, native shrubs, scattered trees, and semi-natural vegetation provide a variety of microhabitats that support different beetle taxa. The presence of species of more than one trophic guild indicates the presence of a relatively diverse coleopteran assemblage in the area of study despite the environmental conditions of semi-arid areas.

The recorded beetles were identified according to the standard taxonomic hierarchy, starting with the order Coleoptera and then identifying them at the family and species levels. The systematic arrangement and species accounts are given in the following sections and tables.

Table 4.1

Order-wise Distribution of Recorded Beetle Species

Order	Number of Families	Number of Species
Coleoptera	9	23

Family-wise Species Richness

Family-level analysis showed variation in species richness among different beetle groups. The highest number of species was recorded from the family Scarabaeidae, followed by Carabidae, Curculionidae, and Tenebrionidae.

Table 4.2

Family-wise Distribution of Soil Beetle Species

Family	Number of Species
Scarabaeidae	6
Carabidae	4
Curculionidae	4
Tenebrionidae	4
Elateridae	2
Trogidae	2
Hydrophilidae	1
Meloidae	1

Geotrupidae	1
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Species Composition of Recorded Beetles

The recorded beetle fauna consisted of species belonging to several families commonly associated with agricultural habitats.

Table 4.3

Recorded Beetle Families and Ecological Importance

Family	Species Number	Ecological Role
Carabidae	4	Predatory beetles, natural pest regulation
Curculionidae	4	Plant-associated beetles
Scarabaeidae	6	Decomposition and soil processes
Tenebrionidae	4	Adapted to dry and semi-arid habitats
Other families	5	Various ecological functions

Species Abundance Analysis

The abundance of beetle species was evaluated according to the number of collected specimens from each species. Species abundance provides information regarding dominant and rare species within the community.

Table 4.4

Species-wise Abundance of Recorded Beetles

Species	Family	Number of Specimens
Calosoma imbricatum	Carabidae	2
Chlaenius amplipennis	Carabidae	1
Diplocheila transcaspia	Carabidae	1
Distichus planus	Carabidae	2
Pycnodactylopsis albogilva	Curculionidae	2
Neocleonus maculipes	Curculionidae	1
Amblyrrhinus poricollis	Curculionidae	3
Myllocerus curvicornis	Curculionidae	1

Biodiversity Indices

To evaluate beetle community structure, biodiversity indices were applied. These indices provide information about species diversity, dominance, and distribution patterns.

Shannon-Wiener Diversity Index

The Shannon diversity index was used to measure species diversity by considering both richness and abundance.

Formula:

$$H' = -\sum P_i \ln(P_i)$$

Where:

H' = Shannon diversity index

P_i = proportion of individuals belonging to species i

Higher Shannon values indicate greater diversity and a more balanced community.

Simpson Diversity Index

Simpson index was used to determine dominance within the beetle community.

Formula:

$$D = \sum P_i^2$$

Lower dominance values indicate higher diversity.

Species Evenness Index

Species evenness was calculated to determine the distribution of individuals among species. **Formula:**

$$J = H' / \ln(S)$$

Where:

S = total number of species

Graphical Representation of Beetle Diversity

The following figures were added to represent biodiversity patterns:

Annexure (A)

A bar graph showing the number of species recorded from each family.

Annexure (B)

A pie chart representing the contribution of each family to total beetle diversity.

New Country Records

The study recorded six beetle species as new country records for Pakistan, including:

1. *Chlaenius* (*Achlaenius*) *amplipennis*
2. *Diplocheila* (*Isorembus*) *transcaspia*
3. *Amblyrrhinus* *poricollis*
4. *Cyaneolytta* *violacea*
5. *Pharaphodius* *calo*
6. *Rhyssesmodus* *orientalis*

These findings indicate that the beetle fauna of Pakistan is still incompletely explored and further biodiversity surveys are required.

Discussion

In the present survey, a total of 23 beetle species were recorded from agricultural fields and surrounding habitats of Konkar, Gadap Town, Karachi. This indicates that even relatively small agricultural landscapes in southern Pakistan can harbour a diverse assemblage of coleopteran fauna. The recorded species reflected the ecological complexity of the study area, belonging to different ecological guilds like predatory, phytophagous, and decomposer beetles. The presence of cultivated fields interspersed with patches of native vegetation and shrubs likely creates a diversity of microhabitats and food resources that permit the persistence of diverse beetle communities in this semi-arid agroecosystem.

One of the most important results of the present study is the documentation of six species reported for the first time from Pakistan. These new country records emphasize that the coleopteran fauna of Pakistan is still incompletely documented despite numerous taxonomic studies that were performed during the last decades. Similar results have been obtained in regional faunistic surveys, where the faunal inventories are often local and report new species for the area, especially

in biotopes with little entomological exploration. The discovery of new country records in a relatively small study area suggests that further systematic surveys in other poorly explored regions of Pakistan may considerably add to the known diversity of the beetle fauna of the country.

Most of the species found were from families typically found in agricultural ecosystems, mainly Carabidae and Curculionidae. Carabidae are well known as important predatory beetles that contribute to the natural regulation of pest populations, while Curculionidae are predominantly phytophagous species closely associated with cultivated crops and wild host plants. Hence, the dominance of these families is in accordance with the agricultural nature of the study area and indicates the availability of suitable habitats and food resources. The higher number of families reported for decomposer and scavenger guilds suggests that the agricultural landscape has multiple ecological functions that support nutrient cycling and ecosystem stability in general. The total species richness recorded in the present survey supports the findings reported from other agricultural and semi-arid regions of Sindh and adjoining areas. The similarities suggest that the beetle community recorded from Konkar is a typical assemblage associated with cultivated landscapes under semi-arid climatic conditions. However, differences in sampling intensity, seasonal coverage, habitat characteristics, and collection methods between studies must be taken into account when directly comparing species richness.

The timing of collection of specimens may also have influenced the diversity observed. Most of the beetles were collected during the warm growing season (April-October), when higher

temperatures, increased vegetation growth, and greater resource availability generally promote insect activity, reproduction, and dispersal. The seasonal peaks in beetle abundance in the warmer months have been reported in several studies from similar climate regions, supporting the seasonal pattern observed in the present survey.

The present study constitutes an important baseline inventory of beetles associated with agricultural habitats in Konkar. Such baseline data are valuable for future biodiversity assessments, ecological monitoring and conservation planning, especially in regions with limited faunal information. Additional habitat types, varying seasons and continued surveys over multiple years would improve the understanding of temporal variation in beetle assemblages and may reveal additional species not encountered during the present investigation. Moreover, future studies combining ecological, molecular and taxonomic approaches would complement the existing knowledge on coleopteran diversity in Pakistan and would provide insights for more effective biodiversity conservation and sustainable agricultural management.

Conclusion

The diversity of beetles in the farms of Konkar indicates their ecological importance in this agro-ecosystem. The fact that there are so many different kinds of them means they could help with natural pest control and nutrient cycling. The study reported on ground beetles (Carabidae), which are known to feed on pest species that damage crops. That means the ecosystem is in good shape. The presence of tenebrionids and other families is also an indication of a fauna well adapted to dry conditions. But without the numbers on the population, you can't tell how common or

dominant a species is. Therefore, these results should be viewed as a list of species present and not as a way to track population changes over time. Also, the specimens were collected only from adults by hand-collecting and traps, and may have missed cryptic or nocturnal taxa. Future studies should include sampling throughout the year from different habitats in Gadap Town and Kirthar foothills using standardized trapping methods and molecular identification tools to improve detection of species and ecological understanding. Long-term studies of beetle communities in relation to farming practices and changes in the weather would also help us to protect biodiversity and control pests in an environmentally friendly way.

Recent advances in molecular taxonomy have significantly improved the accuracy of insect identification and biodiversity assessment. DNA barcoding, particularly through the mitochondrial cytochrome c oxidase subunit I (COI) gene, has become a widely accepted tool for species verification, cryptic species detection, and phylogenetic analysis (Hebert and Gregory, 2022). Molecular approaches are especially valuable for taxonomically challenging groups where morphological identification alone may be insufficient. Future studies on the coleopteran fauna of Pakistan should integrate traditional morphological methods with DNA-based techniques to enhance taxonomic resolution and improve the reliability of biodiversity inventories. The application of molecular tools, combined with standardized ecological sampling and long-term monitoring programs, will provide a more comprehensive understanding of beetle diversity, distribution patterns, and

ecological responses to environmental change.

Recommendation

The study recommended a baseline of research for the future because there is an open field to understand the existing seasonal crops, their integrated pest management, and affects the insects that show diversity patterns.

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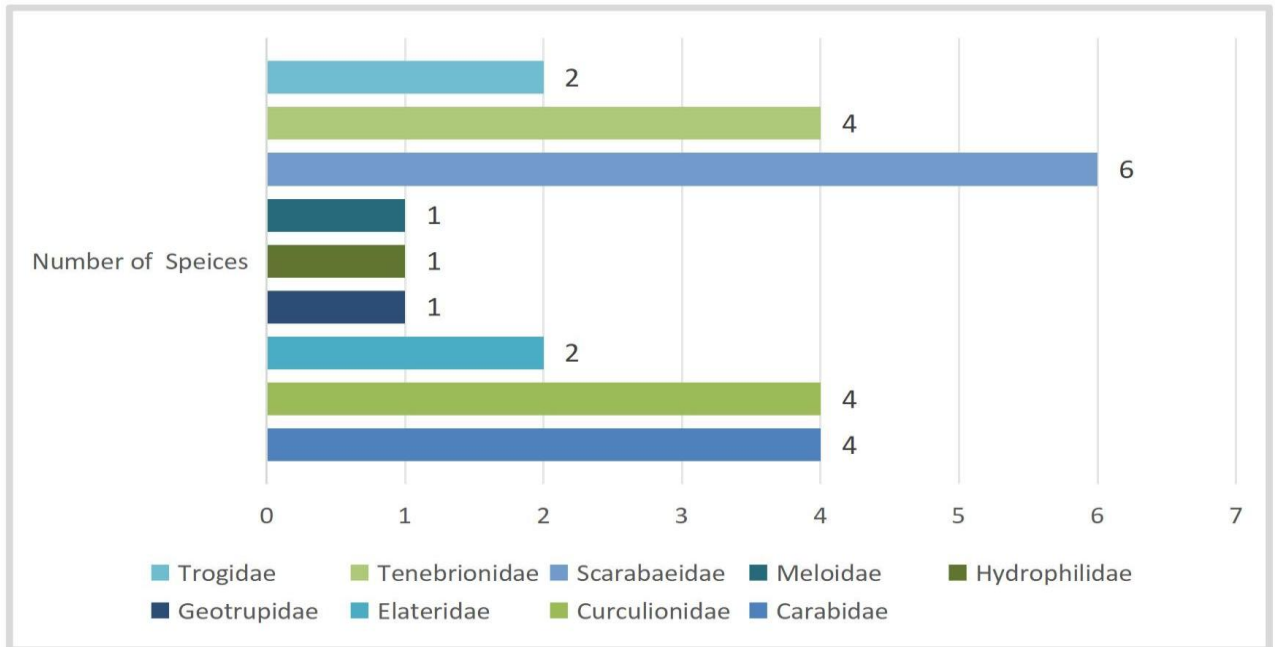
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Annexure (A)

Figure 4.1

Family-wise Species Richness of Soil Beetles



Annexure (B)

Figure 4.2

Percentage Contribution of Different Beetle Families

