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RESEARCH ARTICLE

Biodiversity and Relative Abundance of Insects Fauna in different Crops of Kamalia Region, Pakistan

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Abstract This study examines insect biodiversity across 28 locations in Kamalia using key ecological indices—Species Richness, Shannon Index, and Simpson Index—to assess species distribution and diversity. The findings highlight significant variations in biodiversity, with areas like the Forest area, Chak No. 740 GB Kamalia exhibiting high species richness and a balanced ecosystem, whereas urbanized locations such as Govt. Girls High School 713 GB Kamalia show lower diversity, dominated by species like Aedes aegypti and Periplaneta americana. The study underscores the impact of human activities, including urbanization, pollution, and habitat fragmentation, on insect populations. It also identifies both beneficial species, such as Apis mellifera linnaeus, and pest species, indicating a complex ecological balance. Key limitations include sampling biases and the exclusion of seasonal variations. To address these gaps, future research should incorporate broader geographic sampling and long-term monitoring. The study emphasizes the need for targeted conservation strategies and sustainable habitat management to preserve biodiversity. Encouraging green spaces and community-based research can help mitigate biodiversity loss. These findings provide valuable insights for researchers, conservationists, and policymakers aiming to balance ecological stability with sustainable development in Kamalia's diverse ecosystems.

Keywords: Biodiversity, species richness, abundance, Shannon index, Simspons Index.

Introduction

The decomposition of organic matter, pollination, pest control, nutrient cycling, and other ecological services are all provided by insects, which are especially important in agroecosystems (Gurr et al., 2012; Majer, 1987). Insects make up over 73% of all known animal species and are one of the most prolific and diverse groups of organisms on Earth. They are also essential to maintaining ecological balance (Raghavendra et al., 2022). Although insects are important, several anthropogenic factors, including intense agricultural practices, habitat fragmentation, pesticide usage, and climate change, are contributing to the loss of insect populations worldwide (Hallmann et al., 2017; Dunn, 2005). This reduction puts at risk not only biodiversity but also the long-term viability of natural ecosystems and food systems (Losey & Vaughan, 2006).

The preservation of biodiversity and agricultural productivity must be balanced in agroecosystems. The very ecosystem services that sustain crop production are undermined by agricultural intensification, which frequently results in a decline in arthropod diversity (Swift et al., 1996; Rana et al., 2019). For improving soil fertility and controlling pest populations, insects like pollinators and natural predators are essential (Cardinale et al., 2006; Rathore & Jasrai, 2013). However, the location, abundance, and diversity of these beneficial insect populations are influenced by bioclimatic factors and environmental changes, which make them extremely susceptible (Yi et al., 2012). Studies have looked at how farming techniques affect biodiversity generally, but few have looked at the insect fauna in particular agricultural regions, especially in developing nations where ecological data are sometimes lacking (Nicholls & Altieri, 2013).

Farmlands, orchards, fallow lands, and woodlands make up the diverse environment of Pakistan's Kamalia Region in District Toba Tek Singh (Khan et al., 2020). It is the perfect case study for examining how agricultural practices affect insect biodiversity because of its diversity. Nevertheless, not much research has been done to assess the ecological importance and diversity of insects in this area. The creation of evidence-based conservation plans adapted to regional environmental and agricultural circumstances is hampered by the lack of baseline data on insect abundance and distribution (Saunders et al., 2020).

By investigating the diversity and relative abundance of insect fauna across different crop systems in the Kamalia Region, this study seeks to close this important knowledge gap. Additionally, it looks for bioclimatic elements that affect insect populations. This study will aid in the development of sustainable and biodiversity-friendly farming techniques by examining the effects of various agricultural strategies on insect communities (Altieri & Letourneau, 1982). It is anticipated that the results would aid ecological conservation initiatives and offer recommendations for controlling insect populations in a way that is advantageous to the environment and agriculture (Samways, 2007).

Materials and Methods

This research was carried out at Riphah University, Faisalabad Campus, between July 2024 and March 2025. The primary aim intended to assess the relative abundance of insect fauna in Kamalia city, situated in the district T. T. Singh. Kamalia is geographically located at 30° 44′ 0″ N, latitude & 72° 39′ 0 ″ E, longitude. The city is bordered by the River Ravi and Chichawatni in the south, Pir Mahal in the west, Rajana and Mamu Kanjan in the north, and Harappa and Sahiwal to the east.

The Kamalia region, District Toba Tek Singh, Pakistan, was the site of this study's July–December 2024 fieldwork, which was centered at the Riphah International University Faisalabad Campus. Assessing the relative variety and richness of insect fauna across various agroecosystems was the main goal. The Kamalia region is perfect for assessing biodiversity since it provides a variety of habitats, such as grasslands, woodland borders, and agricultural areas (Khan et al., 2020).

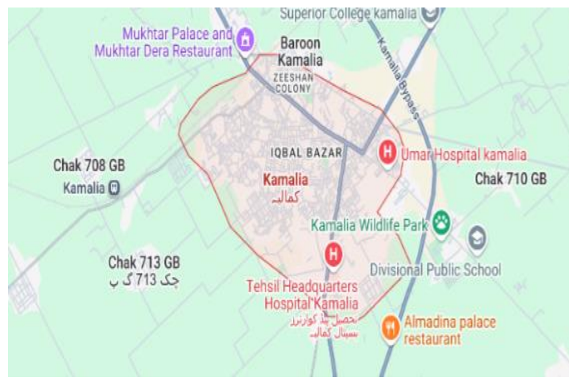

Figure 1. The boundary of Kamalia Tehsil, Punjab, Pakistan.

On a weekly basis sampling took place in 200 m² of well-chosen crop fields. To investigate how climatic factors affected insect populations, digital thermometers and hygrometers were used to collect environmental data, such as temperature and humidity (Yi et al., 2012).

Several techniques of collection were used. A commonly used technique in ecological research, sweep netting entailed swinging a net horizontally across vegetation to catch insects that were above the canopy. Specimens were preserved in jars with 70% alcohol and 30% glycerine, and this procedure was carried out between 5:00 and 7:00 a.m. (Altieri & Letourneau, 1982). In order to ensure accuracy and least harm to the specimen, visible and delicate insects were collected using forceps and handpicking (Majer, 1987).

Pitfall traps were used to catch insects that live on the ground in order to augment canopy-level collection. These traps were double-cup containers filled with a mild detergent solution to immobilize insects, and they were buried flush with the earth (Cardinale et al., 2006). To attract pollinators, fluorescent bowl traps in blue and yellow were positioned at random at each field location. The traps were in operation from 9:00

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a.m. to 5:00 p.m., and the contents were gathered at the end of the day (Hallmann et al., 2017).

The insects were taken to the Riphah International University's entomology laboratory so they could be identified. Standard taxonomic keys were used to identify specimens to the species level after morphological characteristics were analyzed under dissecting microscopes (Kumlert et al., 2018). A deeper comprehension of insect population dynamics and the development of regionally specific conservation strategies were facilitated by the analysis of the recorded data for species richness, diversity indicators, and ecological roles (Wilson & Fox, 2021).

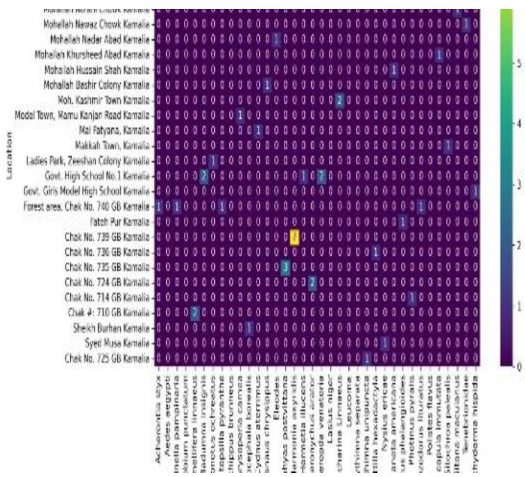

Figure 2. Heatmap illustrating the abundance of insect species across different locations in Kamalia, with locations ordered by K-Means clustering. Species are represented by their scientific names, and cell values indicate observed counts.

The patterns of insect diversity in Kamalia's urban and rural areas differ significantly. Urban locations like *Govt. Girls High School 713 GB Kamalia* and *Govt. Girls Model High School Kamalia* are mostly inhabited by species such as *Aedes aegypti* and *Apis mellifera Linnaeus*, both commonly associated with human-modified ecosystems. These areas often have low plant diversity and are subject to pesticide use, limiting the variety of insect species. In contrast, the *Forest area, Chak No. 740 GB Kamalia* hosts a broader range of insects, including *Acherontia styx*, *Anavitrinella pampinaria*, and *Chrysoperla carnea*, reflecting a richer ecosystem. Urbanized zones also support specialized insects like *Periplaneta americana* and *Polistes flavus*.

Results

Table 1. Species Richness, Shannon Diversity and Simpsons Diversity Index at locations in Kamalia:

No.	Location	Species Richness	Shannon Index	Simpson Index
1	Chak #: 709 GB	1	0	0
2	Bashir Colony	1	0	0
3	Ravi Town	3	1	1
4	Chak #: 710 GB	1	0	0
5	GHS No.1	3	1	1
6	GHS 713 GB	2	1	1
7	Chak #: 724 GB	1	0	0
8	Chak #: 735 GB	1	0	0
9	Chak #: 736 GB	1	0	0
10	Nadar Abad	1	0	0
11	GGMHS	1	0	0
12	Khurshid Abad	1	0	0
13	Makkah Town	1	0	0
14	Model Town	1	0	0
15	Nawaz Chowk	1	0	0
16	Chak #: 714 GB	1	0	0
17	Chak #: 725 GB	1	0	0
18	Chak #: 740 GB	4	1	1
19	Mal Fatyana	1	0	0
20	Chak #: 739 GB	1	0	0
21	Fateh Pur	1	0	0
22	Sheikh Burhan	1	0	0
23	Syed Musa	1	0	0
24	Kashmir Town	1	0	0
25	Zeeshan Colony	1	0	0
26	Ladies Park	1	0	0
27	Hussain Shah	1	0	0
28	Norani Chowk	1	0	0

Species richness, Shannon diversity index, and Simpson diversity index are three ecological metrics that show significant differences in insect diversity across 28 sites in the Kamalia region. In agroecosystems with different degrees of disturbance, these indicators show significant trends in species variety, evenness, and dominance (Morris et al., 2014).

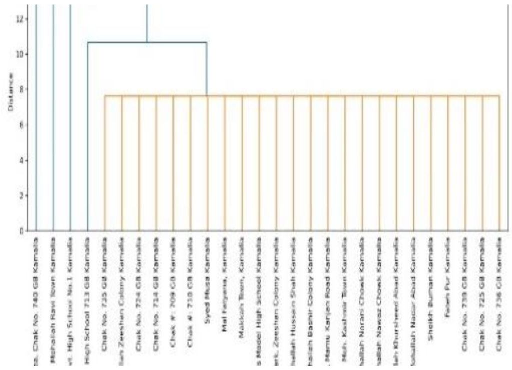

Figure 3. Hierarchical clustering dendrogram of sampling locations in Kamalia based on insect species composition, using Ward's linkage method. The y-axis represents the linkage distance, indicating similarity between locations.

Species Richness

In terms of species richness, Figure 3 & 4 show that most sites, such as Chak 709 GB and Mal Fatyana, only recorded one species, indicating a low level of diversity. On the other hand, Mohallah Ravi Town and Govt. High School No. 1 Kamalia each had three species, while the forest area at Chak No. 740 GB had the highest richness (4 species). According to these findings, a greater variety of insect species can be found in semi-natural or less disturbed habitats because they provide more ecological niches (Cardinale et al., 2006; Hallmann et al., 2017).

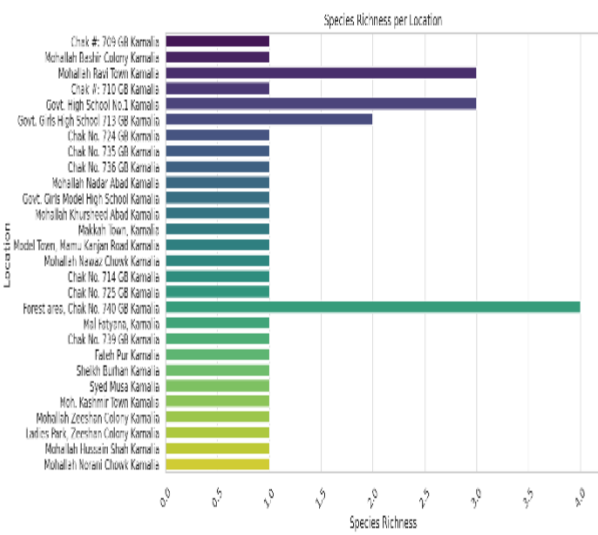

Figure 4. Bar plot representing species richness across different locations in Kamalia. Species richness is defined as the number of distinct species recorded at each site, highlighting variation in biodiversity among sampling locations.

Shannon diversity index

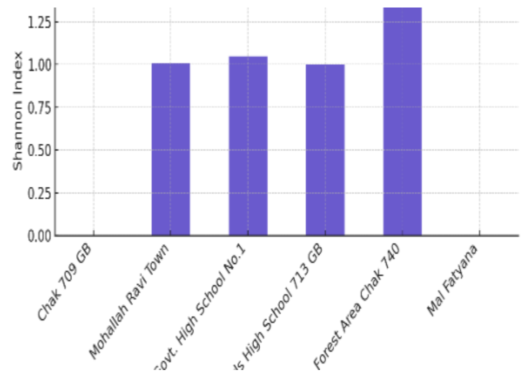

Figure 5. The highest biodiversity was observed at *Forest Area Chak 740* (H' ≈ 1.38), while *Chak 709 GB* and *Mal Fatyana* showed no recorded diversity (H' = 0). Other sites exhibited moderate diversity levels (H' ≈ 1.0–1.05).

A second indication of the poor diversity in many places is the Shannon diversity index (Figure 5), which combines species abundance and evenness. For example, Chak 709 GB has a Shannon index of 0 which indicates a single-species dominance. In contrast, the Forest area near Chak 740 GB received a score of 1.39, whilst Govt. High School No. 1 had a score of 1.05; this suggests that the distribution of coexisting species is more even (Magurran, 2007).

Simpson diversity index

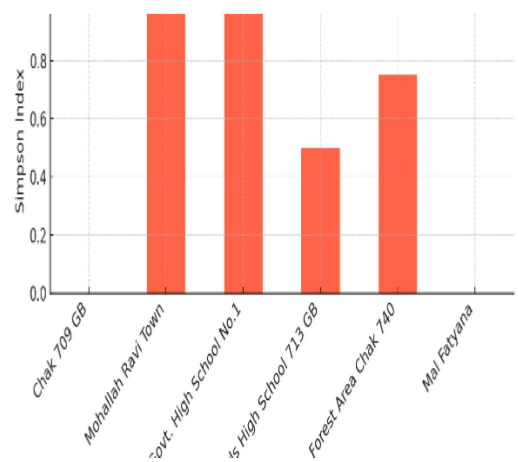

Figure 6. *Mohallah Ravi Town* and *Govt. High School No.1* showed the highest diversity (Index = 1.0), while *Chak 709 GB* and *Mal Fatyana* had no recorded diversity (Index = 0). Other locations exhibited moderate to low diversity.

The Simpson diversity index, shown in Figure 6, exhibits a similar trend. Sites like Forest area Chak

740 GB (0.75) and Govt. Girls High School 713 GB (0.5) exhibit higher index values, indicating better balance and less species dominance. This implies that because of improved habitat structure and a reduction in human stresses, these regions might have higher ecological stability (Altieri & Letourneau, 1982).

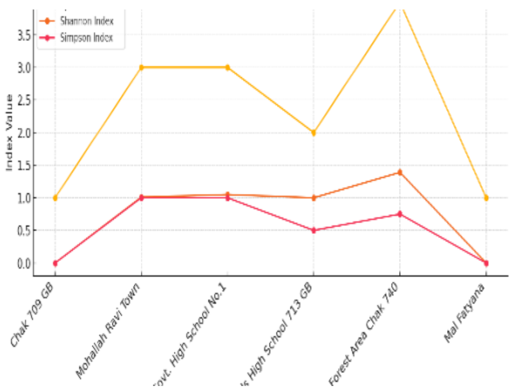

Figure 7. Comparative analysis of Species Richness, Shannon Index, and Simpson Index across six locations, illustrating variation in biodiversity levels.

A comparison of all three indices at specific sites is shown in a composite line graph (Figure 7). It highlights how, on every metric, natural or semi-natural locations do better than intensively cultivated or urbanized areas.
These findings highlight the significance of protecting semi-natural areas like Chak 740 GB to preserve ecological resilience and biodiversity, showing a strong correlation between reduced insect biodiversity and human disturbance, habitat simplification, and pesticide use (Rathore & Jasrai, 2013; Yi et al., 2012).

Discussion

According to species richness, the Shannon Diversity Index, and the Simpson Diversity Index, the results of this study show significant heterogeneity in insect diversity throughout the Kamalia region. Low species richness (usually one species) was found in most surveyed sites, indicating low ecological complexity and biodiversity. Only a few places showed moderate to high diversity, including Mohallah Ravi Town, Govt. High School No. 1 Kamalia, and the wooded region of Chak No. 740 GB Kamalia. These findings suggest that a greater range of insect species are more common in natural and semi-natural settings, most likely as a result of improved habitat quality, the availability of floral resources, and less anthropogenic disturbance.
These findings are consistent with earlier research that emphasized the influence of land use and habitat structure on the composition of insect communities: A diversified agroecosystem with mixed vegetation and low pesticide use promotes greater arthropod diversity (Altieri & Letourneau, 1982). Natural and less disturbed environments support beneficial insect populations necessary for pollination and pest regulation (Gurr et al., 2012). The low diversity found in urbanized or heavily modified areas of Kamalia, such as residential neighbourhoods and school campuses, documented a global decline in insect populations as a result of urbanization, chemical use, and habitat loss (Hallmann et al., 2017).
The study has a number of limitations in spite of the new information. First, only one six-month period was used for data collection, which would have excluded species having seasonal occurrences. An extended investigation spanning several seasons would probably provide a more thorough comprehension of insect behaviour. Second, although methods such as pitfall traps and sweep nets were employed, the emphasis was mostly on insects that were visible or surface-dwelling, which may have resulted in an underrepresentation of nocturnal or soil-dwelling species (Cardinale et al., 2006). In addition, environmental factors that may affect insect dispersion, such as pesticide residues, soil quality, and microclimatic conditions, were not thoroughly examined.
This study concludes that Kamalia's biodiversity is unevenly distributed and heavily impacted by human activity and habitat quality. In order to preserve insect populations that are essential to the sustainability of agroecosystems, it emphasizes the necessity of conservation and management practices that place a high priority on habitat preservation, biodiversity-friendly farming, and the use of less chemicals.

Conclusions

This study used a variety of sample techniques, including bowl traps, pitfall traps, and sweep nets, to thoroughly examine the insect species in the Kamalia region. With a few notable exceptions, such as the forest area in Chak No. 740 GB Kamalia, which showed comparatively high species richness and balanced diversity indices (Shannon Index = 1.39; Simpson Index = 0.75), the results showed low overall insect diversity throughout the majority of urban and semi-urban areas. The prevalence of pests like Periplaneta americana and Aedes aegypti in cities highlights the impact of human activity on biodiversity. These findings emphasize the importance of ecological preservation, particularly in areas that have been impacted by human activity. Longitudinal studies should be the main focus of future research in order to track seasonal variations in biodiversity and evaluate how agricultural practices affect insect populations. In addition, incorporating molecular identification techniques should improve species resolution and facilitate more accurate conservation plans (Smith et al., 2020).

Author Contributions

Qi Xue: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Qian Tang: Writing – review & editing, Visualization, Formal analysis, Conceptualization. Lin Deng: Writing – review & editing, Validation, Supervision, Resources, Project administration, Funding acquisition. Wei Luo: Writing – review & editing, Conceptualization. Mingle Xia: Writing – review & editing, Conceptualization. Shuang Fu: Writing – review & editing, Conceptualization. Chaoqun Tan: Writing – review & editing, Conceptualization. Jun Hu: Writing – review & editing, Conceptualization. Rajendra Prasad Singh: Writing – review & editing.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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Data Availability

The data can be made available on request from corresponding authors.

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