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RESEARCH ARTICLE
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Diverse Insect Fauna of the Garden Campus, Abdul Wali Khan University, Mardan, KPK, Pakistan

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ABSTRACT

This study was conducted in the Abdul Wali Khan University Campus, Mardan in the Gardan Campus. This study has developed a detailed classification system for the identification of insect order within Insecta class. The study was conducted in June 2023 in the campus with specimen collection, while considering ample care and precaution. Hand nets were the predominant specimen collection methods used in this study. The specimens were identified with proper care and, where these specimens were big, pinned for closer examination of any distinctive features; the smallest specimens mounted on triangular card points made the identification work easier. The next poll found that there were four classes of insects, namely, Diptera, Coleoptera, Orthoptera, and Lepidoptera. Of the four classes, there were 1000 species making up four families whereby they were identified mainly through making detailed visual observation of the color of the wings and patterns. Authoritative field guides were never lacking. Diversity indices permit the most useful application in comparing insect diversity in the campus ecosystem by summarizing richness-that is, the absolute number of different species-with abundance or evenness (the distribution of individuals across species)-into one numerical value. The species count for the Order Diptera was 393 (39% of the total) the highest of all Orders; for the Order Orthoptera, 318 species (31%); the Order Coleoptera, 192 species (19%); and the Order Lepidoptera, 97 species (10%). This research therefore will go a long way to help in the knowledge of insect biodiversity within the campus of Gardan due to availability of an identification key such as that as a reference. A finding like this, however, has great importance for further studies and especially about the conservation aspect of the area.

Key words: Exploration, Categorization, Insect's orders, Collections, Species identification.

Introduction

Hexapodous arthropods, commonly known as insects, comprise the largest number of species among living organisms. It is estimated that insects constitute at least 75% of all animal species and 67% of all species of organisms (**Wilson, 1992**). Insects are nearly ubiquitous in terrestrial and freshwater habitats, although very few species are found in open oceans, where crustaceans dominate (Gullan & Cranston, 2010). Various estimates of the total number of insect species, based on different sampling methods in various habitats, range from about 1 million to 30 million (Erwin, 1982; Stork, 1997). The true total probably lies between these estimates, but it is unlikely to be known, primarily due to the limited number of specialists in insect classification and uneven collecting efforts, as well as environmental degradation and habitat destruction that may lead to species extinction before they are even discovered (Pimm et al., 2014).Insects are characterized by a head with one pair of antennae, one pair of mandibles, two pairs of maxillae (the second pair fused into a labium), a labrum, usually one pair of compound eyes, and several simple eyes or ocelli (**Chapman, 1998**). The thorax consists of three segments: the prothorax, mesothorax, and metathorax, each bearing a pair of walking legs. Insects may be winged or wingless, and when winged, they have one or two pairs of wings. Mouthparts, antennae, legs, and wings differ across insect orders (**Borror et al., 1989**). The abdomen typically has up to 11 segments, and in some groups, ovipositors, copulatory structures, or prolegs may be present (**Kristensen, 1999**). The tracheal system manages oxygen transport, with little involvement from blood (**Wigglesworth, 1972**). Most insects undergo indirect metamorphosis, and sexual reproduction involves internal fertilization (**Gillott, 1995**).

Mouthparts, wings, and metamorphosis are key characteristics used in insect classification (**Grimaldi & Engel, 2005**). Chewing mouthparts, considered the most primitive, are common among beetles, caterpillars, and grasshoppers (**Snodgrass, 1935**). Sucking mouthparts are typical of butterflies and moths (**Kristensen, 1999**). Honeybees have chewing-sucking mouthparts, while piercing-sucking mouthparts are found in mosquitoes, horseflies, and other species (**Chapman, 1998**). Wingless insects, such as silverfish, or advanced forms like fleas, have evolved apterous conditions (**Grimaldi & Engel, 2005**).

Insects play crucial roles in ecosystems and human agriculture. About 80% of flowering plants are pollinated by insects (**Ollerton et al., 2011**). In the U.S. alone, insect pollination contributed an estimated $117 billion in agricultural products in 1998 (**Losey & Vaughan, 2006**). Insects also play significant roles in nutrient cycling, soil aeration, and ecosystem maintenance, with an estimated value of over $3 trillion per year (**Daily et al., 1997**). Many animals rely on insects as a primary food source, making them integral to the food chain (**Berenbaum, 1995**). Biological control provided by insects is valued at over $400 billion annually (**Costanza et al., 1997**).

Insects are also important for human industry and research. The silkworm, *Bombyx mori*, is the sole producer of commercial silk, while the cochineal insect (*Dactylopius coccus*) produces red dye for textiles and cosmetics (**Berenbaum, 1995**). Insects are excellent indicators of ecosystem

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health and have contributed significantly to scientific discoveries (**Wilson, 1992**). However, they can also be vectors of disease, affecting approximately 200 million people annually (**Saul, 1999**).

In light of the ecological and economic importance of the class Hexapoda, the present study aims to collect, identify, and classify various insect orders from the Garden Campus of Abdul Wali Khan University, Mardan, Khyber Pakhtunkhwa, Pakistan.

Material and methods

Study Area

Insect specimens were collected from the Garden Campus of Abdul Wali Khan University, Mardan, and studied during 2023 (Abdul Wali Khan University Mardan, 2023).

Insect Collection

Insect collections were carried out using a hand net. Hand netting by sweeping was largely applied in locations where the chances of collecting small-sized insects were greater, for instance, long grasses and low shrubs which comprised of allowing this process (Donald et al., 1981). Small specimens were sorted using assistance from a binocular microscope produced by Nikon Corporation, 2023 .

Preservation

Smaller specimen were preserved in 70% alcohol so that they would not dry and decay rapidly. Then, the specimens were kept in 97% alcohol for 24 hours so that they can be mounted on card points (**Donald et al., 1981**).

Pinning, Spreading, Mounting

Large specimens were pinned vertically, through the body using a suitable thickness pin so that no legs were injured while doing the pinning. Specimens were pinned a little to the right of the midline in a few cases, so that all the characters on one side will be visible. For smaller specimens, card points mounted, which were pinned through the base. Glue was applied to attach the insect to the tip of the card. Field label was provided for each specimen with locality, date, collector's name, and host. After identification, a label showing the name of the order was attached (**Nikon Corporation, 2023).**

Conservation

All specimens were conserved in wooden collection boxes with naphthalene balls to keep them free from pests and mold (**Donald et al., 1981**).

Identification

Identification was based on literature that was available from Donald et al. (1981). Observations of the specimens were performed using a Grad Nikon Trinocular microscope with a maximum magnification power of 400X (Nikon Corporation, 2023). Identification keys for the orders of Class Hexapoda were developed as described by Donald et al. (1981).

Repository

All the listed materials have been kept at insect museum Department of Entomology Abdul Wali Khan University Mardan, KPK (Abdul Wali Khan University Mardan, 2023).

Results and discussion

The collection was done in the Entomology research laboratory, Gardan Campus, Abdul Wali Khan University, Mardan. A total of 1000 species were recorded that fall into four families. Birds were recorded based on ocular observation of wing colors and patterns. All the diversity indices

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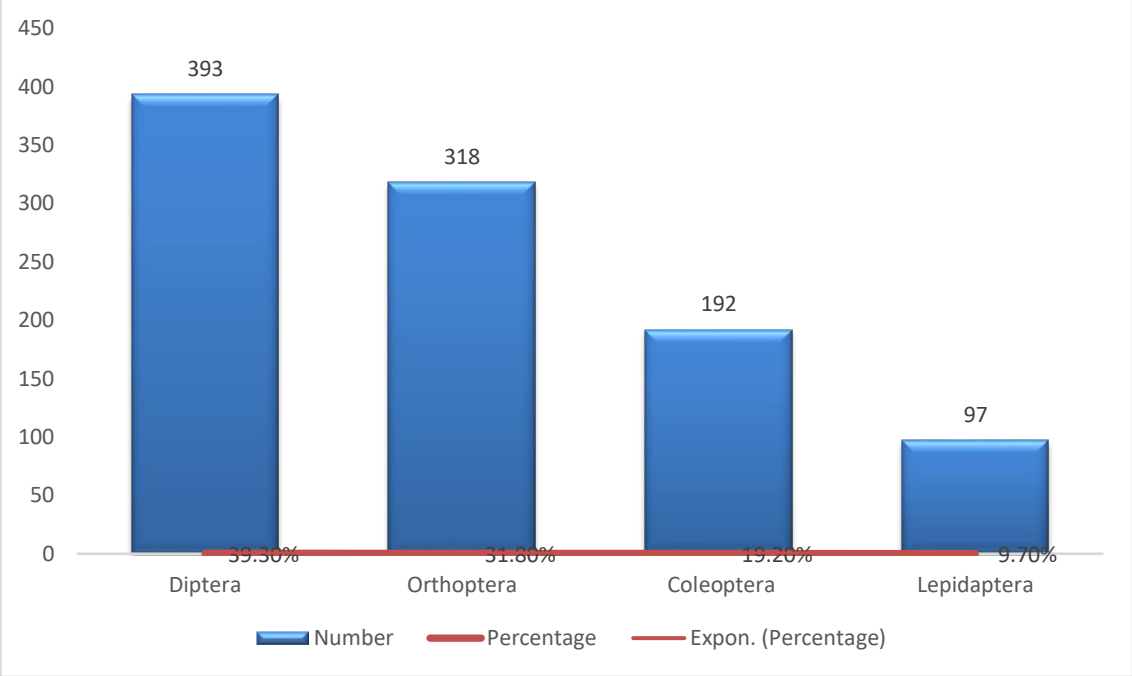
considered contained richness and abundance. Diptera was seen to occur with a frequency of 393 species followed by Orthoptera (318), Coleoptera (192), and Lepidoptera with 97 species. These were graphically visualized for better clarity of data

Generally, insects have one pair of antennae, one pair of mandibles, two pairs of maxillae, and a labium. The latter two are formed into the labium while others are in the form of independent maxillae. Labrum is generally present. They have one compound eye and simple eyes or ocelli. Thorax is divided into three parts. Each bears a pair of legs. In pterygote orders, wings are present both mesothorax and metathorax. Abdomen with variable number of segments; very few indications of abdominal appendages.

Table 1: Number and percent distribution of Orders under different Species

S.NO	Order	Number	Percentage
1	Diptera	393	39.3%
2	Orthoptera	318	31.8%
3	Coleoptera	192	19.2%
4	Lepidoptera	97	9.7%



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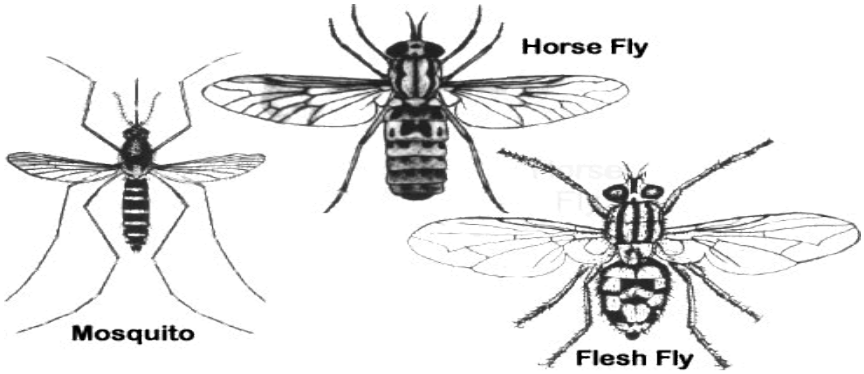
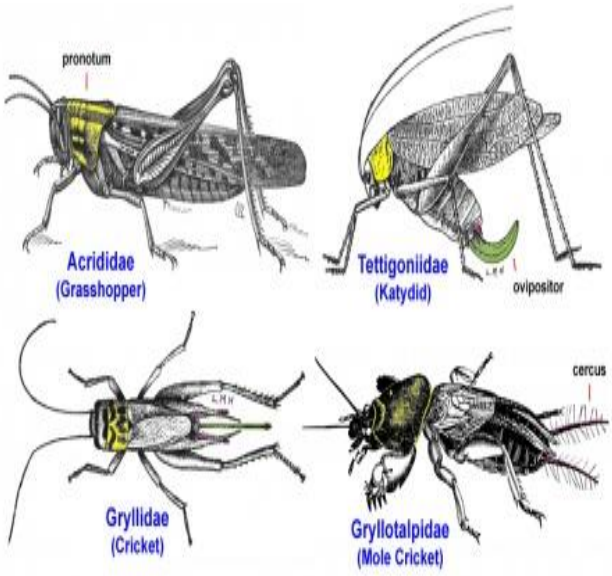
Order Diptera:

Flies are characterized by sucking mouthparts and a single pair of wings, the second pair being vestigial to form halteres. They may have small or large antennae, large compound eyes, and typically have mouthparts that are modified for particular feeding habits. The larvae of Diptera are holometabolous insects; their early forms have been termed as maggots. Ecologically, flies play significant roles in pollination, the spread of diseases, and serve as predators. Some species within this order are perceived as pests, while others are beneficial.



Order Orthoptera (Crickets, Grasshoppers, Katydids):

Orthopterans have incomplete metamorphosis and jump. Some have no wings, and others have two pairs of wings. The front wings are straight and narrow called tegmina, while the hind wings are membranous and folded up underneath. Orthoptera have long antennae and a cylindrical body with mandibulate mouthparts. They are notorious for their agricultural damage, particularly grasshoppers and locusts.



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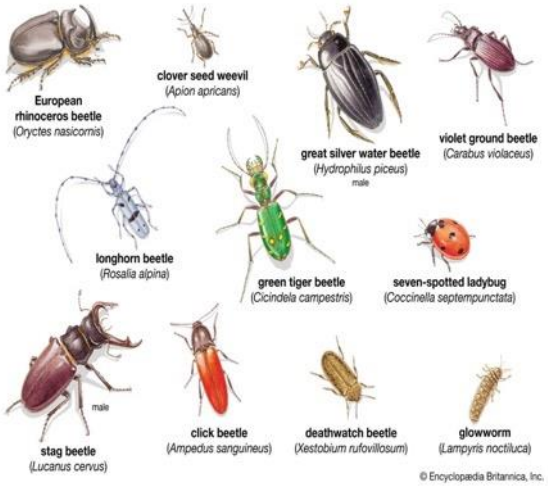
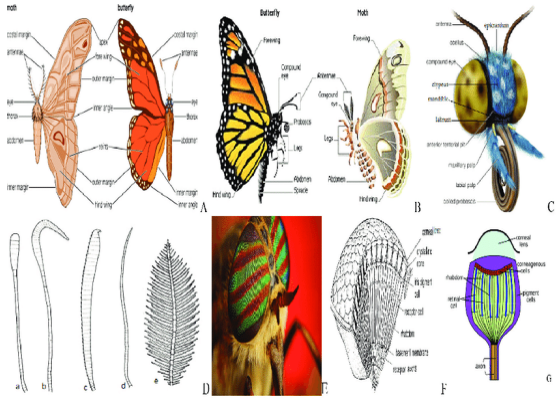


Order Coleoptera (Beetles):

Bees The front wings of the beetles take an own type of form which is called elytra. In this way, these elytra work somewhat like some rigid cover that protects the hind wings. Normally, the elytra do not overlap and are divided down the back by an uninterrupted line. Beetles have chewing mouthparts and most beetles can fly; however their wings are usually hidden. They undergo complete metamorphosis, and larvae have other specific names including white grubs and wireworms. Beetles are the largest order in insects, over 300,000 described species, and usually of economic importance to agriculture and forestry.

Order *Lepidoptera* (Butterflies and Moths):

The lepidopterans are characterized by the sucking mouth with coiled parts, scaled wings, and complete transformation. Butterflies possess thread-like antennae, whereas moths may have thread-like, feathery, or spindle-shaped antennae. Many moth larvae have been documented as pests due to their damage on plants and stored products. Members of the *Lepidoptera* are incredibly diverse and are dispersed to all continents; most of the members play an extremely important role in an ecosystem.



Conclusion

It analyzed the insect diversity of the area of Gardan Campus, Abdul Wali Khan University Mardan. For preparing the identification key for the insect orders present here, a hand net was used for the survey in June 2023. Specimens more than 10 mm size were pinned using insect pins, while specimens of less than 10 mm size were mounted on triangular card points for easy identification.

At the end, the findings of this study in this category revealed the existence of four insect orders: Diptera, Coleoptera, Hemiptera, and Hymenoptera. Later on, a key was developed in detail to identify those insect orders at Gardan Campus, Abdul Wali Khan University, Mardan.

In conclusion, the present study reveals that Abdul Wali Khan University, Mardan-Gardan Campus is relatively rich in insect diversity. Continuous and more comprehensive collections throughout the whole year may further strengthen and refine the constructed identification key.

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