Original Research Article

Diversity and Abundance of foliage insect communities in bitter ground field with regard to diurnal rhythms within Faisalabad, Pakistan

ABSTRACT

Biodiversity is the variability of life on earth that boosts up the ecosystem productivity. Diversity and abundance are the key components that are beneficial for the present and future researchers to control many problems being faced by harmful insects and to promote beneficial insect population for ecosystem sustainability. Therefore, the present study was designed to find out the “Diversity and abundance of foliage insect communities in Bitter gourd field” under the ecological conditions of District Faisalabad. After completing the whole research trials as per methodology, total 211 specimens were collected belonging to 9 orders, 38 families, 63 genera and 73 species in morning and total 213 specimens were collected belonging to 8 orders, 42 families, 58 genera and 65 species in evening. So, keeping in view the importance of these aspects, calculations were made as per Shannon Diversity Index. In bitter gourd fields, maximum diversity was recorded as (1.0533) for evening, while least was recorded (1.0528) for morning and, maximum diversity (H'_{max}) was recorded (2.3284) for evening and least (2.3243) for morning. Maximum evenness was (0.0229) for evening and least (0.0227) for morning while maximum dominance was (1.0229) for evening and least (1.0227) for morning. The maximum value for richness was recorded as (17.1230) for evening while least value (17.0443) for morning.

Keywords: Diversity; Abundance; Richness; Evenness; Dominance.

1. INTRODUCTION

Biological diversity is also called as biodiversity that can be defined as the variation among the living creatures that prevail within the particular and precise ecosystems [1]. It can also refer to all the distinct the ecological complexity and the processes that take place in their respective environments and body structures [2]. Major portion of phylum Arthtropoda is covered by class Insecta. Arthropods may represent as much as 85% of all known species and a large proportion of the meso- and macrofauna of the soil and fields. The arthropods are the basis for the formation of soil aggregates and humus, which physically stabilize the soil and increase its capacity to store nutrients. They are valuable ecological indicators and can be substantially impacted by intensive management. The Population dynamics are mainly impacted by a number of biotic components of the ecosystem: symbiosis, parasitism, predation and competition of food [3,4].

Insects are the most distinguishable form on earth. This is an approximate of over a half of the total species that exist on the globe. They can be found in all habitats such as swamps, jungles, deserts, even in highly harsh environments such as pools of crude petroleum.

Several insect species are predators or parasitoids on other harmful pests while others are pollinators, decomposers of organic matter or producers of important products such as honey or silk. Some are used to produce pharmacologically active compounds such as venoms or antibodies. On the other side, these are considered as pests that cause damage to humans, farm animals and crops. Insects have different types of bio-communication like visual, chemical, tactile and acoustic communication. They play a vital role in nutrient recycling, decomposition, soil fertility and pollination [5]. Among different order of class Insecta, Coleoptrera comprises of beetles and 3/4 of species are phytophagous in both the larval and adult stages and feed on plants in agriculture, forestry, and the household, the beetle can be considered a pest. Beetles are not only pests but can also be beneficial, usually by controlling the populations of pests. The word "coleoptera" is from the Greek *keleos*, meaning "sheath," and *pteron*, meaning "wing," thus "sheathed wing." The reason for the name is that most beetles have two pairs of wings, the front pair, and the "elytra," being hardened and thickened into a sheath-like or shell-like protection for the rear pair and for the rear part of the beetle's body, Coleoptera are found in nearly all natural habitats, that is, vegetative foliage from trees and their bark to flowers, leaves, and underground near roots, even inside plants like galls, tissue, including dead or decaying ones [6].

Order Hymenoptera comprises of wasps, bees and ants. Female ovipositor is modified into a stinger. Order Hemiptera is a worldwide distributed group of insects inhabiting both terrestrial and aquatic habitats and has an important ecological role while Lepidopteran species are the most important pests of major annual and perennial crops, forests and stored products throughout the world. Orthoptera comprises 26,550 valid species that is found throughout the world. Family Acrididae covers up large portion of this order and have grasshoppers, having antennae usually shorter than the body (about one-half body length, with less than 30 segments), three-valved ovipositor and three segmented tarsi [7].

Order Odonata contains different species of many Dragonflies and Damselflies that are responsible for ecological balance. These insects lay their eggs in or near only fresh water and thus, their high abundance in an area is a good indication of the quality of freshwater. Many ecological factors such as the acidity of water, the amount and type of aquatic vegetation, the temperature and flow of water affect the distribution of the nymphs and adults. These are used as bioindicators for wetland quality. Some species of insects can tolerate a wide range of conditions whiles others are very sensitive to their environment [8,9]. The order Diptera (the true flies) is one of the most species-rich, anatomically varied and ecologically innovative groups of organisms, contributing 10–15% of known animal species. About 150,000 species of Diptera are well described. They have medical and veterinary significance, being responsible for the transmission of a wide variety of pathogens such as viruses, bacteria, fungi, protozoan and metazoan parasites in humans and animal [13,14]. The vegetable *Momordica charontia* belong to family Cucurbitaceae and known as bitter gourd, balsam pear, bitter melon and bitter cucumber. It is grown as an ornamental plant and is used mostly in cooking and making medicine. Bitter gourd has vitamin C. It has antimicrobial, antiviral, antihepatotoxic, and antiulcerogenic properties. It is a good source of carbohydrates, proteins, vitamins, and minerals and has increased nutritive value among cucurbits and has high protein content (Desai and Musmade 1998). Bitter gourd is used as an antioxidative, and antidiabetic agents [11] that plays a significant role in the treatment of diabetes. The antioxidant properties of carotenoids protect plants during photosynthesis may also protect humans from cancer causing agents and eliminate free radical effects associated with heart disease. Bitter gourd vegetable contains 14 carotenoids depending on stage of maturity. It always requires pollinating insects for productive and efficient pollination and better vegetable and seed setting [10,12].

2. MATERIAL AND METHODS

2.1. Study Area.

Present research was conducted to accord the "Diversity and abundance of foliage insect communities in Bitter gourd field" under ecological conditions of Faisalabad (Punjab) Pakistan.

2.2. Vegetation.

Present study was conducted in Bitter gourd fields at Vegetables Research Fields, Institute of Horticulture Sciences, University of Agriculture Faisalabad (Punjab), Pakistan. These fields were surrounded by tropical and subtropical vegetables such pumpkin, okra and many others at the area of $100m^2$

2.3 Collection and Identification.

To collect the foliage insect fauna, fields of bitter gourd (*Momordica charantia)* were sampled weekly twice a day randomly for four hours from 08 to 10am and 04 to 06 pm for a season by following methods:

- Direct hand picking
- By using Sweep Net
- By using Forceps

Collected specimens were stored in jars containing 70:30% alcohol and glycerine solution and there after collected specimens were shifted to Biodiversity Laboratory, Department of Zoology, Wildlife and Fisheries, University of Agriculture, Faisalabad for further systematic studies. Here, the specimens were separated and preserved in separate glass vials, containing 70:30% alcohol and glycerine solution for further identification. The glass vials were labeled as sampling number, plant name, along with temperature and humidity of the sampling day. The author collected the data items in several ways as shown in Figure 1. The collected specimens were identified and sorted with the aid of:

- Naked eye
- Magnifying glass
- Microscope

All the specimens were identified up to species level according to the taxonomic/ reference material [16,17], and on electronic keys (internet).

Figure 1. Foliage insect collection by using aerial net and a killing bottle from Bitter gourd field.

<u>2.4 Statistical Analysis</u>.

Thereafter, all the observed specimens were arranged in table form according to their morphological characters e.g. order, family, genus and species. To determine the various aspects of diversity, Shannon Diversity Index was used [15].

Diversity (H') is computed through the following equation (1).

$$H' = -\sum pi \; ln \; pi, \qquad (1)$$

Where p_i is the proportion of individuals found in the *i*th species. The value of p_i is estimated as n_i / N. Furthermore, maximum diversity is calculated by the following equation:

$$Hmax = \sum_{i=1}^{S} \frac{1}{S} \, ln \frac{1}{S} = \, ln \, S \qquad (2)$$

After that we can calculate the Evenness Hill's modified ration (E).

$$E = \frac{(\frac{1}{\lambda})}{e^{H-1}} = \frac{N_2 - 1}{N_1 - 1} \qquad (3)$$

Where, E is the index of evenness, λ is the Simpson's index of diversity and N1 and N2 are the number of abundant and very abundant species respectively in the sample. The richness, diversity and evenness indices were computed by using the Programmed SPDIVERS.BAS. Richness then be calculated through the following equation.

$$S = n + \left(\frac{n-1}{n}\right)^k \quad (4)$$

where, S is species richness, n is total number of species present in sample population and k represents the number of "unique" species (of which only one organism was found in sample population). Dominance is computed by the following equation.

$$D = 1 - E \quad (4)$$

Where, "E" is evenness.

3. RESULTS AND DISCUSSION

The present study was conducted to evaluate diversity, abundance, dominance, evenness and richness of foliage insects of bitter gourd field. After completing the whole research trials as per methodology, total 211 specimens were collected belonging to 9 orders, 38 families, 63 genera and 73 species in morning and total 213 specimens were collected belonging to 8 orders, 42 families, 58 genera and 65 species in evening as shown in Table 1. Based on the data collected we also measure the relative abundance of recorded species as shown in Table 2 and Figure 2.

Table 1. Overall taxa composition in Bitter gourd field.

Categories	Morning	Evening
Order	9	8
Family	38	42
Species	73	65

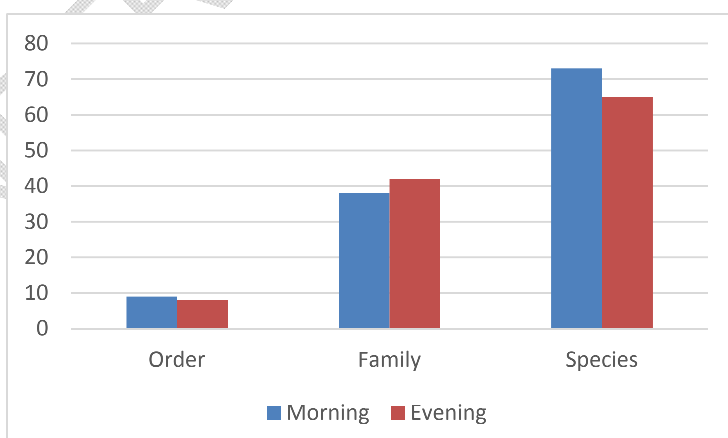

Figure 2. Graphical view of taxa composition

Table 2. Overall Relative Abundance of recorded species in Morning and Evening.

Order	Family	Species	Morning	Evening
Coleoptera	Chrysomelidae	Chrysolina coerulans	0.95 (2)	0.00 (0)
		Aulacophora foveicollis	0.47 (1)	0.00 (0)
		Leptinotarsa juncta	0.00 (0)	0.47 (1)
		Cassida viridis	0.47 (1)	0.47 (1)
	Meloidae	Lytta vesicatoria	0.47 (1)	0.94 (2)
	Carabidae	Loricera pilicornis	0.95 (2)	1.41 (3)
		Pterostichus anthracinus	0.47 (1)	2.35 (5)
		Pterostichus melanarius	0.47 (1)	0.47 (1)
	Byturidae	Xerasia grisescens	0.95 (2)	2.82 (6)
	Curculionidae	Liparus coronatus	0.00 (0)	0.47 (1)
	Attelabidae	Parapoderus nigripennis	0.00 (0)	0.47 (1)
	Dermestidae	Dermestes ater	0.95 (2)	0.00 (0)
	Coccinellidae	Brumoides suturalis	0.95 (2)	0.47 (1)
		Hippodamia convergens	0.00 (0)	0.47 (1)
		Coccinella septempunctata	0.47 (1)	0.47 (1)
		Epilachna borealis	0.47 (1)	0.00 (0)
Hemiptera	Pentatomidae	Bagrada hilaris	3.79 (8)	3.76 (8)
		Murgantia histrionic	0.47 (1)	2.82 (6)
		Palomena prasina	0.00 (0)	0.47 (1)
		Podisus maculiventris	2.37 (5)	0.00 (0)
	Miridae	Lygus rugulipennis	4.74 (10)	0.00 (0)
		Lygus maritimus	0.47 (1)	0.00 (0)
	Cicadellidae	Xyphon sagittifera	0.47 (1)	0.00 (0)
		Balclutha abdominalis	0.00 (0)	0.47 (1)
		Balclutha impictus	0.00 (0)	0.47 (1)
	Pyrrhocoridae	Dysdercus suturellus	0.47 (1)	0.47 (1)
		Dysdercus cingulatus	2.37 (5)	2.35 (5)
	Scutelleridae	Scutiphora pedicellata	0.47 (1)	0.00 (0)
	Aphididae	Aphis craccivora	0.47 (1)	0.00 (0)
	Reduviidae	Triatoma protracta	0.00 (0)	0.47 (1)
	Cixiidae	Haplaxius pictifrons	0.00 (0)	0.47 (1)

	Lygaeidae	Oxycarenus hyalinipennis	0.47 (1)	0.47 (1)
	Syrphidae	Eupeodes latifasciatus	0.95 (2)	0.00 (0)
		Eristalinus aeneus	2.84 (6)	0.47 (1)
		Lucilia sericata	0.47 (1)	0.00 (0)
		Lucilia cuprina	0.47 (1)	0.94 (2)
	Calliphoridae	Xyphosia miliaria	0.47 (1)	0.47 (1)
Diptera	Tephritidae	Sepsis cynipsea	1.90 (4)	0.00 (0)
	Sepsidae	Ophiomyia phaseoli	0.00 (0)	0.47 (1)
	Agromyzidae	Musca domestica	0.00 (0)	0.94 (2)
	Muscidae	Sarapogon spp.	0.00 (0)	0.47 (1)
	Asilidae	Fannia scalaris	0.00 (0)	3.76 (8)
Dermaptera	Fanniidae	Diastata fuscula	0.00 (0)	0.47 (1)
	Diastatidae	Simulium yahense	0.47 (1)	0.00 (0)
	Simuliidae	Neoitamus melanopogon	0.95 (2)	0.00 (0)
	Asilidae	Forficula auricularia	0.47 (1)	0.00 (0)
	Forficulidae	Myrmecocystus mimicus	2.37 (5)	1.88 (4)
		Solenopsis mandibularis	0.47 (1)	2.35 (5)
	Formicidae	Formica exsectoides	0.47 (1)	1.41 (3)
		Camponotus pennsylvanicus	0.47 (1)	0.00 (0)
Hymenoptera		Lasius niger	0.00 (0)	0.94 (2)
		Apis mellifera	0.47 (1)	2.35 (5)
	Apidae	Apis florae	4.27 (9)	0.47 (1)
		Xylocopa violacea	1.90 (4)	0.00 (0)
		Ectemnius cavifrons	0.47 (1)	0.00 (0)
	Crabronidae	Polistes wattii	20.38 (43)	24.41 (52)
	Vespidae	Polistes dominula	0.95 (2)	0.00 (0)
		Vespa orientalis	8.06 (17)	2.35 (5)
		Austrohormius maculipennis	0.47 (1)	0.00 (0)
	Braconidae	Apanteles glomeratus	0.47 (1)	0.00 (0)
		Ascogaster vexator	0.47 (1)	0.00 (0)
		Chelonus abdominalis	0.00 (0)	0.47 (1)
		Doryctobracon areolatus	0.00 (0)	1.41 (3)
		Cybaeus spp.	0.47 (1)	0.00 (0)

	Cybaeidae	Marpissa muscosa	0.00 (0)	0.47 (1)
	Salticidae	Oxyopes macilentus	0.00 (0)	0.47 (1)
	Oxyopidae	Olios argelasius	0.00 (0)	0.47 (1)
Araneae	Sparassidae	Parasteatoda tepidariorum	0.00 (0)	1.41 (3)
	Theridiidae	Tegenaria domestica	0.00 (0)	0.94 (2)
	Agelenidae	Omocestus viridulus	0.47 (1)	0.00 (0)
		Cedarinia spp.	0.95 (2)	0.00 (0)
		Chorthippus curtipennis	0.95 (2)	0.47 (1)
		Chorthippus parallelus	0.47 (1)	0.00 (0)
		Chorthippus brunneus	0.00 (0)	0.47 (1)
		Chortophaga viridifasciata	0.47 (1)	0.00 (0)
		Acrida acuminate	1.42 (3)	0.47 (1)
		Acrida anatolica	0.47 (1)	0.00 (0)
	Acrididae	Acrida turrita	0.00 (0)	0.94 (2)
		Acrida hungarica	0.00 (0)	0.47 (1)
		Melanoplus differentialis	0.47 (1)	0.47 (1)
		Melanoplus femurrubrum	0.47 (1)	0.00 (0)
		Schistocerca alutacea	0.00 (0)	1.41 (3)
		Trimerotropis verruculata	0.00 (0)	1.88 (4)
		Dichromorpha viridis	0.47 (1)	0.00 (0)
	Tettigoniidae	Neoconocephalus triops	0.00 (0)	0.47 (1)
		Decticus verrucivorus	0.47 (1)	0.00 (0)
	Tetrigidae	Tetrix arenosa	3.79 (8)	1.41 (3)
	Gryllidae	Metioche vittaticollis	0.47 (1)	0.00 (0)
		Anaxipha exigua	0.95 (2)	0.00 (0)
	Tineidae	Tineola bisselliella	0.47 (1)	0.47 (1)
		Pyrisitia nise	0.00 (0)	0.47 (1)
	Pieridae	Pieris rapae	0.47 (1)	0.00 (0)
		Leptidea sinapis	0.47 (1)	0.00 (0)
	Lycaenidae	Celastrina neglecta	0.47 (1)	0.47 (1)
		Zizula hylax	3.32 (7)	0.00 (0)
	Geometridae	Epirrita dilutata	0.47 (1)	0.00 (0)
		Operophtera bruceata	0.47 (1)	0.00 (0)
	Nymphalidae	Danaus chrysippus	0.47 (1)	0.00 (0)

	Noctuidae	Mythimna unipuncta	0.47 (1)	0.47 (1)
		Agrotis ipsilon	0.47 (1)	0.47 (1)
	Hesperiidae	Hasora chromus	3.32 (7)	11.74 (25)
	Cordulegastridae	Cordulegaster boltonii	0.00 (0)	2.82 (6)
	Libellulidae	Macrodiplax cora	0.95 (2)	0.47 (1)
	Coenagrionidae	Ischnura rufostigma	0.00 (0)	0.47 (1)
		Enallagma cyathigerum	0.00 (0)	0.47 (1)
Total			**211**	**213**

In a process of relative abundance we also measure the relativity of abundance up to the genus level for morning and evening as presented in Table 3.

Table 3: Relative abundance up to Genus Level in Morning and Evening

Order	Family	Genus	Morning	Evening
Coleoptera	Chrysomelidae	Chrysolina	0.95 (2)	0.00 (0)
		Aulacophora	0.47 (1)	0.00 (0)
		Leptinotarsa	0.00 (0)	0.47 (1)
		Cassida	0.47 (1)	0.47 (1)
	Meloidae	Lytta	0.47 (1)	0.94 (2)
	Carabidae	Loricera	0.95 (2)	1.41 (3)
		Pterostichus	0.95 (2)	2.82 (6)
	Byturidae	Xerasia	0.95 (2)	2.82 (6)
	Curculionidae	Liparus	0.00 (0)	0.47 (1)
	Attelabidae	Parapoderus	0.00 (0)	0.47 (1)
	Dermestidae	Dermestes	0.95 (2)	0.00 (0)
	Coccinellidae	Brumoides	0.95 (2)	0.47 (1)
		Hippodamia	0.00 (0)	0.47 (1)
		Coccinella	0.47 (1)	0.47 (1)
		Epilachna	0.47 (1)	0.00 (0)
Hemiptera	Pentatomidae	Bagrada	3.79 (8)	3.76 (8)
		Murgantia	0.47 (1)	2.82 (6)
		Palomena	0.00 (0)	0.47 (1)
		Podisus	2.37 (5)	0.00 (0)
	Miridae	Lygus	5.21 (11)	0.00 (0)
	Cicadellidae	Xyphon	0.47 (1)	0.00 (0)
		Balclutha	0.00 (0)	0.94 (2)
	Pyrrhocoridae	Dysdercus	2.84 (6)	2.82 (6)
	Scutelleridae	Scutiphora	0.47 (1)	0.00 (0)

	Aphididae	Aphis	0.47 (1)	0.00 (0)
	Reduviidae	Triatoma	0.00 (0)	0.47 (1)
	Cixiidae	Haplaxius	0.00 (0)	0.47 (1)
	Lygaeidae	Oxycarenus	0.47 (1)	0.47 (1)
Diptera	Syrphidae	Eupeodes	0.95 (2)	0.00 (0)
		Eristalinus	2.84 (6)	0.47 (1)
	Calliphoridae	Lucilia	0.95 (2)	0.94 (2)
	Tephritidae	Xyphosia	0.47 (1)	0.47 (1)
	Sepsidae	Sepsis	1.90 (4)	0.00 (0)
	Agromyzidae	Ophiomyia	0.00 (0)	0.47 (1)
	Muscidae	Musca	0.00 (0)	0.94 (2)
	Asilidae	Sarapogon	0.00 (0)	0.47 (1)
	Fanniidae	Fannia	0.00 (0)	3.76 (8)
	Diastatidae	Diastata	0.00 (0)	0.47 (1)
	Simuliidae	Simulium	0.47 (1)	0.00 (0)
	Asilidae	Neoitamus	0.95 (2)	0.00 (0)
Dermaptera	Forficulidae	Forficula	0.47 (1)	0.00 (0)
Hymenoptera	Formicidae	Myrmecocystus	2.37 (5)	1.88 (4)
		Solenopsis	0.47 (1)	2.35 (5)
		Formica	0.47 (1)	1.41 (3)
		Camponotus	0.47 (1)	0.00 (0)
	Apidae	Lasius	0.00 (0)	0.94 (2)
		Apis	4.74 (10)	2.82 (6)
		Xylocopa	1.90 (4)	0.00 (0)
	Crabronidae	Ectemnius	0.47 (1)	0.00 (0)
	Vespidae	Polistes	21.33 (45)	24.41 (52)
		Vespa	8.06 (17)	2.35 (5)
	Braconidae	Austrohormius	0.47 (1)	0.00 (0)
		Apanteles	0.47 (1)	0.00 (0)
		Ascogaster	0.47 (1)	0.00 (0)
		Chelonus	0.00 (0)	0.47 (1)
		Doryctobracon	0.00 (0)	1.41 (3)
Araneae	Cybaeidae	Cybaeus	0.47 (1)	0.00 (0)
	Salticidae	Marpissa	0.00 (0)	0.47 (1)
	Oxyopidae	Oxyopes	0.00 (0)	0.47 (1)
	Sparassidae	Olios	0.00 (0)	0.47 (1)
	Theridiidae	Parasteatoda	0.00 (0)	1.41 (3)
	Agelenidae	Tegenaria	0.00 (0)	0.94 (2)

Orthoptera	Acrididae	Omocestus	0.47 (1)	0.00 (0)
		Cedarinia	0.95 (2)	0.00 (0)
		Chorthippus	1.42 (3)	0.94 (2)
		Chortophaga	0.47 (1)	0.00 (0)
		Acrida	1.90 (4)	1.88 (4)
		Melanoplus	0.95 (2)	0.47 (1)
		Schistocerca	0.00 (0)	1.41 (3)
		Trimerotropis	0.00 (0)	1.88 (4)
		Dichromorpha	0.47 (1)	0.00 (0)
	Tettigoniidae	Neoconocephalus	0.00 (0)	0.47 (1)
		Decticus	0.47 (1)	0.00 (0)
	Tetrigidae	Tetrix	3.79 (8)	1.41 (3)
	Gryllidae	Metioche	0.47 (1)	0.00 (0)
		Anaxipha	0.95 (2)	0.00 (0)
Lepidoptera	Tineidae	Tineola	0.47 (1)	0.47 (1)
	Pieridae	Pyrisitia	0.00 (0)	0.47 (1)
		Pieris	0.47 (1)	0.00 (0)
	Lycaenidae	Leptidea	0.47 (1)	0.00 (0)
		Celastrina	0.47 (1)	0.47 (1)
		Zizula	3.32 (7)	0.00 (0)
	Geometridae	Epirrita	0.47 (1)	0.00 (0)
		Operophtera	0.47 (1)	0.00 (0)
	Nymphalidae	Danaus	0.47 (1)	0.00 (0)
	Noctuidae	Mythimna	0.47 (1)	0.47 (1)
		Agrotis	0.47 (1)	0.47 (1)
	Hesperiidae	Hasora	3.32 (7)	11.74 (25)
Odonata	Cordulegastridae	Cordulegaster	0.00 (0)	2.82 (6)
	Libellulidae	Macrodiplax	0.95 (2)	0.47 (1)
	Coenagrionidae	Ischnura	0.00 (0)	0.47 (1)
		Enallagma	0.00 (0)	0.47 (1)
Total			**211**	**213**

3.1 Abundance up to Family Level.

3.1.1 Bitter gourd (Morning).

To highlight their major distribution and contribution, relative abundance was also recorded upto genus level. After calculation, it was recorded maximum for genus *Polistes* 21.33% (N = 45), *Vespa* 8.06% (N = 17), *Lygus* 5.21% (N = 11), *Apis* 4.74% (N = 10), *Bagrada* and *Tetrix* 3.79% (N = 8), *Zizula* and*Hasora* 3.32% (N = 7), *Dysdercus* and *Eristalinus* 2.84% (N = 6).

3.1.2 Bitter gourd (Evening).

In bitter gourd field, *Polistes* was recorded as an extraordinary genus with relative abundance of 24.41% (N = 52), followed by *Hasora* 11.74% (N = 25), *Bagrada* and *Fannia* 3.76% (N = 8), *Pterostichus*, Xerasia, *Murgantia*, *Dysdercus,Apis* and *Cordulegaster* 2.82% (N = 6) referred to the Tabled 4.

Table 4: Relative abundance up to Family Level in Morning and Evening

Order	Family	Morning	Evening
Coleoptera	Chrysomelidae	1.90 (4)	0.94 (2)
	Meloidae	0.47 (1)	0.94 (2)
	Carabidae	1.90 (4)	4.23 (9)
	Byturidae	0.95 (2)	2.82 (6)
	Curculionidae	0.00 (0)	0.47 (1)
	Attelabidae	0.00 (0)	0.47 (1)
	Dermestidae	0.95 (2)	0.00 (0)
	Coccinellidae	1.90 (4)	1.41 (3)
Hemiptera	Pentatomidae	6.64 (14)	7.04 (15)
	Miridae	5.21 (11)	0.00 (0)
	Cicadellidae	0.47 (1)	0.94 (2)
	Pyrrhocoridae	2.84 (6)	2.82 (6)
	Scutelleridae	0.47 (1)	0.00 (0)
	Aphididae	0.47 (1)	0.00 (0)
	Reduviidae	0.00 (0)	0.47 (1)
	Cixiidae	0.00 (0)	0.47 (1)
	Lygaeidae	0.47 (1)	0.47 (1)
Diptera	Syrphidae	3.79 (8)	0.47 (1)
	Calliphoridae	0.95 (2)	0.94 (2)
	Tephritidae	0.47 (1)	0.47 (1)
	Sepsidae	1.90 (4)	0.00 (0)
	Agromyzidae	0.00 (0)	0.47 (1)
	Muscidae	0.00 (0)	0.94 (2)
	Asilidae	0.00 (0)	0.47 (1)
	Fanniidae	0.00 (0)	3.76 (8)
	Diastatidae	0.00 (0)	0.47 (1)
	Simuliidae	0.47 (1)	0.00 (0)
	Asilidae	0.95 (2)	0.00 (0)
Dermaptera	Forficulidae	0.47 (1)	0.00 (0)
Hymenoptera	Formicidae	3.79 (8)	6.57 (14)
	Apidae	6.64 (14)	2.82 (6)

	Crabronidae	0.47 (1)	0.00 (0)
	Vespidae	29.38 (62)	26.76 (57)
	Braconidae	1.42 (3)	1.88 (4)
Araneae	Cybaeidae	0.47 (1)	0.00 (0)
	Salticidae	0.00 (0)	0.47 (1)
	Oxyopidae	0.00 (0)	0.47 (1)
	Sparassidae	0.00 (0)	0.47 (1)
	Theridiidae	0.00 (0)	1.41 (3)
	Agelenidae	0.00 (0)	0.94 (2)
Orthoptera	Acrididae	6.64 (14)	6.57 (14)
	Tettigoniidae	0.47 (1)	0.47 (1)
	Tetrigidae	3.79 (8)	1.41 (3)
	Gryllidae	1.42 (3)	0.00 (0)
Lepidoptera	Tineidae	0.47 (1)	0.47 (1)
	Pieridae	0.95 (2)	0.47 (1)
	Lycaenidae	3.79 (8)	0.47 (1)
	Geometridae	0.95 (2)	0.00 (0)
	Nymphalidae	0.47 (1)	0.00 (0)
	Noctuidae	0.95 (2)	0.94 (2)
	Hesperiidae	3.32 (7)	11.74 (25)
Odonata	Cordulegastridae	0.00 (0)	2.82 (6)
	Libellulidae	0.95 (2)	0.47 (1)
	Coenagrionidae	0.00 (0)	0.94 (2)
Total		**211**	**213**

3.2 Abundance up to Order Level.

3.2.1 Bitter gourd (Morning).

As far as relative abundance up to family was concerned in case of bitter gourd (morning), relative abundance was also recorded in the same context as it was observed in species and genera case. Total 38 families were recorded and among them relative abundance was recorded extraordinary for family Vespidae 29.38% (N = 62), followed by Pentatomidae, Apidae and Acrididae6.64% (N = 14), Miridae 5.21% (N = 11).

3.2.2 Bitter gourd (Evening).

There are total 42 recorded families in evening. Relative abundance was accessed and recorded extraordinary for family Vespidae 26.76% (N = 57), followed by Hesperiidae 11.74% (N = 25), Pentatomidae 7.04% (N = 15), Formicidae and Acrididae6.57% (N = 14) referred to Table 5 and Figure 3.

Table 5: Relative abundance up to Order Level in Morning and Evening

Phylum	Order	Morning	Evening
	Coleoptera	8.06 (17)	11.27 (24)
	Hemiptera	16.59 (35)	12.21 (26)
	Diptera	8.53 (18)	7.98 (17)
	Dermaptera	0.47 (1)	0.00 (0)
Arthropoda	Hymenoptera	41.71 (88)	38.03 (81)
	Araneae	0.47 (1)	3.76 (8)
	Orthoptera	12.32 (26)	8.45 (18)
	Lepidoptera	10.90 (23)	14.08 (30)
	Odonata	0.95 (2)	4.23 (9)
Total		**211**	**213**

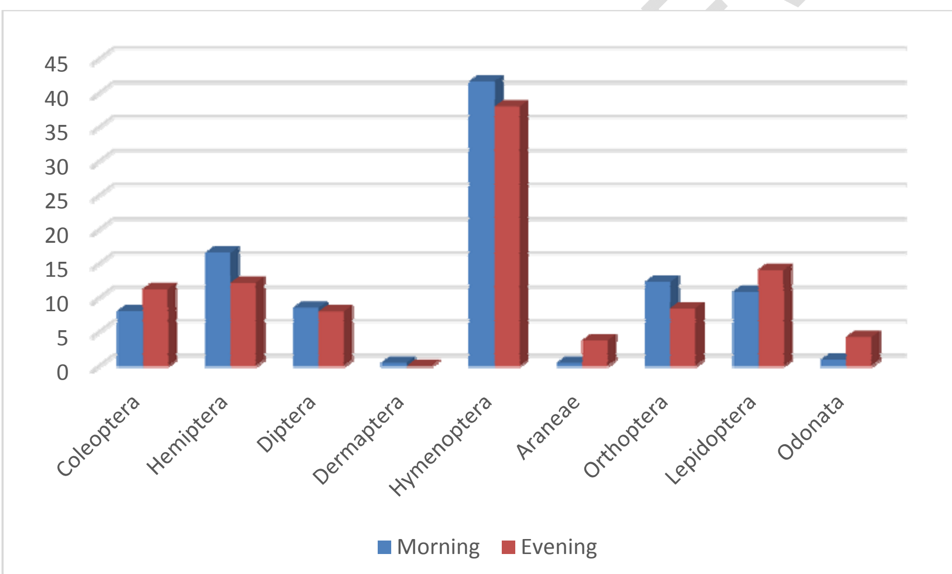

Figure 3: Order level abundance

Data presented in is pertaining to relative abundance of recorded species for various orders from bitter gourd (Morning). It was recorded highest for order Hymenoptera 41.71% (N = 88), followed by Hemiptera 16.59% (N = 35), Orthoptera 12.32% (N = 26), Lepidoptera 10.90% (N = 23), Diptera 8.53% (N = 18) and Coleoptera 8.06% (N = 17). However, least relative abundance (N ≤ 10) was recorded for order Dermaptera, Araneae and Odonata. In bitter gourd (Evening) highest relative abundance was for order Hymenoptera 38.03% (N = 81), followed by Lepidoptera 14.08% (N = 30), Hemiptera 12.21% (N = 26), Coleoptera 11.27% (N = 24), Orthoptera 8.45% (N = 18) and Diptera 7.98(N = 17). However, least relative abundance (N ≤ 10) was recorded for order Araneae and Odonata.

Table 6: Diversity indices recorded in Morning and Evening

Diversity Indices	Morning	Evening
Diveristy (H′)	1.0528	1.0533
$Diversity_{Maximum}$ (H'_{max})	2.3243	2.3284
Evenness (E)	0.0227	0.0229
Dominance (D)	1.0227	1.0229
Richness (R)	17.0443	17.1230

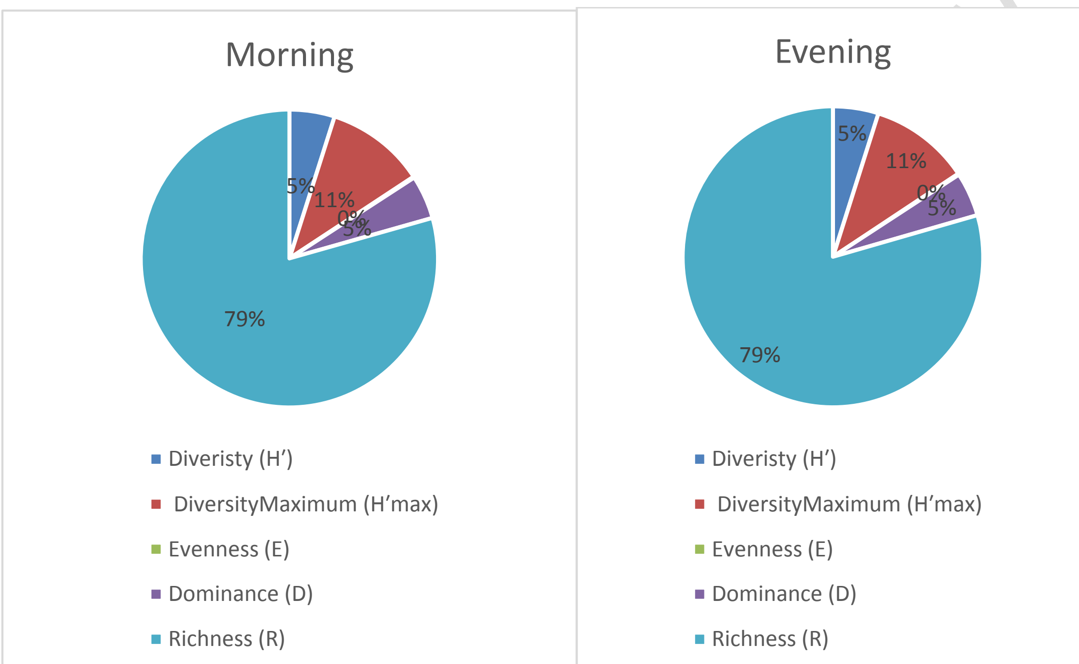

Figure 4: Diversity indices

Diversity Indices are key components for quantitative measurements of taxa composition and consists of diversity, evenness, dominance and richness of inhabiting taxa in that particular area. So, keeping in view the importance of these aspects, calculations were made as per Shannon Diversity Index (Shannon, 1948). In bitter gourd fields, maximum diversity was recorded as (1.0533) for evening, while least was recorded (1.0528) for morning and, $diversity_{Maximum}$ (H'_{max}) was recorded (2.3284) for evening and least (2.3243) for evening. Maximum evenness was (0.0229) for evening and least (0.0227) for morning while maximum dominance was (1.0229) for evening and least (1.0229) for morning. The maximum value for richness was recorded as (17.1230) for evening while least value (17.0443) for morning as shows in Table 6 and Figure 4.

4. CONCLUSION

This research study involves the Diversity and Abundance of foliage insect communities in bitter ground field with in the area of Faisalabad, Pakistan. It has been concluded that diversity exists among different orders of insects as 73 insect species were identified under 9 orders in morning while 65 species in evening under 8 orders. From above all discussion pertaining to results of present study. A total of 211 specimens were collected belonging to 9 orders, 38 families, 63 genera and 73 species in morning and total 213 specimens were collected belonging to 8 orders, 42 families, 58 genera and 65 species in evening. Highest relative abundance was recorded to taxa, Polistes wattii (Hymenoptera: Vespidae) 20.38% (N = 43) in morning while Polistes wattii (Hymenoptera: Vespidae) was recorded as an extraordinary contributing species with relative abundance of 24.41% (N = 52) in evening. Highest relative abundance are recorded for Hymenoptera 41.71% (N = 88) and least relative abundance (N ≤ 10) was recorded for order Dermaptera, Araneae and Odonata. Highest relative abundance was recorded for order Hymenoptera 38.03% (N = 81) and least relative abundance (N ≤ 10) was recorded for order Araneae and Odonata. Diversity was recorded as (1.0528) for morning and (1.0533) for evening, while diversity maximum (H′max) was recorded (2.3243) for morning and (2.3284) for evening. Evenness was (0.0227) for morning and (0.0229) for evening while dominance was (1.0227) for morning and (1.0229) for evening. The value for richness was recorded as (17.0443) for morning while(17.1230) for evening.

Competing interests

THE AUTHORS DECLARE NO CONFLICT OF INTEREST.

Authors' Contributions

Komal Abid conduct this research study while **Dr Noureen Rana** supervised the overall processing.

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