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Diversity and Relative Abundance of Entomofauna of Four Ecologically Different Areas of Chittagong University Campus, Bangladesh

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ABSTRACT

The present study was conducted to find the relative abundance and diversity of insects in the four areas of the Chittagong University (CU) campus from January 2018 to December 2018. The entire study found six orders - Odonata, Orthoptera, Coleoptera, Lepidoptera, Diptera, and Hymenoptera. Three families under Odonata, two under Orthoptera, four under Coleoptera, five under Lepidoptera, five under Diptera, and three under Hymenoptera were collected from the four study spots. Among them, fifteen species of Odonata, seven species of Orthoptera, seven species of Coleoptera, thirty-five species of Lepidoptera, five species of Diptera, and four species of Hymenopteran were identified. The highest number of insects (478) were collected in January 2018, whereas the lowest number of insects (404) were collected in August 2018. The highest abundance (1598) of insects was found in spot 1 (ground area) and the lowest (990) in spot 2 (hilly area). Lepidoptera (2688) was the most dominant order in the four studied spots, followed by Odonata (1453), Orthoptera (505), Coleoptera (223), Diptera (202), and Hymenoptera (186). During the study period, the highest species richness was observed in Spot 3 (2.61 ± 0.01) and lowest in Spot 2 (2.03 ± 0.008); the highest species diversity was observed in Spot 1 (1.36 ± 0.02) and lowest in Spot 2 (1.09 ± 0.01); and the highest species evenness was observed in Spot 1 (0.53 ± 0.006) and lowest in Spot 2 (0.47 ± 0.006). Compared with the previous study, it can be concluded that the species diversity and abundance of Odonata, Orthoptera, and Lepidoptera were increased, whereas the diversity and abundance of Coleoptera and Hymenoptera were decreased. The abundance and diversity of insects depended on seasonal fluctuation and ecological and environmental conditions.

INTRODUCTION

Insects have been an immensely successful animal group, with possibly 2-10 million species on earth today. Although evidence suggests that many insects died out at the end of the Cretaceous, most have survived many geological events over the last few millions of years. This is now changing, with the human impact estimated to threaten the survival of a quarter of all insect species. In the agricultural ecosystem, biodiversity is important for food production and other ecological services, including the recycling of nutrients, regulation of microclimate and local hydrological processes, suppression of undesirable organisms, and detoxification of harmful chemicals. So, the task is now urgent to conserve this immense variety of life which is so vital to many ecosystem functions. Threats are many and varied, with habitat destruction the worst threat, especially in the tropics where most insect diversity lives. Other threats include invasive alien organisms, certain biological control practices, the use of pathogens, genetically modified crops, and global climate change. Chittagong University (CU) Campus is enriched with diverse insect fauna. The present investigation was undertaken to study the abundance and diversity of insects in four ecologically different sites of the CU Campus, which were also widely separated by distance. The insects included in the study belonged to the orders-Odonata, Orthoptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera. Several works on insect diversity and abundance abroad and in our country. Amin *et al.* (2018) research on the functional and group abundance of insects on Eggplant. In total 488 insects were collected from the eggplant field, which belonged to 20 species in 21 families and 10 orders. The abundance, richness and diversity of pest, predator, pollinator and other categories of insects differed significantly and the pest revealed the highest abundance and richness compared to others. Rahman *et al.* (2017) studied the abundance and diversity of beneficial insect and spider species in the rice ecosystem in the Sylhet region. Many beneficial insect and spider species were found abundant at all growing stages in both rice fields. Siregar *et al.* (2016) studied the diversity and abundance of insect pollinators in three different agricultural land uses, i.e., oil palm plantation, rubber plantation, and jungle-rubber in Jambi, Sumatera. A total of 497 individuals of insect pollinators were collected by them which belonged to 43 species in three orders (Hymenoptera, Diptera, and Lepidoptera). Siddiki (2015) studied the insect diversity and composition during the wet and dry seasons in three forest types of Johor, Malaysia. They focused on ten common insect orders. A total of 929 insects were found in the study of Balakrishnan *et al.* (2014) on diversity of some insect fauna in different coastal habitats of Tamil Nadu, southeast coast of India. Zou (2014) focused on two distinct taxa: ground beetles (Coleoptera: Carabidae) and geometrid moths (Lepidoptera: Geometridae) to study the diversity patterns along environmental gradients in the temperate forests of Northern China. Hong *et al.*

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(2012) worked on insect diversity of Mt. Oseosan where a total 446 species of 108 families belonging to 11 orders were identified. Park *et al.* (2012) surveyed insect diversity of Yeonpyeong-do Island in Korea and the total of 209 species of 65 families under 10 orders were identified.

Aim and Objectives

1. To study the morphological and structural characteristics of Insect species from the four selected sampling sites in CU Campus.
2. To investigate the abundance of identified species of the selected sampling sites during one year study period.
3. To investigate the variation in abundance among the species of the four selected Spots.
4. To investigate the Shanon-Weiner diversity of the orders in the sampling sites.
5. To investigate community dominance of the identified species in the sampling sites.
6. To know and use fundamental concepts and information in areas of abundance and diversity of Insects.

METHODOLOGY

The present study was conducted in the CU campus, which is situated in close proximity of Sitakunda hill forest. The area lies between about 22o27'30" and 22o29'0" North latitudes and 91o46'30" and 91o47'45" East longitudes. The campus is dominated by hills, valleys, creeks and streams, lakes, crop fields, and grass and fallow lands. This is the junction of hills and plains adorned with hilly streams. These features constitute a suitable habitat for insect diversity. Approximately 72% of the total land is constituted by hillocks, which are 15-90 m high. The rest of the land is valley and/or plain.

The campus consists of many secondary forests with woody trees, flowering plants, fruit plants, medicinal plants, herbs, and shrubs. The campus area has received great attention in various aspects of biodiversity and species richness, particularly for insects, birds, and wild mammals.

During the study period, samplings were done for one year, from January-2018 to December-2018. A collection of data was done once in a month from four ecologically different areas in the four-terminal area (North, East, South and West) of CU Campus (spot-1: Garden Area, spot-2: Hilly Forest area, spot-3: Botanical Garden with Hilly Stream, spot-4: Pond area with agricultural crop field). Figure-1 shows the four studied spot in a map. Spot-1 was located at the northern side of the campus. There was beautiful flower garden in front of the agricultural field which consisted of many flowering plants like- Golap (*Rosa sinensis*), Gada (*Tagetes erecta*), Togor (*Tabernaemontena divaricata*), Hasna-hena (*Cestrum nacturnum*), Kamini (*Murraya paniculata*), Belly (*Jesminus sambac*), herbs, shrubs, and few tall trees such as- Mahagoni (*Sweitenia mahagoni*), Teak (*Tectona grandis*), Neem (*Azadirachta indica*), Jarul (*Lagerstroemia speciosa*), Krishnochura (*Delonix regia*), etc.

Plenty of small plants were available, especially *Mikania micrantha, Asparagus racemosus*, and so on. Some wild flowering plants, including *Lantana camara* and *Ficus benghalensis* were also found in this semi-hilly area. Spot-2 was the hilly forest area on the campus's eastern side. There was a dense growth of bush, tall and short trees, herbs, shrubs, and also wild flowering trees. Many kinds of valuable trees such as- Eucalyptus (*Eucalyptus citriodora*), Jarul (*Lagerstroemia speciosa*), Bamboo (*Bambusa* sp.), Cycas (*Cycas pectinata*), Hortoki (*Terminalia chebula*), Polash (*Butea monosperma*), Nagessor (*Mesua nagassarium*), Teak (*Tectona grandis*), Debdaru (*Polytthia longifolia*), Krishnochura (*Delonix regia*), Garjon (*Dipterocarpus turbinatus*), Akashmoni (Accacia racemosus) were seen throughout the entire area. Wildflowers and grassland were also found in this hilly forest area. Spot-3 was an ideal botanical garden established on the southern side beside a hilly stream with more than 10,000 plants of about 400 species comprising over 150 families of both exotic and indigenous species of timber, medicinal, fruits, spices, beverage, latex, orchids, novelty etc. have been preserved or are growing naturally and used as experimental materials. Many kinds of flower plants such as- Joba (*Hibiscus rosa-sinensis*), Chondromollika (*Chrysanthemum coronarium*), Golap (*Rosa sinensis*), Gada (*Tagetes erecta*), Togor (*Tabernaemontena divaricata*), Hasna-hena (*Cestrum nacturnum*), Rongon (*Ixora coccinea*), Bakul (*Mimusops elengi*), Gondhoraj (*Gardenia jasuninoides*), Kamini (*Murraya paniculata*), Dahlia (*Dahlia*), Belly (*Jesminus sambac*), Rojonigondha (*Polianthes tuberose*) etc. were planted in the garden which increased the beauty of the garden. Spot-4 was situated at the western and south-western parts of the campus area. The Spot was occupied by wetland and crop fields. The rice crop fields were occupied with seasonal rice (*Oryza sativa*) plants i.e., Aus, Aman and Boro in the three stages i.e., nursery, transplanting and ripening. In this area, rice was extensively cultivated throughout the year.

Insects were collected once in a month from each sampling location mainly in the morning for one hour. Sweeping process in each collection accomplished the collection of samples. Insect sweeping net was used for this purpose. Hand-picking collection was also followed for the small insects occupied in the leaf, grass as well as in the soil.

The captured insects were chloroformed, killed, sorted, stretched, mounted, labeled, and preserved following general entomological procedures (Borror *et al.* 1989). A total of 5257 insect specimens were collected during the study period.

The insects were identified with the help of taxonomic keys and characters. Firstly, specimens were identified up to family level. Then each specimen was examined up to genus and species level by comparison with previously identified specimens preserved at the Department of Zoology, University of Chittagong. The collected insect specimens were classified up to family following Borror *et al.* (1989), Richards and Davies (1977), and then up to generic level. Identification was made following Bingham (1908) and Talbot (1975) for lepidopterans, Kirby (1914) for orthopterans and hymenopterans, Maulik (1919) for coleopterans, Fraser (1936) for odonates, Van Emden

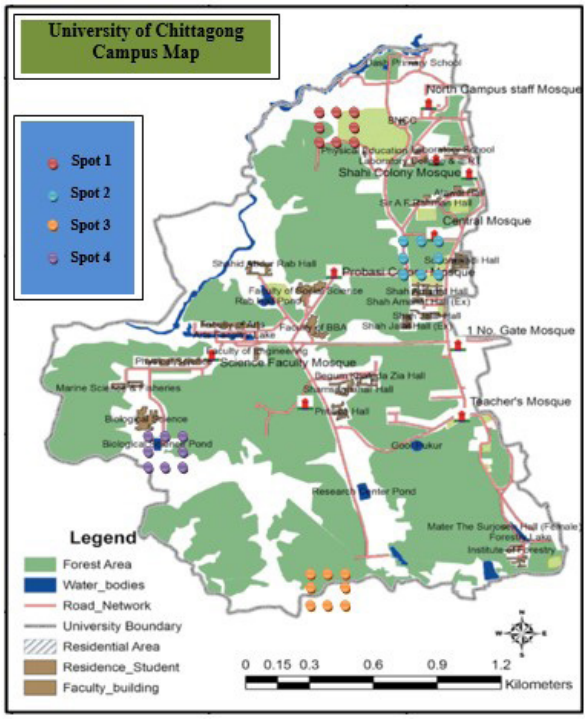

Figure 1: Map of the Study Area showing the Study Spots

(1965) for dipterans, Richards and Davies (1977) for butterflies, dragonflies, damselflies and beetles and Burton (1974). Help from internet sources was also taken for identification.

Shannon-Weiner Species Diversity Indices and Community Dominance were calculated to know the abundance and diversity status of the insect fauna of the CU campus area.

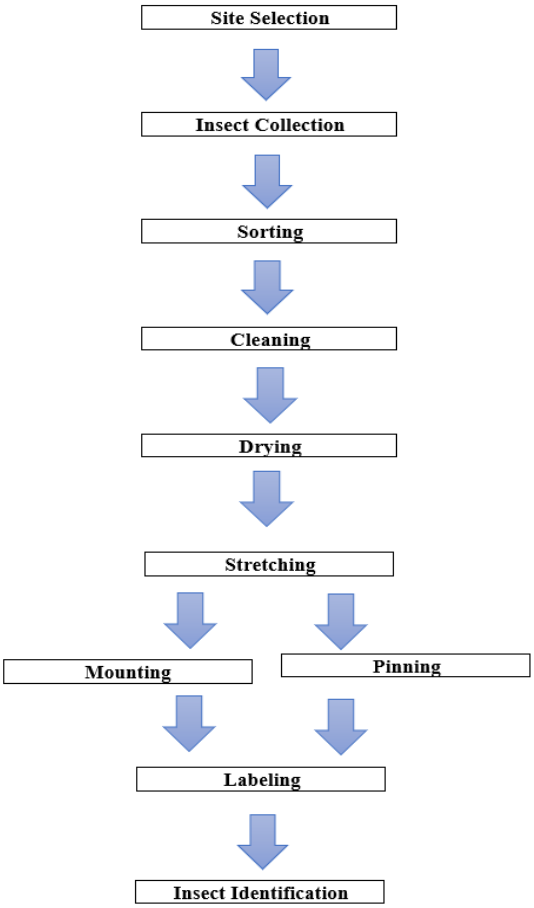

Figure 2: The workflow

RESULT AND DISCUSSION

The present study deals with the faunistic study of the insect community in CU campus. The study of the abundance and diversity of insects helps to gather information on the statistics of entomofauna. Sánchez-Bayo, F. and Wyckhuys, K. A. G. (2019) studied the entomofauna and found that over 40% of insect species were threatened with extinction. Their findings showed that habitat loss by conversion to intensive agriculture was the main driver of the decline, while agrochemical pollutants, invasive species and climate change were the additional causes.

A total of 5257 insect specimens were collected during the study period. The collected specimens were primarily sorted into 6 orders. Then they were identified into several different families within these orders. The orders are- Odonata, Orthoptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera. 3 families under order Odonata, 2 families under order Orthoptera, 4 families under order Coleoptera, 5 families under order Lepidoptera, 5 families under order Diptera and 3 families under order Hymenoptera were identified. For each order, families, genus and species a diagnosis is given. The collection included 73 species which are listed below:

Table 1: List of the insects collected during the study period

Order	Family	Scientific name	Common name
Odonata	Libellulidae	*Orthetrum sabina* (Drury, 1770)	Green Marsh Hawk
		Orthetrum pruinosum (Burmeister, 1839)	Crimson-tailed Marsh Hawk
		Neurothemis tullia (Drury, 1773)	Pied Paddy Skimmer
		Neurothemis fulvia (Drury, 1773)	Fulvous Forest Skimmer
		Rhyothemis variegata (Linnaeus, 1763)	Common Picturewing
		Rhodothemis rufa (Rambur, 1842)	Rufous Marsh Glider
		Brachydiplax chalybea (Brauer, 1868)	Rufous-Backed Marsh Hawk
		Crocothemis servilia (Drury, 1770)	Scarlet Skimmer
		Brachythemis contaminata (Fabricius, 1793)	Ditch Jewel
	Coenagrionidae	*Ceriagrion coromandelianum* (Farbicius, 1798)	Coromandel Marsh Dart
		Mortonagrion aborense (Laidlaw, 1914)	N/A
		Agriocnemis lacteola (Selys, 1877)	Milky Dartlet
	Platycnemididae	*Onychargia atrocyana* (Selys, 1865)	Black Marsh Dart
		Copera marginipes (Rambur, 1842)	Yellow Bush Dart
		Copera vittata (Selys, 1863)	Blue bush Dart
Orthoptera	Acrididae	*Dissosteira carolina* (Linnaeus, 1758)	Road-duster
		Oxya velox (Fabricius, 1787)	Paddy Field Grasshopper
		Oxya chinensis (Thunberg, 1825)	Short Horned Grasshopper
		Oxya hyla hyla (Serville, 1831)	Rice Grasshopper
		Paratettix sp. (Bolivar, 1887)	Creek Pygmy Grasshopper
		Atractomorpha sp. (Saussure, 1862)	Vegetable Grasshopper
	Gryllidae	*Gryllus pennsylvanicus* (Burmeister, 1838)	Field Cricket
Coleoptera	Chrysomelidae	*Aulacophora frontalis* (Baly, 1888)	Pumpkin Beetle
		Aulacophora indica (Gmelin, 1790)	Orange Pumpkin Beetle
		Aspidomorpha sanctaecrucis (Fabricius, 1792)	Golden Tortoise Beetle
		Aspidomorpha miliaris (Fabricius, 1775)	Green Tortoise Beetle
	Coccinellidae	*Menochilus sexmaculatus* (Fabricius, 1781)	Lady Bird Beetle
	Carabidae	*Harpalus distinguendus* (Duftschmid, 1812)	Ground Beetle
	Tenebrionidae	*Eleodes hispilabris* (Say,1824)	Darkling Beetle
Lepidoptera	Papilionidae	*Papilio helenus* (Linnaeus, 1758)	Red Helen
		Papilio polytes (Cramer, 1775)	Common Mormon
		Papilio demoleus (Linnaeus, 1758)	Lemon Butterfly
		Papilio clytia (Linnaeus, 1758)	Common Mime
		Graphium agamemnon (Linnaeus, 1758)	Green-Spotted triangle
	Pieridae	*Leptosia nina* (Fabricius, 1781)	Psyche
		Eurema hecabe (Linnaeus, 1758)	Common Grass Yellow

		Catopsilia pomona (Fabricius, 1775)	Lemon Emigrant
		Pieris canidia (Evans,1912)	Indian Cabbage White
		Delias hyparete (Wallace, 1867)	Painted Jezebel
		Cepora nerissa (Fabricius, 1775)	Common Gull
		Appias libythea (Swinhoe,1890)	Striped Albatross
	Nymphalidae	*Athyma inara* (Westwood, 1850)	Himalayan Colour Sergeant
		Junonia lemonias (Linnaeus, 1758)	Lemon Pansy
		Junonia almana (Linnaeus, 1758)	Peacock Pansy
		Junonia atlites (Linnaeus, 1763)	Grey Pansy
		Junonia hierta (Fabricius, 1798)	Yellow Pansy
		Junonia iphita (Cramer, 1779)	Chocolate Pansy
		Ypthima baldus (Fabricius, 1775)	Common Five-ring
		Lebadea martha (Fabricius, 1787)	Knight
		Mycalesis perseus (Fabricius, 1798)	Common Bushbrown
		Polyura athamas (Drury, 1770)	Common Nawab
		Hypolimnas bolina jacintha (Drury, 1773)	Orienta Great Eggfly
		Neptis hylas (Moore, 1872)	Common Sailor
		Phalanta phalantha (Drury, 1770)	Common Leopard
		Hypolimnas bolina bolina (Linnaeus, 1758)	Sunda Great Eggfly
		Parantica melaneus (Cramer, 1775)	Chocolate Tiger
		Euploea core (Cramer, 1780)	Common Crow
		Elymnias sp. (Hubner, 1818)	Palmfly
	Lycaenidae	*Neozephyrus quercus* (Linnaeus, 1758)	Purple Hairstreak
		Castalius rosimon (Fabricius, 1775)	Common Pierrot
		*Spindasis sp. (*Tytler, 1915)	Rufous Silverine
	Hesperiidae	*Notocrypta paralysos* (Fruhstorfer, 1911)	Banded Demon
		Baoris farri (Moore, 1878)	Paintbrush Swift
		Telicota bambusae (Moore, 1878)	Dark Palm Dart
Diptera	Sarcophagidae	*Saracophaga sp.* (Meigen, 1826)	True Fly
	Muscidae	*Musca domestica* (Linnaeus, 1758)	House Fly
	Drosophillidae	*Drosophila melanogaster* (Meigen, 1830)	Common Fruit Fly
	Tabanidae	*Tabanus sp.* (Linnaeus, 1758)	Horse Fly
	Calliphoridae	*Calliphora vicina* (Robineau-Desvoidy, 1830)	Blue Bottle Blowfly
Hymenoptera	Sphecidae	*Sphex lobatus* (Fabricius, 1775)	Digger Wasp
		Sceliphron violaceum (Fabricius, 1775)	Fassorial Wasp
	Apidae	*Xylocopa latipes* (Drury, 1773)	Tropical Carpenter Bee
	Vespidae	*Polistes sp.* (Latreille, 1802)	Paper Nest Wasp

During the collection period, a total of 5257 insects were collected (Table-2). January and April were the most dominant months. In January and April, 478 (9.10%) and 465 (8.85%) insects were collected where Lepidoptera, Odonata and Orthoptera insects were mostly available. In February, March, July, November and December, 452 (8.60%), 454 (8.64%), 418 (7.95%), 430 (8.18%) and 416 (7.91%) the abundance was medium. In the month of August 404 (7.68%), September 412 (7.84%) and October 407 (7.74%) the abundance of the insects was lower.

From 12 months observation (Table-3) the highest abundance of insects was found in Spot 1, medium abundance of insects was found at Spot 2 and Spot 4 and lowest abundance of insects was found in Spot 3.

From this study it is seen that the maximum numbers of insects were collected in the months of January (478), April (465) and May (462) when the temperature and weather condition was suitable and minimum number were collected in the months of August (404), October (407) and September (412) due to monsoon season.

Table 2: Number of insects collected per order and month wise % composition of the collected insect orders during the study period.

Order	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Total	% (month)
Odonata	123	117	118	117	121	120	124	119	123	122	121	128	1453	27.64
Orthoptera	56	43	35	44	45	46	39	36	39	42	45	35	505	9.61
Coleoptera	27	21	17	20	20	13	16	17	18	17	20	17	223	4.24
Lepidoptera	244	244	251	244	244	251	207	202	203	193	205	200	2688	51.13
Diptera	16	13	15	23	17	17	12	14	16	14	25	20	202	3.84
Hymenoptera	12	14	18	17	15	12	20	16	13	19	14	16	186	3.54
Total	478	452	454	465	462	459	418	404	412	407	430	416		
% (Order)	9.10	8.60	8.64	8.85	8.79	8.73	7.95	7.68	7.84	7.74	8.18	7.91		

Table-3 shows the order wise distribution of the collected insects in the four study Spots during the study period. Butterflies (Lepidoptera) were the most abundant group in Spot 4 (834), Spot 1 (762), Spot 2 (655) and Spot 3 (437). The lowest insect abundance order was Hymenoptera which was found very few in number in different study Spots, such as 62 from Spot 4, 45 from Spot 2, 43 from Spot 3 and 36 from Spot 1 respectively.

Amongst the orders, a total of 2688 lepidopterans, 1453 odonates, 505 orthopteran, 223 coleopterans, 202 dipterans, 186 hymenopterans were collected during the study period. Of the total collected insects, maximum numbers of insects were collected from Spot-1 and minimum numbers from Spot-3. Spot-1 had more insect species than were found at other sites. These differences could be the result of habitat and microhabitat differences among the sites. This Spot consisted of several flower gardens, grassland and was also rich in small to big sized plants which were the natural breeding ground and food source of butterflies, bees, wasps and beetles which may explain the highest total number of species captured at this site. From the study, it was seen that lepidopteran, odonate, orthopteran and coleopteran species were most abundant in Spot-1. Thus, the large number of

Table 3: Showing number of insects collected per order from the four Spots and % composition of the collected insects during the study period.

Order	Spot 1	Spot 2	Spot 3	Spot 4	Total	%(Spot)
Odonata	431	313	322	387	1453	27.64
Orthoptera	163	89	98	155	505	9.61
Coleoptera	134	0	49	40	223	4.24
Lepidoptera	762	655	437	834	2688	51.13
Diptera	72	39	41	50	202	3.84
Hymenoptera	36	45	43	62	186	3.54
Total	1598	1141	990	1528	5257	
% (Order)	30.40	21.70	18.83	29.07		

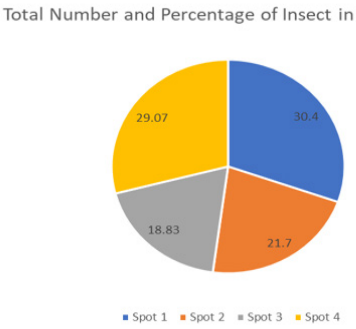

Figure 1: Percentage of the total insect found in each four Spots

lepidopteran and odonate insects was collected from Spot-4 which was rich in grass areas. Orthopteran and hymenopteran insects were mostly collected from Spot-2 because of forest hilly areas. The large sized butterflies and other large sized insects were the inhabitants of forest and hilly areas and medium to small sized insects were the inhabitants of plain land and flower garden. The most significant characters were that the abundance of hymenopteran species very low in all Spots and also in the study months.

Lepidopteran species were the most abundant insect order in almost all the months except July, August, September, October, November and December. Hymenoptera is the lowest abundant insect order which was found in very low number except the month of March, April, July, and October. Except Hymenoptera, insects of all orders were found more or less in almost all the months. James (2011) while studying the diversity and abundance of insect fauna in Rajshahi University Campus illustrated that the highest number of insects was found in November 2008 followed by February 2009 and the lowest population of insects was found in January 2009.

Table – 4 showed the community dominance value with the dominant species found in each month in the studying spots.The community dominance value was 8.8% in the Spot-1 in October, which was recorded as the highest value of the year. *Dissosteira Carolina* and *Ceriagrion coromandelianum* were found in October. The second dominant species *Ceriagrion coromandelianum* was used to calculate the community dominance value in the month October. In July, the most dominating insects were *Crocothemis servilia* and *Aulacophora indica* in the Spot-1 and the community dominance value was 5.83%, which was the lowest value in the Spot-1. The lowest value of community dominance indicated the diversity of species in the respective month. In Spot-1, the most dominating species were *Oxya hyla hyla, Crocothemis servilia* and *Brachythemis contaminate*. The second most dominating species was the Copera spp.

In Spot-2, *Leptosia nina* and *Papilio clytia* were found in the month of August and the dominance value was 10.11%. The community dominance was low i.e., 8.41% in November. The most dominating insects were *Hypolimnas bolina jacinth* and *Junonia iphita* So, the most diversified month was November in Spot-2. In Spot-2, the most dominating species were *Athyma inara, Pieris canidia* and *Junonia atlites*. The second most dominating species were *Junonia spp*. and *Papilio spp*.

In Spot-3, *Oxya hyla hyla* and *Brachydiplax chalybea* were found in the month of August and the dominance value was 12.79%. The community dominance was low i.e., 8.05% in January. The most dominating insect were *Copera marginipes* and *Orthetrum pruinosum*. So, the most diversified month was January in Spot-3. In Spot-3, the most dominating species was *Mortonagrion aborense*. The second most dominating species were *Copera marginipes, Rhyothemis variegate*, *Copera vittata* and *Brachythemis contaminate*.

In Spot-4, *Oxya velox* and *Mortonagrion aborense* were found in the month of January and the dominance value was 8.61%. The community dominance was low i.e., 7.53% in June. The most dominating insects were *Catopsilia Pomona* and *Junonia almana*. So, the most diversified month was January in Spot-4. In Spot-4, the most dominating species was *Ceriagrion coromandelianum*. The second most dominating species were *Brachydiplax chalybea* and *Orthetrum sabina*.

Species richness varied from month to month. But throughout the year the species richness was highest in the Spot 3 and lowest in the Spot-2 (Table-5). The highest species richness value was 2.66 found in Spot 3 in November and lowest value was 1.97 which was also found in November in Spot 2. The average highest species richness value was observed in the months of September and October (2.38 ± 0.14) and lowest value in January (2.31±0.13) and April (2.31 ± 0.11) during the study period. Species richness value (average) fluctuated between 2.32 (±0.13) to 2.37 (±0.15) in the rest of the months (According to Table-5).

Species diversity (H') values in the twelve months study period in the four study areas was also given in Table-5. The species diversity value was lowest in Spot 2 throughout the year. The species diversity value was highest in the Spot 1 in the month of January, February, March, June, July, September, November and December and in the Spot 3 in the rest of the months. The highest species diversity was 1.45 in January which was found in Spot 1 and in August which was found in Spot 3. On the other hand, the lowest species diversity was 1.01 in March. The average highest species diversity value was observed in the month of October (1.31 ± 0.09) and the lowest value in the month of June (1.20 ± 0.05) during the entire study period. Species diversity value (average) fluctuated between 1.21 (±0.08) to 1.29 (±0.13) in the rest of the months (According to Table-5).

Species evenness values varied from month to month during the entire study period in the four study areas. The highest species evenness value was found in Spot 1 in the months of January, February, March, June, September and December. The value was highest in July in spot 1 and 4 and in November in spot 1 and 3. The value was highest in the remaining months in spot 3. The lowest species evenness value was in spot 4 in the months of February

Table 4: Monthly % Community Dominance (DC) of entomofauna of four ecologically different areas in CU Campus collected from January 2018 to December 2018.

Spot-1		
Month	**Most dominating species**	**DC (%)**
Jan	*Oxya hyla hyla, Rhodothemis rufa*	7.33
Feb	*Agriocnemis lacteola, Onychargia atrocyana*	6.43
Mar	*Copera marginipes, Rhyothemis variegata*	6.57
Apr	*Brachythemis contaminate, Ceriagrion coromandelianum*	6.43
May	*Oxya velox, Brachydiplax chalybea*	6.43
Jun	*Crocothemis servilia, Copera vittata*	6.57
Jul	*Crocothemis servilia, Aulacophora indica*	5.83
Aug	*Copera marginipes, Agriocnemis lacteola*	7.44
Sep	*Brachythemis contaminate, Menochilus sexmaculatus*	7.03
Oct	*Dissosteira Carolina, Ceriagrion coromandelianum*	8.8
Nov	*Onychargia atrocyana, Oxya hyla hyla*	6.77
Dec	*Orthetrum Sabina, Menochilus sexmaculatus*	7.09
Spot-2		
Month	*Most dominating species*	**DC (%)**
Jan	*Athyma inara, Junonia atlites*	10
Feb	*Pieris canidia, Junonia lemonias*	9.47
Mar	*Pieris canidia, Cepora nerissa*	9.47
Apr	*Catopsilia Pomona, Graphium agamemnon*	9.89
May	*Junonia almanac, Mycalesis perseus*	9.38
Jun	*Athyma inara, Hypolimnas bolina jacintha*	9.38
Jul	*Junonia almanac, Junonia atlites*	9.18
Aug	*Leptosia nina, Papilio clytia*	10.11
Sep	*Catopsilia Pomona, Papilio helenus*	9.57
Oct	*Graphium Agamemnon, Papilio demoleus*	10
Nov	*Hypolimnas bolina jacintha, Junonia iphita*	8.41
Dec	*Leptosia nina, Parantica melaneus*	9
Spot-3		
Month	*Most dominating species*	**DC (%)**
Jan	*Copera marginipes, Orthetrum pruinosum*	8.05
Feb	*Rhyothemis variegate, Crocothemis servilia*	8.64
Mar	*Brachythemis contaminate, Mortonagrion aborense*	8.43
Apr	*Tabanus sp., Oxya velox*	10.11
May	*Rhodothemis rufa, Ceriagrion coromandelianum*	8.14
Jun	*Neurothemis fulvia, Copera marginipes*	8.75
Jul	*Ceriagrion coromandelianum, Copera marginipes*	10.47
Aug	*Oxya hyla hyla, Brachydiplax chalybea*	12.79
Sep	*Copera vittata, Mortonagrion aborense*	11.54
Oct	*Onychargia atrocyana Oxya velox*	11.69
Nov	*Rhyothemis variegate, Mortonagrion aborense*	11.84
Dec	*Brachythemis contaminate, Copera vittata*	11.11
Spot-4		
Month	*Most dominating species*	**DC (%)**
Jan	*Oxya velox, Mortonagrion aborense*	8.61
Feb	*Onychargia atrocyana, Ceriagrion coromandelianum*	8.09

Mar	*Rhyothemis variegate, Rhodothemis rufa*	7.91
Apr	*Ceriagrion coromandelianum, Copera vittata*	7.59
May	*Brachydiplax chalybea, Crocothemis servilia*	7.86
Jun	*Catopsilia Pomona, Junonia almana*	7.53
Jul	*Eurema hecabe, Paratettix sp.*	7.89
Aug	*Papilio clytia, Ceriagrion coromandelianum*	8.33
Sep	*Oxya velox, Brachydiplax chalybea*	8.04
Oct	*Papilio demoleus, Brachythemis contaminata*	7.83
Nov	*Orthetrum Sabina, Copera marginipes*	7.89
Dec	*Graphium Agamemnon, Orthetrum sabina*	8.33

and May while it is lowest in spot 3 in December. The value was lowest in both spot 3 and 4 in June and spot 2 and 4 in May. The lowest value was found in spot 2 for the rest of the month. The highest value was 0.56 and the lowest value was 0.43, found in spot 2 in March.

The average highest species evenness value was observed in October (0.52 ± 0.02) and the lowest value in the month of March (0.48 ± 0.03) during the entire study period. Species evenness value (average) fluctuated between 0.49 (±0.03) to 0.51 (±0.04) in the rest of-the months (According to Table-5).

From Figure-2, it has been seen that Spot 3 had more species richness (2.61 ± 0.01) with low insect abundance (990) whereas spot 2 was less species rich (2.03 ± 0.008) with moderate Insect abundance (1141). Spot 1 was most diversified (1.36 ± 0.02) with high insect abundance (1598, 30.40%). On the contrary, spot 2 showed low species diversity (1.09 ± 0.01) with comparatively low insect abundance (1141, 21.70%). Though the present study showed that the collected specimens were poorly distributed in all spots, the highest species evenness was found in the Spot 1 (0.53 ± 0.006) with highest insect abundance (1598, 30.40%). Species evenness was low in the Spot 2 (0.47 ± 0.006) with low abundance (1141, 2170%). The environmental factor (both biotic and abiotic) like temperature, rainfall, humidity, vegetations and food sources directly affect the diversity and distribution of insect populations, which was also supported by Morais *et al.* (1999), Kittleson (2004), Bispo and Olivera (2007) and Goldsmith (2007). The influence of humidity on density and diversity in the environment is likely to be an indirect effect operating via effects on availability. The differences could be the result of habitat and microhabitat differences among the sites.

Table 5: Average (±SE) Monthly fluctuation in Species richness (SR), Species diversity (H'), and Species evenness (E/J') of the collected insects in four study Spots.

Month		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**
Species richness (SR)	Spot 1	2.30	2.33	2.34	2.33	2.33	2.34	2.40	2.40	2.37	2.38	2.35	2.38	2.35±0.009
	Spot 2	2.05	2.02	2.02	2.04	2.02	2.02	2.01	2.05	2.06	2.05	1.97	2.00	2.03±0.008
	Spot 3	2.58	2.61	2.60	2.56	2.58	2.63	2.58	2.58	2.64	2.65	2.66	2.62	2.61±0.01
	Spot 4	2.29	2.34	2.33	2.31	2.32	2.31	2.43	2.46	2.43	2.43	2.43	2.46	2.38±0.02
	Average	2.31 ±0.13	2.33 ±0.14	2.32 ±0.14	2.31 ±0.11	2.32 ±0.13	2.33 ±0.14	2.36 ±0.14	2.37 ±0.15	2.38 ±0.14	2.38 ±0.14	2.35 ±0.17	2.37 ±0.15	
Species diversity (H')	Spot 1	1.45	1.37	1.35	1.34	1.38	1.29	1.32	1.28	1.36	1.36	1.44	1.38	1.36±0.02
	Spot 2	1.05	1.07	1.01	1.06	1.09	1.13	1.10	1.08	1.11	1.14	1.06	1.17	1.09±0.01
	Spot 3	1.30	1.30	1.27	1.42	1.42	1.18	1.25	1.45	1.29	1.43	1.44	1.22	1.33±0.03
	Spot 4	1.22	1.17	1.19	1.30	1.23	1.19	1.30	1.22	1.28	1.31	1.22	1.23	1.24±0.01
	Average	1.26 ±0.09	1.23 ±0.07	1.21 ±0.08	1.28 ±0.11	1.28 ±0.11	1.20 ±0.05	1.25 ±0.07	1.26 ±0.10	1.26 ±0.05	1.31 ±0.09	1.29 ±0.13	1.25 ±0.06	
Species evenness (E/J')	Spot 1	0.56	0.53	0.52	0.51	0.53	0.50	0.51	0.50	0.52	0.53	0.56	0.53	0.53±0.006
	Spot 2	0.45	0.46	0.43	0.45	0.47	0.49	0.47	0.46	0.48	0.49	0.46	0.50	0.47±0.006
	Spot 3	0.50	0.50	0.49	0.54	0.55	0.46	0.48	0.56	0.50	0.55	0.56	0.47	0.51±0.01
	Spot 4	0.47	0.45	0.45	0.50	0.47	0.46	0.51	0.47	0.49	0.51	0.47	0.48	0.48±0.006
	Average	0.50 ±0.03	0.49 ±0.03	0.48 ±0.03	0.50 ±0.03	0.51 ±0.03	0.48 ±0.01	0.50 ±0.01	0.50 ±0.04	0.50 ±0.02	0.52 ±0.02	0.51 ±0.04	0.50 ±0.02	

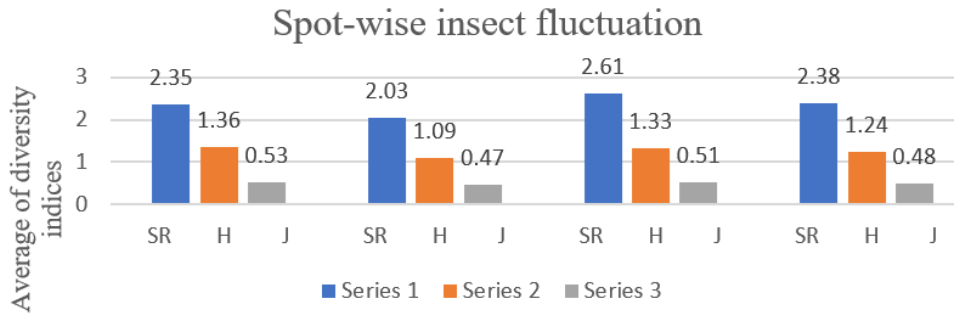

Figure 2: Spot-wise Species richness (SR), Species diversity (H), and Species evenness (J) of the collected insects.

The climate condition of the campus is characterized by moderately high temperature, with plenty of sunshine in summer, moderate to excessive humidity, heavy rainfall in rainy season and charming cool dry weather in winter. During the study period temperature varied from 19o C in January to 28o C in May to September and 27o C in October to 20o C in December and mean annual rainfall was 225 mm. Ecologically the campus is a tropical green forest area but the ecology has been suffering badly due to various biotic and abiotic factors and manmade causes. Data of average monthly temperature, rainfall, humidity and wind speed for the entire study period were collected from the practical field study. The data is given below:
In the present study, it was seen that some species were

Table 6: Meteorological Data

Month	Average Minimum Temperature (˚C)	Average Maximum Temperature (˚C)	Average Temperature (˚C)	Average Rainfall/ Precipitation (mm)	Wet Days (>0.1 mm)	Relative Humidity (%)	Average Wind Speed (mph)
Jan'18	13.7	26.4	20.0	6	2	58	1
Feb'18	16.1	28.9	22.5	15	3	58	1
Mar'18	20.4	31.6	26.0	50	5	65	2
Apr'18	23.6	32.3	27.9	120	7	71	2
May'18	25.0	32.4	28.7	233	13	77	2
Jun'18	25.3	30.8	28.0	578	22	83	2
Jul'18	25.2	30.4	27.8	707	26	85	2
Aug'18	25.2	30.5	27.8	517	25	86	2
Sep'18	25.2	31.3	28.2	270	21	84	2
Oct'18	24.0	31.2	27.6	205	8	78	1
Nov'18	19.5	29.3	24.4	52	2	71	1
Dec'18	15.1	26.8	20.9	9	1	68	1
Mean			25.8	230.17	11.25	73.67	1.58

collected regularly while others were rare. These findings are consistent with many community studies, which show that a small number of species dominates the community, whilst the majority of species are relatively rare (El-Moursy *et al.* 1999). Five out of six insect orders showed seasonal variability. The only insect order Hymenoptera did not show any significant seasonal variation in abundance. Four broad patterns were distinct in the seasonal distribution of fauna. Most of Odonata and Lepidoptera members were significantly higher during pre-summer (January to March, November, and December). Orthoptera and Coleoptera peaked during pre-summer and summer (March-May, November and December). Diptera peaked during the monsoon period (April to June). The number of insects fluctuated in different months of the year due to several reasons. Fluctuations in rainfall appeared to play a role in deciding the abundance of individual and overall fauna, along with other variables such as litter depth, litter moisture, humidity, and temperature that are directly or indirectly related to rainfall and insect population densities (Wagner *et al.* 2003, Vineesh *et al.* 2007). On the basis of the present observation and data collection, it can be said insect availability depends not only depended on seasonal fluctuation but also on suitable host plants. Hence, their presence or absence, their abundance serves to monitor ecological changes in habitat thus warning about the deterioration of habitat.

CONCLUSION

The present study indicates that the insect diversity is

rich in the CU campus. Moreover, insects play a vital role in the food chain and food web of any ecosystem. So, the present study is providing a clear checklist for environmentalists to understand the present condition of the ecosystem of the CU campus area.

RECOMMENDATION

This research may help to make a further checklist of insect fauna of the CU campus. Additionally, from the comparative analysis with the previous study it is distinguishable that whether the faunistic diversity increases or decreases as the university developed many infrastructures consequently the human settlement increases day by day.

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