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DIVERSITY OF INSECT SPECIES AT NOAKHALI SCIENCE AND TECHNOLOGY UNIVERSITY CAMPUS, BANGLADESH

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Abstract: Monitoring of ecosystem health in a specific area through insect diversity assessment is widely used. A study was carried out from November 2023 to May 2024 at 20 plots of the study area in Noakhali Science and Technology University, Noakhali, Bangladesh. A total of 5391 individuals, 58 species belonging to 54 genera, 35 families and 8 orders were observed during this study with Hymenoptera (26%) as the dominant order in species richness followed by Odonata (20%), Lepidoptera (18%), Orthoptera (10%), Diptera (9%), Coleoptera (8%), Hemiptera (9%), and Mantodea (0%). The biodiversity of insect fauna was found rich with a Shannon-Wiener diversity index score of 3.39 (H'= 3.39) and with a Margalef's richness score 6.63 (R= 6.63). According to the study's month-by-month analysis, the highest species diversity was observed in February. Lepidoptera was found as the most speciose order having 18 species. *Lasius niger* of Hymenoptera was identified as the most dominant species having 15.29 % of the total samples followed by Lepidopteran species *Borbo cinnara* with 6.66 % and Odonata species *Macrodiplax cora* with 6.21 % of the samples. About 32.13% of the insect preferred bushy areas as their habitat followed by grassland (25.43%), urban settlement (13.47%), and agricultural land (10.42%). Among the recorded species, 36 (62.07%) species were categorized as beneficial insects as they are known to function as predators, pollinators, honey producers, biological control agent as well as recycler of organic waste. In contrast, 22 (37.93%) species were categorized as harmful due to their reported role in crop and plant damage and disease transmission. The findings contribute to future biodiversity assessment and conservation planning by providing a baseline dataset on insect diversity at the NSTU campus.

Key words**:** Insects, Habitat, Conservation, Biodiversity, Fauna, NSTU

INTRODUCTION

Insects are the largest and most diverse group of organisms in the world among the animal phyla. They interact, either individually or collectively,

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with their immediate surroundings or ecosystem, which is composed of both physical characteristics (abiotic) and living beings (biotic) (Smith and Kennedy 2009, Schowalter 2022). A large proportion of terrestrial biodiversity is made up of insects, serving as vital indicators of environmental health and playing an essential role in ecosystem dynamics (Stork 1988, Losey and Vaughan 2006). There are around 5.5 million insect species on earth, with approximately one million having been documented and named (Stork 2018). New species are frequently found. Hemiptera (true bugs), Lepidoptera (butterflies and moths), Diptera (true flies), Hymenoptera (wasps, ants, and bees), and Coleoptera (beetles) are the most diversified insect groups, with each having over 100,000 known species (Stork 2018). However, a large fraction of insect species remained undescribed, and insufficient data on population dynamics impedes insect conservation efforts (Ong *et al.* 2024).

Insects, as fundamental elements of the ecosystem, perform a variety of ecological functions, including pollination, bio-control (parasites, parasitoids and predators), and nutrient cycling; all of which are critical for human existence and well-being. Their interactions with humans are similarly diverse. They often compete with one another for food in the field or in storage. Some insects transmit diseases to plants, livestock, or humans and damage houses, furniture, or clothing. Insects, on the other hand, create important commodities such as silk, honey, wax, and colours; some are even consumed by humans (Borror *et al.* 1989, Losey and Vaughan 2006, Klein *et al.* 2007, Dicke 2017). Despite the importance of insects, there is a significant vacuum in our understanding of Bangladesh's insect faunal diversity.

Bangladesh harbors a rich and diverse insect fauna, representing a wide range of insect orders (Nasiruddin and Hoque 2015). Bangladesh's long coastline, numerous rivers and their tributaries, lakes, haors, baors, ponds, and other types of wetlands, as well as lowland tropical evergreen forests, semi-evergreen forests, hill forests, moist deciduous forests, swamps, and flat lands with tall grasses, comprise the country's unique geographical location, diverse ecosystems, and climate, which contribute to its enormous species diversity (Chowdhury 2001, Nishat *et al.* 2002). Regrettably, not much study has been done in our country on insect diversity, despite the ambient environment (Chowdhury and Bashar 2021). Therefore, evaluating insect diversity is essential to comprehending the dynamics and health of ecological systems, especially in urbanized landscapes where anthropogenic pressures on natural habitats are growing. For example, major risks to insect diversity include overexploitation of forest resources, changes in land use (e.g., farming or urbanization), pollution, industrial raw waste, pesticides, artificial lighting, introduction of non-native tree species for ornamental purposes and invasive species (Tscharntke *et al.* 2005, Khatri and Tyagi 2015, Owens *et al.* 2018, Braak *et al.* 2018, Wagner and Van Driesche 2010). Since there are significant gaps in our understanding of the patterns of insect diversity (Danks 1996, Yi *et al.* 2012), protecting insect diversity is a challenge and an important global issue. It is stated that local species diversity inventories, descriptive and experimental studies of the trophic structure of communities contribute to the advancement of insect diversity estimation and the knowledge of insect community dynamics (Danks 1996, Chowdhury and Bashar 2021). Therefore, this study was aimed to fill this gap by conducting a baseline survey to explore the entomofauna occurring at Noakhali Science and Technology University campus.

MATERIAL AND METHODS

Study area: The study was carried out at the Noakhali Science and Technology University (NSTU) campus in Sonapur, which is eight kilometers southwest of Maijdee. It has a land area of 101 acres (0.41 km2) located between 90°24′ and 91°52′ east longitude and 22°26′ and 22°56′ north latitude. Nine representative sites within the campus were selected based on habitat characteristics, namely: NSTU central temple, BSAS hall, Moyna dwip, Santiniketan, Central library, Semi-permanent wetland, Nil dighi, Agricultural field, and VIP guest house (Figure 1). For the purpose of assessing insect diversity, seven different microhabitats that represent variations in vegetation structure, moisture levels, and human disturbance were chosen including bushy area, grassland, urban settlement, tree, ground, waterbody, and agricultural land.

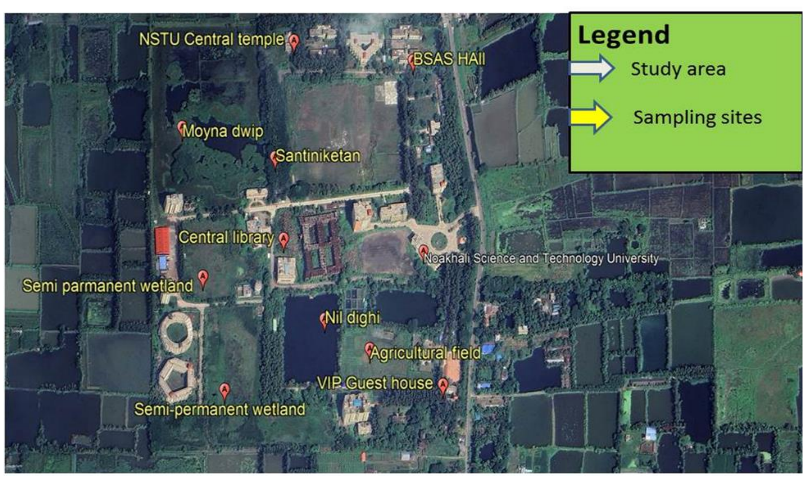

Fig.1. Map of the study area

Data collection method: Samples were taken twice a month between November 2023 and May 2024. On each day, 20 plots (20m × 10m each) within nine sampling sites were visited and direct field observations were followed to document insects spotted between 8 AM and 5 PM, and occasionally up to 6.30 PM according to Bangladesh Standard Time (BST). Sweep nets, aerial nets, and forceps were utilized for direct sampling of insect species. Sweep nets were used to collect insects from the ground and low-lying vegetation, specifically moths, grasshoppers, , mantids, and beetles. Aerial nets were employed to collect insects, mostly butterflies, bees, dragonflies, and dipterans, from below the canopy layer, however not all insect groups were studied. Hand picking was employed with fine forceps to catch insects (e.g., ants, beetles, as well as crawling and dwelling insects) of leaf blades, flowers, dried leaves, trees, branches, and the ground layer. The insects were handled with extreme caution to avoid damage.

Following collection, each specimen was put in a killing jar containing a 10% formalin solution. The samples were then brought to the laboratory, where they were cleaned with distilled water and air dried. Each specimen was placed in a separate vial based on its order and morphological characteristics to perform species level identification using microscopes and references from the literature (Borror *et al*. 1989, Bashar 2014) and confirmed by expert entomologists. Following identification, specimens were preserved in a vial consisting ethanol-glycerin solution (70:30) and labeled with their scientific names.

Data Analysis: The identified specimens were arranged in a tabular format according to their systematic position (order, family, genus, and species). Margalef's index (Margalef 1958) was used to measure the species richness. Diversity indices were calculated using the Shannon-Wiener index (Shannon and Wiener 1949) and Simpson's index (Simpson 1949). Evenness was determined by Pielou's (1966) and other diversity indexes including relative dominance. Statistical analyses were performed using MS Excel and PAST version 4.03 software, ensuring accuracy and consistency in data interpretation.

RESULTS AND DISCUSSION

Species Composition and Richness: During the study period, a total of 5391 individuals were recorded, belonging to 58 species, 35 families, and eight orders (Coleoptera, Hemiptera, Hymenoptera, Lepidoptera, Odonata, Mantodea, Diptera and Orthoptera) (Table 1). Among the insect's species, 18 species were recorded from the order Lepidoptera (31.03%) belonging to ten families followed by Diptera (12 species; 7 families; 20.69%), Odonata (7 species; 2 families; 12.09%),

Table1. Diversity of insect fauna in NSTU campus observed during November 2023 to May 2024. (Note: N- Number of individual; RA- Relative Abundance; SR- Species Richness; EI- Economic Importance)

Order	Family	Common Name	Scientific Name	N	RA	SR	EI
Coleoptera	Coccinellidae	Lady bird beetle	*Coccinella transversalis*	113	2.10	1.54	Predator
		Epilachna beetle	*Epilachna dodecastigma*	80	1.48	1.09	Pest
	Curculionidae	Fruit weevil	*Sternochetus frigidus*	5	0.09	0.07	Pest
		Green Immigrant leaf weevil	*Polydrusus formosus*	109	2.02	1.48	Pest
	Chrysomelidae	Pumpkin beetle	*Aulachophora foveicollis*	114	2.11	1.55	Pest
Mantodea	Mantidae	Praying Mantis	*Mantis religiosa*	15	0.28	0.20	Predator
Diptera	Asilidae	Robber Fly	*Ommatius tibialis*	9	0.17	0.12	Predator
		Robber Fly	*Ommatius coeraebus*	13	0.24	0.18	Predator
	Culicidae	Aedes Mosquito	*Aedes agepti*	108	2.00	1.47	Transmit disease
	Dolichopodidae	Long Legged Fly	*Condylostylus sipho*	40	0.74	0.54	Predator
	Drosophilidae	Vinegar Fly	*Drosophila bipectinata*	10	0.19	0.14	Pest
	Muscidae	Stable Fly	*Stomoxys calcitrans*	106	1.97	1.44	Pest
		Common Housefly	*Musca domestica*	52	0.96	0.71	Transmit disease
		Rice Seedling Fly	*Atherigona oryzae*	16	0.30	0.22	Pest
		Oriental Fruit Fly	*Bactrocera dorsalis*	35	0.65	0.48	Pest
	Stratiomyidae	Soldier Fly	*Odotomyia* sp.	42	0.78	0.57	Recycling waste
		Black soldier fly	*Hermetia illucens*	31	0.58	0.42	Recycling waste
	Syrphidae	Marmalade Hoverfly	*Episyrphus balteatus*	16	0.30	0.22	Biological agent
Hemiptera	Gerridae	Common Water Striders	*Aquarius remigis*	310	5.7	4.22	Predator
	Pyrrhocoridae	Red Cotton Bug	*Dysdercus cingulatas*	3	0.06	0.04	Destructive pest
	Alydidae	Rice bug	*Leptocorisa varicornis*	23	0.43	0.31	Pest
	Cicadellidae	Rice Green Leafhopper	*Nephotettix nigropictus*	128	2.37	1.74	Pest
	Membracidae	Treehopper	*Centrotypus flexuosus*	40	0.74	0.54	Food of birds
Hymenoptera	Formicidae	Common Black Ant	*Lasius niger*	824	15.28	11.22	Pollinator
		Carpentar Ant	*Camponotus festinus*	125	2.32	1.70	Recycling waste
		Weaver Ant	*Oecophylla longinoda*	176	3.26	2.40	Biological agent
	Vespidae	Lesser banded hornet	*Vespa affinis*	159	2.95	2.17	Pollinator
	Tenthredinidae	Sawfly	*Hoplocampa minuta*	40	0.74	0.54	Pest
	Apidae	Honey Bee	*Apis indica*	98	1.82	1.33	Pollinator and

Order	Family	Common Name	Scientific Name	N	RA	SR	EI
							produce honey
Lepidoptera	Acraeidae	Common Punchinello	*Zemeros flegyas*	8	0.15	0.11	Pollinator
	Danaidae	Plain Tiger Butterfly	*Danaus chrysippus*	16	0.30	0.22	Pollinator
	Gelechiidae	Potato Tuber Moth	*Gnorimoschema opercullela*	3	0.06	0.04	Pest
	Hesperiidae	Rice Swift	*Borbo cinnara*	359	6.66	4.89	Pollinator
		Common Awl	*Hasora chromus*	18	0.33	0.25	Pollinator
	Lycaenidae	Banded Blue Pierrot	*Discolampa ethion*	13	0.24	0.18	Pollinator
		Common Pierrot	*Castalius rosimon*	31	0.58	0.42	Pollinator
		Blue butterfly	*Rapala varuna*	25	0.46	0.34	Pollinator
		Lime Blue Butterfly	*Chilades lajus*	33	0.61	0.45	Pollinator
	Nymphalidae	Blue Moon Butterfly	*Hypolimnus bolina*	6	0.11	0.08	Pollinator
		Grey Pansy	*Junonia atlites*	21	0.39	0.29	Pest
		The Choclate Pansy	*Precis iphita*	15	0.28	0.20	Pollinator
	Papilionidae	Common Mormon	*Papilio polytes*	22	0.41	0.30	Pollinator
		Lemon Butterfly	*Papilio demolens*	14	0.26	0.19	Pest
	Pieridae	Common Grass Yellow	*Eurema hecabe*	171	3.17	2.33	Pollinator
	Pyralidae	Yellow Stem Borer	*Scirpophaga incertulas*	47	0.87	0.64	Pest
	Satyridae	Common Four Ring Butterfly	*Ypthima huebneri*	155	2.88	2.11	Pollinator
		Dark Evening Brown	*Melanitis phedium*	23	0.43	0.31	Pollinator
Odonata	Coenagriidae	Damselfly	*Ceriagrion cerinorubellum*	210	3.90	2.86	Predator
		Narrow Winged Damselfly	*Agriocnemis femina*	236	4.38	3.21	Biological agent
		Narrow Winged Damselfly	*Agriocnemis nana*	40	0.74	0.54	Predator
	Libellulidae	Skimmer	*Macrodiplax cora*	335	6.21	4.56	Predator
		Scarlet Skimmer	*Crocothemis servilia*	186	3.45	2.53	Predator
		Asian Pintail Dragonfly	*Acisoma panorpodies*	23	0.43	0.31	Predator
		Wandering Glider	*Pantala flavescens*	22	0.41	0.30	Predator
Orthoptera	Acrididae	Rice Grasshopper	*Oxya hyla*	326	6.05	4.44	Pest
		Short Horned Grasshopper	*Oxya japonica*	94	1.74	1.28	Pest
	Gryllidae	Field Cricket	*Brachytrypes orientalis*	5	0.09	0.07	Pest
	Tetrigidae	Grouse Locust	*Hedotettix gracillis*	94	1.74	1.28	Pest

Hymenoptera (6 species; 2 families; 10.34%), and Coleoptera (5 species; 3 families; 8.62%). The order Hymenoptera shows the highest species richness value (19.37) followed by Odonata (14.33), Lepidoptera (13.35) (Table 2). It is noteworthy that these insect orders have widespread distribution of species across all habitats and are globally extensive. *Lasius niger* belongs to order Hymenoptera was identified as the dominant species having a species richness value of 11.22 followed by *Borbo cinnara* (Lepidoptera; 4.89), *Macrodiplax cora* (Odonata; 4.56), and *Oxya hyla* (Orthoptera; 4.44). Insect dominance affects the structure of insect communities, and the diversity of insects reflects their capacity to adapt to a variety of environmental situations (Waterhouse 1947).

As one of the largest insect orders, Hymenoptera (ants, bees, and wasps) dominated this study, which is not surprising considering that they are often found almost anywhere due to their abundance in terms of numbers of individuals and their role as pollinators, pests, biological agents, and recyclers of waste (Chowdhury and Bashar 2021). Within the order, Formicidae (1125) showed the highest species richness among the four families. In addition, insects belonging to the Odonata and Lepidoptera are vital biological indicators and their availability indicated good environmental quality where they live. Two families (Coenagriidae, Libellulidae) were found under this order (1052 individuals) in our study and showed second highest species richness. On the other hand, family Hesperiidae (377) showed the highest species richness among the ten families under the order Lepidoptera.

The study was conducted during non-monsoon season, the highest number of species (S) and individuals (N) was observed in the month February (Figure 2). On the other hand, November recorded the lowest S values due to unfavorable condition of weather of winter season.

Relative Abundance, Diversity Indices and Habitat Usage: Of the 8 orders that were studied, Hymenoptera is the most abundant insect order with 26% of the total 5391 individuals followed by Odonata 20%, Lepidoptera 18%, Orthoptera 10%, Diptera 9%, Coleoptera 8%, Hemiptera 9%, and Mantodea 0%. The least number of species was recorded from the order Mantodea with a single (2%) species and highest species were recorded from the order Lepidoptera with 18 (31%) species. Rank-abundance curves of insect species showed that *Lasius niger* (15.29 %) as the most abundant insect species followed by *Borbo cinnara* (6.66 %), *Macrodiplax cora* (6.21 %), and *Oxya hyla* (6.05 %) (Figure 3). The species abundance data indicate that certain species exhibit much higher relative abundance compared to others resulting species unevenness. A diverse range of insect species and moderate evenness was found in the study area according to Margalef"s Richness Index (R= 6.63), Shannon-Wiener Index (H'= 3.39) and Pielou's Evenness (J= 0.84). However, the high dominance (DI =

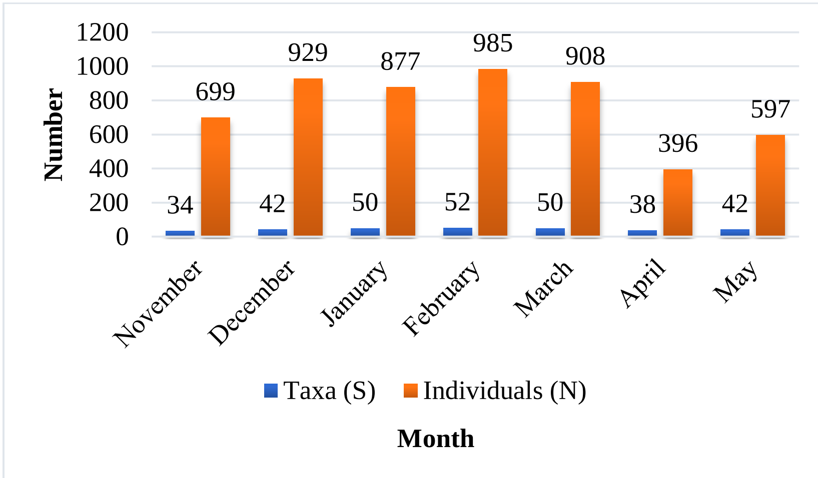

Fig. 2. Bar Diagrams representing N and S for five months in the study area.

0.95) and low Simpson's Diversity Index (λ= 0.051) indicate that a few species dominate the community. The highest insect diversity was found in the order Diptera (H'= 3.08; R= 1.78) where the lowest diversity was observed in the order Mantodea (H'= 0; R=0). Evenness with the greatest value being associated with Order Diptera (J= 1.24) and the lowest value being went with the Order Hemiptera (J = 0.53). The order Diptera was determined as the most dominant group of all the 8 orders of insect with the Simpson's Dominance Index value, DI= 0.86 (Table 2). Such patterns of distribution could be influenced by habitat preferences, resources availability, competition among species and sensitivity to environmental changes. Pollution or alteration of a habitat will lead to tolerant species flourishing, while sensitive species will migrate to a more suitable habitat (Medina *et al.* 2007).

Table 2. Diversity indices of different insect order

Order Name	Diversity indices						
	Relative Abundance (RA)	**Shannon-Wiener Index (H)**	**Simpson's Diversity Index (λ)**	**Margalef"s Richness Index (R)**	**Pielou's Evenness (J)**	**Simpson's Dominance Index (DI)**	**Species Richness (D)**
Coleoptera	7.81	1.43	0.25	0.66	0.88	0.75	5.73
Mantodea	0.28	0	1	0	-	0	0.20
Diptera	8.87	**3.08**	0.14	**1.78**	**1.24**	**0.86**	6.51
Hemiptera	9.35	0.85	**0.45**	0.64	0.53	0.55	6.86
Hymenoptera	**26.38**	1.31	0.38	0.69	0.74	0.62	**19.37**
Lepidoptera	18.18	2.09	0.19	**2.47**	0.72	**0.80**	13.35
Odonata	19.51	1.62	0.22	0.86	0.83	0.78	14.33
Orthoptera	9.62	0.96	0.38	0.48	0.68	0.54	7.07
Overall Diversity	_	3.39	0.051	6.63	0.84	0.95	_

The family Formicidae (RA= 20.87), Libellulidae (RA= 10.50), Coenagriidae (RA= 9.02), Acrididae (RA= 7.79), Hesperiidae (RA= 6.99), and Gerridae (RA= 5.75) had high relative abundance and dominant status, probably because of their ability to tolerate a wide range of environmental factors (Chang *et al.* 2014). In tropical regions, ants (Formicidae) dominate the insect biomass, and their nests are heated by the sun to facilitate brood development, which causes their number peak during non-monsoon months (Nielsen 1978).

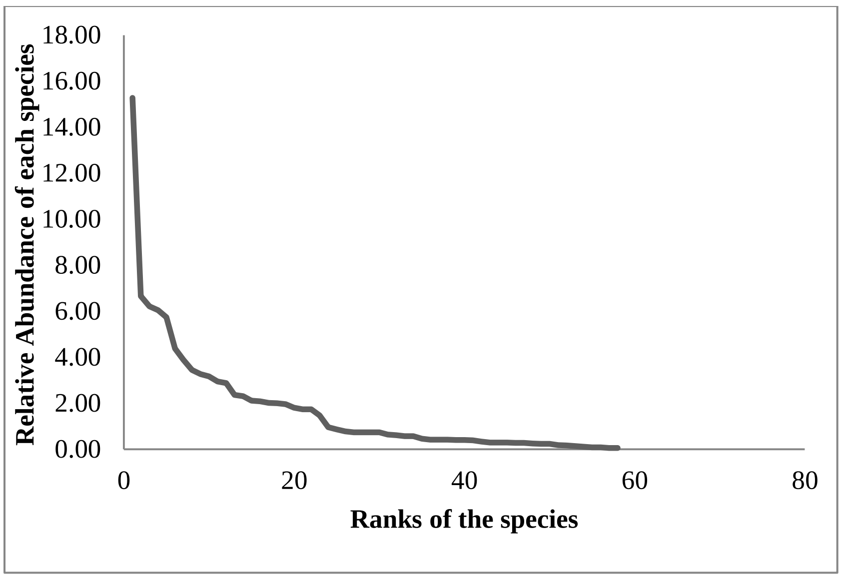

Fig. 3. Rank-abundance curves for insect species recorded from the study area where ranks the species in order of their abundance from the highest to lowest.

Considering microhabitat use, the bushy area (32.13%) was the most used habitat among the seven microhabitat categories, followed by grassland (25.43%), urban settlement (13.47%), and agricultural land (10.42%) (Figure 4). The presence of diverse habitats such as flowering plants, fruiting trees, agricultural fields, and water bodies likely contributed to the abundance and diversity of insects. The vegetation variety in a given area or habitat has a direct impact on the distribution of insects and serving as an alternative food source for arthropods to sustain in the environment (Selvi *et al.* 2015).

Economic Importance and Conservation Issues: Among the 58 insect species recorded at NSTU campus, 36 (62.07%) were identified as beneficial, acting as biological control agents, pollinators and honey producers, as well as recycling organic waste. In contrast, 22 species (37.93%) have been found to be harmful, causing harm to plants, humans, and other animals to varying degrees (Table 1). A total of 15 species, including ants, ladybird beetles, dragonflies

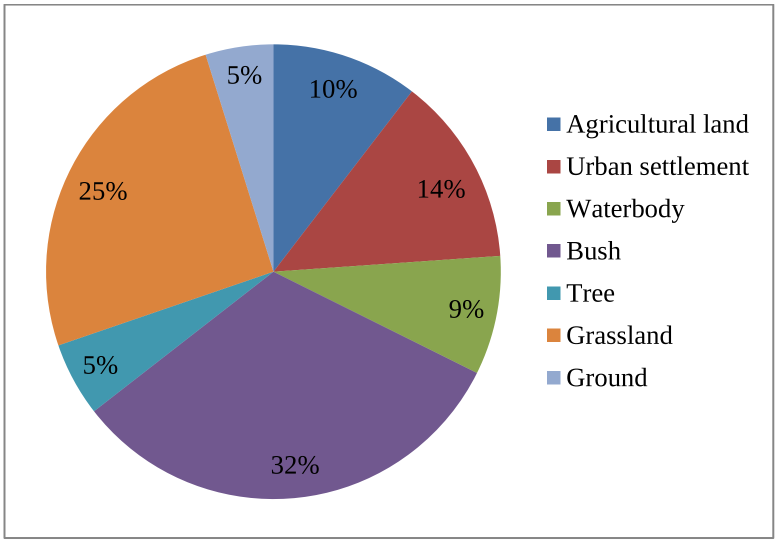

Fig. 4. Species richness in different habitats.

, damselflies, hoverflies, water striders, long-legged flies, robber flies, and mantids, were identified as predaceous insects or biological control agents that prey on a wide range of plant-eating insects that harm crops, particularly early in the growing season. In addition, 17 species from the orders Lepidoptera and Hymenoptera have been identified as pollinators according to Chowdhury and Bashar (2021). Furthermore, 22 insect species were recognized as dangerous, including beetles, weevils, mosquitoes, flies, bugs, hoppers, crickets, and locusts, due to their reported role in crop and plant damage and disease transmission.

In addition to functioning as excellent pollinators and biological control agents, insects are essential natural resources in ecosystems. Pollination is essential to an ecosystem's health and diversity. Insect pollinators support both agricultural and wild plants. Insects from the orders Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Neuroptera, and Thysanoptera play an important role in pollinating various agricultural, medicinal, and horticultural crops (Strong 1984), and the current study identified pollinators from the Hymenoptera and Lepidoptera. Coleoptera, Diptera, Hemiptera, Odonata, and Dictyoptera have been identified as predatory insect orders, with odonates, Hymenoptera, and Diptera serving as biological control agents. Some insects, particularly Homoptera, Lepidoptera, and Orthoptera, serve as food for birds and regulate their local abundance (Chowdhury and Bashar 2021).

Despite the significance of insects, the observed unequal distribution and decreased abundance of many species are probably due to the loss of water bodies, jungles, bushy regions, and other natural habitats. Throughout the year, human activities such as wetland conversion, fishing, agricultural land conversion, sewage disposal, garbage discharge, and infrastructure construction take place. In general, pollution is a serious issue as well. Sensitive species are therefore compelled to relocate a more appropriate habitat as a result of the study area being exposed to several threats. Thus habitat alternation or pollution, either by natural process or by anthropogenic impacts, can shape invertebrate communities.

CONCLUSION

However, this study gives a baseline assessment of insect diversity at the NSTU campus throughout the non-monsoon season, emphasizing the importance of long-term seasonal monitoring. Toward better management of an area, long-term seasonal monitoring of the physiochemical properties and an assessment of flora and fauna diversity, as well as socioeconomic factors, is recommended. In addition, ongoing development activities, habitat destruction, and anthropogenic pressure are all threats to biodiversity. To ensure the sustainability of insect production, it is imperative that the environmental and habitat conditions in the natural ecosystems be conserved.

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