Butterfly Diversity in a Tropical Urban Habitat (Lepidoptera: Papilionoidea)

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Abstract

Butterflies are important pollinators and indicators of environmental health. Habitat destruction and fragmentation caused by developmental activities and poor natural resource management are the main reasons for the drastic decline of butterfly populations throughout the world, and prompt the need for effective conservation management. We assessed the diversity, richness, seasonal distribution and conservation priorities of butterflies in an inner-city parkland habitat (University of Dhaka, Bangladesh) and investigated the biotic, and abiotic factors affecting butterfly diversity. A total of 93 species from 5 families were recorded from January to December 2014. Nymphalidae and Papilionidae were the most and least dominant families in terms of species number. Butterflies across families generally selected nectar plants randomly, although some showed preference towards herbs. Spatial interpolation of butterfly richness indicated that the most suitable area was around Curzon Hall, an area containing different types of vegetation. Precipitation was the only abiotic factor with a significant relationship with butterfly species richness. The establishment of green areas with complex structural vegetation will improve microclimatic conditions for butterflies, promoting healthier urban ecosystems, and the conservation of butterflies and other associated species in inner-city areas.

Key-Words: Biodiversity, Bangladesh, conservation, entomology, seasonal distribution, species richness, urban ecosystems.

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Introduction

Over the past few decades, the maintenance of biological diversity has become an issue of both local and global concern, with biodiversity declines continuing unabated despite international biodiversity targets such as the Convention on Biological Diversity's Aichi Targets aiming to reduce biodiversity loss (Tittensor et al. 2014; Butchart et al. 2010). Tropical ecosystems are particularly affected by biodiversity loss, since they are high in species diversity and abundance while pressures affecting species are often most pronounced (Collen et al. 2008). Habitat loss through agricultural conversion of land and urbanisation are the main factors driving species towards extinction (e.g., Schipper et al. 2008; Böhm et al. 2013). Rates of urbanization have increased faster in tropical regions than the rest of the world, from 30.5% in 1980 to 45% in 2010 (Edelman et al. 2014). Yet urban areas are not devoid of biodiversity and are subject to the same factors affecting ecosystems elsewhere, i.e. climate, substrate, resident biodiversity, and topography (Pickett et al. 2011). Retaining, establishing and effectively managing urban ecosystems can aid the conservation of biodiversity and increase public well-being (Chong et al. 2014).

The compilation of species lists and identification of habitat preferences, and abundances are the first steps in effectively conserving biodiversity through the establishment of species baselines and basic ecological requirements. Insects are the most diverse group of animals making up around 90% of the total animal species (Glenner et al. 2006; Scheffers et al. 2012), yet for most tropical insect groups, we know almost nothing about their ecology, distribution and abundance. Butterflies (Lepidoptera: Rhopalocera) are important pollinators (Proctor et al. 1996; Amin et al. 2015; Rader et al. 2016) and are indicators of environmental health due to their sensitivity to climatic and other abiotic factors (such as temperature, precipitation, humidity and

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light levels) and anthropogenic pressures (such as habitat fragmentation, pesticides and pollution) (Clausen et al. 2001; Fleishman et al. 2009; van der Putten et al. 2010; Stefanescu et al. 2004). Butterflies rely on host plants interactions for the completion of their lifecycles, often rendering them highly habitat-specific and their abundance season-specific (Bernays & Chapman 2007; Awmack & Leather 2002). Additionally, their aesthetic value makes them popular among amateur naturalists and collectors. As a result, they are a relatively well studied group throughout the world, especially in temperate regions, where they are regularly used to monitor environmental changes (Thomas 2005; New 1997). However, significant data gaps remain, specifically in tropical regions (Lewis & Senior 2011).

Habitat loss is a very common result of urbanization which together with habitat fragmentation, can cause drastic reduction in species diversity. Changes in habitat quality might be manifested as altered host plant quality, microclimate, predation risk, or soil attributes (McKinney 2002; Rickman & Connor 2003). Factors such as presence of pesticides, changes in light and nutrients, air pollution, soil compaction, water regimes and exotic species also contribute to changes in habitat quality.

Changes in habitat quality caused by urbanization might alter insect richness, resulting either in decreases, or more rarely in increases, in the richness of specific insect groups (McKinney 2008). Insects, such as butterflies, which are found in both rural and urban habitats, diversity and richness is much lower in urban areas than in natural ones (Raupp et al. 2010). However, the density of individual herbivores, and thus the resultant damage on the host plant, can be much higher in the urban setting (McIntyre 2000). Higher densities of herbivorous insects in urban areas might arise for two reasons: i) as a result of the stresses on the urban plants by soil compaction, air pollution, temperature and water imbalances, which makes plants specially prone

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to insect attack, or ii) because the population numbers of the natural enemies of herbivores are often lower in urban areas (Connor et al. 2002). In addition, in some cases, exotic plants serve as alternative hosts for some insect species which support greater populations than in original habitats, again increasing pressures on natural host plants (Agrawal et al. 2006; Graves & Shapiro 2003; Shapiro 2002).

Larsen (2004) documented around 236 species of butterfly in Bangladesh. Additional species have been discovered since (Bashar 2014; Chowdhury & Hossain 2013; Chowdhury et al. 2016) and a number of recent ecological studies have focused on butterflies in Bangladesh (Chowdhury et al. 2014; Khan 2014; Khandokar et al. 2013). However, only limited work has been carried out to link the diversity of butterfly species to the associated plants and wider ecology (Bashar et al. 2006).

Here, we provide an initial baseline for butterfly diversity in a tropical urban setting in Dhaka, Bangladesh. We investigated diversity and seasonal distribution of butterflies in relation to biotic and abiotic factors in an inner city environment where habitats are under great pressure from human impact, such as pollution and urban development. Dhaka, a city of 17 million inhabitants, is the capital of Bangladesh and suitable habitats for wildlife are scarce with the few existing areas under serious threat. We investigated important butterfly-plant associations and develop recommendations of how butterfly conservation and monitoring can be supported in an urban tropical environment based on our findings.

Material and Methods

Study Area

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This study was carried out at the University of Dhaka campus which is situated at the center of the capital of Bangladesh (23.73° N and 90.39° E). Having more than 115000 people per square kilometer, Dhaka is one of the most populated cities in the world, and experiences much urban development and pollution. However, the University of Dhaka campus is relatively undisturbed, with a number of vegetation layers including canopy, shrubs and herbs which could sustain relatively high levels of biodiversity. There are numbers of water resources in the University of Dhaka campus which have made this campus as a sound habitat for butterfly populations.

Figure 1. Map of the University of Dhaka campus (Adapted from a map, created by Department of Geography, University of Dhaka)

Butterfly Surveys

Surveys were carried out multiple times per week from the 1st of January 2014 to the 31st of December 2014. During the survey, paths taken were carefully chosen through campus on a given day in such a way that the entire campus was covered each week indeed no surveys were carried out when it rained. Each survey took about two hours and covered approximately $1km^2$. Surveys were conducted between early morning and late afternoon by the first author. To avoid biasness, the direction of survey area was changed periodically. All butterflies visible from the path were recorded. In this study, two different cameras (Sony DSC W560 Cybershot and Canon Powershot SX 510HS) were used to take photographs in order to aid identification of butterflies to species level along each survey path, using a number of published resources (Ek-Amnuay & Komaradat 2012; Kehimkar 2008; Chowdhury & Hossain 2013; Bashar 2014). Collections were

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restricted to those species which could not be identified properly by using the above method. In these cases, butterflies were collected using sweep nets. Each specimen was placed in a plastic bottle and taken to the laboratory for identification. As the activity and species richness of butterflies are known to depend on both time of day and season of the year (Harvell et al. 2002; Stefanescu et al. 2004; Forister et al. 2010). We summarized total observed species richness per week for consistency.

We studied the influence of abiotic factors on butterfly species richness by including relative humidity (%), temperature (°C) and precipitation (mm) into our analysis. Data for these factors were obtained from a meteorological website (wunderground.com). We considered weekly data for the analysis to reflect our weekly aggregates of butterfly species richness. We also collated the national-level conservation status (Not Assessed (NA), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), and Critically Endangered (CR)) of recorded species from the recent publication of the Bangladesh National Red List for butterflies (IUCN Bangladesh 2015). Statistical analyses were carried out using R (version 3.3.0) (R Core Team 2014) and the significance level was set at 5%.

Butterfly Richness and Plant Associations

Butterflies plant activities were recorded nectar collecting or visits to flowers were observed. In this study, we observed few butterfly associated plants in which they were being mostly observed, collecting nectar, roosting or other showing other features. We categorized different associated plant species into herbs, shrubs and trees and analyzed them with a one-way ANOVA.

The effect of environmental variables on butterfly diversity was analysed with general linear models (LM) with species richness as response variable and temperature, precipitation and

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humidity as explanatory variables. Initial models were simplified by removing non-significant terms following the marginality rule (Pekar & Brabec 2016). The models generated were tested for violations to the 5 model assumptions (normality of residuals, homoscedasticity of residuals, collinearity, serial autocorrelation and bias from influential observations based on Cook distances) following recommendations by Thomas et al. (2013) and met all assumptions except from some evidence of autocorrelation.

Spatial Prediction of Butterfly Species Richness

We used spatial interpolation to map the predicted occurrence of butterflies across the University of Dhaka campus. Spatial interpolation is the prediction of values of attributes at unsampled locations S_0 from existing measurements at ($s_1,\ldots,s_n$). This procedure converts a sample of point observations into an alternative representation such as a contour map or grid. Deterministic interpolation techniques create surfaces from measured points based on either the extent of similarity or degree of smoothing. In this study, we used inverse distance weight (IDW) interpolation to smooth data.

The IDW algorithm is a moving average interpolator that is usually applied to highly variable data (Lu & Wong 2008). For example, for certain data types it is possible to return to the collection site and record a new value that is statistically different from the original reading but within the general trend for the area. The IDW technique calculates a value for each grid node by examining surrounding data points that lie within a user-defined search radius. It implements the assumption that things that are close to one another are more alike than those that are farther apart. To predict a value for any unmeasured location, IDW will use the measured values

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surrounding the prediction location. Thus it assumes that each measured point has a local influence that diminishes with distance.

It computes one such weighted average:

$$T(s_0) = \sum_{i=1}^{n} w_{i0}\, Y(s_i)$$

where $Y(s_i)$ is the richness of the butterflies at location s_i and weights $w_{ij}$are determined according to the distance between points s_i and s_j, and scaled by parameter κ:

$$w_{ij} = \frac{1}{h_{ij}^{\kappa}} with h_{ij} = ||s_i - s_j||$$

Values of κ > 1 reduce the relative impact of distant points and produce a fluctuating map and values of κ < 1 increase the impact of distant points and produce a smooth map.

Results

Over the study period, we observed 93 species of butterflies belonging to 62 genera and five families (see table S1 in the supplementary information). Among those five families, the most abundant family was Nymphalidae for which we recorded 27 species; Papilionidae was the least abundant family, with 7 species. The other recorded families were Lycaenidae (26 species), Hesperiidae (19 species) and Pieridae (13 species). Overall, recorded species richness was highest in week 22 (May, 51 species observed) with a second peak in week 51 (December), with

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lowest species richness recorded in week 40 (July, only 28 species observed) (Figure 2). Of the butterfly species recorded, 26 are reported as nationally threatened (see supplementary information). Some of the most species-rich families on campus also showed high proportions of threatened species being recorded, namely 47% (9 out of 19 species) for Hesperiidae and 35% (9 out of 26 species) for Lycaenidae. The remaining eight threatened species belong to the Nymphalidae (6 out of 27 species) and Pieridae and Papilionidae (one species each).

Figure 2. Weekly butterfly species richness at the University of Dhaka campus throughout the study period.

Butterfly species richness had a negative relationship with temperature, precipitation and humidity (Fig. 3; LM, $F(5,46) = 5.28$, $P < 0.001$, Adjusted $R^2 = 0.30$). However, only the main effect of precipitation was significant (LM, $t = 3.25$, $P = 0.002$), whereas temperature (LM, $t = 1.91$, $P = 0.06$) and humidity (LM, $t = 1.92$, $P = 0.06$) were not significant. In addition, interactions between temperature and humidity (LM, $t = 7.90$, $P = 0.007$) and precipitation and humidity (LM, $t = 10.31$, $P = 0.002$) were significant.

Figure 3. The relationship of abiotic factors to butterfly species richness: a. Average Temperature vs. Species Richness; b. Average Precipitation vs. Species Richness and c. Average Humidity vs. Species Richness.

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There was no statistically significant relationship between different vegetation types and butterfly families (One-way ANOVA, $F_{12} = 0.38$, $P = 0.86$).

The inverse distance interpolation of the predicted species richness of the families of butterflies around the University of Dhaka campus along with their actual richness indicate that butterflies were mostly active in the Curzon Hall area of University of Dhaka campus.

Figure 4. Map of the University of Dhaka campus showing measured (a) and predicted (b) species richness of butterflies using the inverse distance weight interpolation.

Discussion

During our study, some of the most common butterfly species (such as *Euchrysops cnejus, Chilasa clytia and Papilio polytes*) were spotted almost during every survey. This may indicate that the species breed locally (although it is conceivable that strong fliers such as *Papilio clytia* and *Papilio polytes* may breed elsewhere), which suggests that the food plants of these butterflies are present in our study area and that their caterpillars are tolerant of this particular habitat. Other butterflies (such as, *Leptotes plinius, Papilio polymnestor and Delias pasithoe* etc), despite generally known to feed on common plant species, were hardly observed during the 12 months study period, suggesting that these are irregular visitors to the study area, most likely due to a lack of appropriate habitat for these species which would otherwise support breeding populations. Specifically, some of these rare butterflies are likely to be migrants and the larval food plants may therefore not be present at the study site (Goehring & Oberhauser 2002): either

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the larval host plants were never present in the study area or have been lost following habitat loss due to urbanization and modification of the University of Dhaka campus. The richness and distribution of butterfly species also fluctuates in accordance to their life cycle which is tied to seasonal changes. However, compared to temperate butterflies, seasonal variation does not typically have a large impact on tropical butterflies which remains well distributed throughout the year, particularly in areas without a pronounced dry season (Hamer et al. 2005). In Bangladesh, where the pronounced dry season lasts from November to May, we observed fluctuations in the number of butterfly species at different times of the year (Figure 2). Butterflies of the University of Dhaka campus showed highest species richness in the dry season with % of the total species observed during this period. This finding is contrary to that of other studies, which report higher numbers in the rainy season (Hamer et al. 2005; DeVries et al. 1997). A possible explanation for this is that human intervention in the form of watering provides more food resources for butterflies on the campus than in surrounding areas and as such attracts a higher than usual number of butterflies during the dry season.

A high number of nationally-threatened (though often globally common) species were recorded on the University of Dhaka campus. While many of these were recorded as rare or very rare (such as, *Anthene lycaenina*, *Tarucus nara* and *Tarucus callinara*) in our study, some were actually common or fairly common (such as, *Catochrysops strabo, Spalgis epius* and *Suastus gremius*). This suggests that urban areas, despite the presence of anthropogenic pressures, can provide important habitats for threatened species. Previous research has shown that urban artificial or semi-artificial habitat can play an important role in the conservation of threatened species (e.g. Reeder et al. 2015; Recuero et al. 2010). Management of vegetation should therefore take into account the needs of threatened and non-threatened species alike.

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Previous studies have shown that the diversity of butterflies greatly depends on the availability of food plants (e.g., Burghardt et al. 2009; Ricketts 2002). From the observation of nectar-feeding in this study, Rubiaceae and Verbenaceae were the most preferred plant families for Pieridae; Asteriaceae for Lycaenidae; Amaranthaceae and Asteriaceae for Nymphalidae; Asteriaceae and Rubiaceae for Hesperiidae and Rubiaceae for Papillionidae. All five families of butterflies collected nectar from plants of the Rubiaceae family, whereas, only a few nymphalids were observed collecting nectar from the Phyllantaceae, Smilacaceae, Anacardiaceae, Urtiaceae and Moraceae. Our results suggest that active management to promote Rubiaceae species, with additional management for Asteriaceae and Poaceae species (the latter specifically for Satyrid species) is likely to maintain current adult butterfly populations at the University of Dhaka campus. In addition, further studies on larval host plants are required to ensure that breeding populations of butterflies are retained in this urban setting.

Satyrid butterflies were mostly active in the drier parts of the year and they were spotted in the more shaded areas. These patterns may be explained by the differences in the usage of microhabitats by species in different taxa; species of satyrid butterflies have a strong preference for dense shade at ground level (Hamer et al. 2003; Hill et al. 2001) and those observed in this study, were mostly found on shade tolerant grasses and bamboos (Poaceae) (Robinson et al. 2001). As a result, it is vital to maintain habitat which provides a range of microclimate and shade levels to the resident species of butterfly.

Any associations between butterfly species richness and different abiotic factors in this study were found to be largely insignificant. We found that only precipitation and the interaction of humidity with temperature and precipitation influenced butterfly species richness. As this study

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only collected data over the period of a single year, more extensive study is required to account for variation in climatic factors between years.

Different vegetation management methods and modes are used on rights-of-way (Smallidge et al. 1996), relying on site limitations and environmental and economic constraints. With the help of experts from different sectors including vegetation management and landscape ecology experts, the habitat needs of butterflies can be integrated. Depending on the life-cycle of the butterfly and the regeneration requirements of the host plants, management activities can be increased in frequency, intensity, or magnitude to create favorable regeneration conditions without jeopardizing butterfly population (Smallidge et al. 1996).

Compared to the other areas of the University of Dhaka campus, the area around Curzon Hall is comprised of different types of vegetation. Interestingly, butterflies of different families were observed displaying a range of behaviors, such as resting, feeding and courtship etc. This suggests that this area is suitable for accommodating resident butterfly populations for a cross-section of species. Our species interpolation map showed that the diversity and richness of butterflies peaked in the Curzon Hall area, with very low occurrences recorded in other areas. Better management of habitat and reduction of habitat destruction, human interference and pollution by visitors and students is essential for the conservation of wider areas of the campus for butterflies.

In order to conserve butterflies in a tropical urban area such as the University of Dhaka campus specific measures must be taken. Conserving different micro-habitats and vegetation layer complexity, reducing habitat fragmentation and preventing man-made pollution as much as possible, and keeping adequate humidity levels during periods of adverse weather will help

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butterflies to colonize the area. In addition, planting nectar plants of different plant families will also help to attract butterflies. It is not certain whether adult butterflies remain in the same micro-habitats where immature stages are concentrated, so suitable resource conditions for both immature and adult stages are necessary to maintain butterfly populations. This also includes management and establishment of a vegetation corridor for the movement of butterflies across campus, including butterfly gardens providing feeding opportunities from plants and fruit.

Continuing population maintenance is a dynamic process. Dynamic systems require constant attention and monitoring (Sibatani 1990). As our current study was only conducted during one year, additional monitoring is required to establish trends in butterflies over time. Specifically, if management for butterfly diversity is introduced in the area, monitoring is needed to establish if management has the desired outcome for species richness and abundance. Often, resources are scarce to carry out such monitoring. However, citizen science is becoming a cornerstone of biodiversity monitoring throughout the world (e.g. Proenca et al. 2016) and butterflies as a charismatic insect taxon lend themselves to such monitoring schemes. Especially in urban landscapes, citizen science may be very effective due to a large pool of potential volunteers (Matteson et al. 2012). Development of a standard monitoring protocol, to be carried out at specific times throughout the year (our data suggests that November to May may be most suitable), is essential, as is securing sufficient volunteers, including students, for the anticipated monitoring effort. In addition, citizen science provides direct conservation engagement and education to city-dwellers and the scheme can relatively easily be expanded to other areas within the green zone of Dhaka (and other tropical urban areas).

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Figure 1. Map of the University of Dhaka campus (Adapted from a map, created by Department of Geography, University of Dhaka)

Figure 2. Bar graph, showing weekly butterfly species richness

Figure 3. Scatter plots showing the relationship of various abiotic factors to butterfly species richness

Figure 4. Map of the University of Dhaka campus showing measured (a) and predicted (b) species richness of butterflies using the inverse distance weight interpolation.

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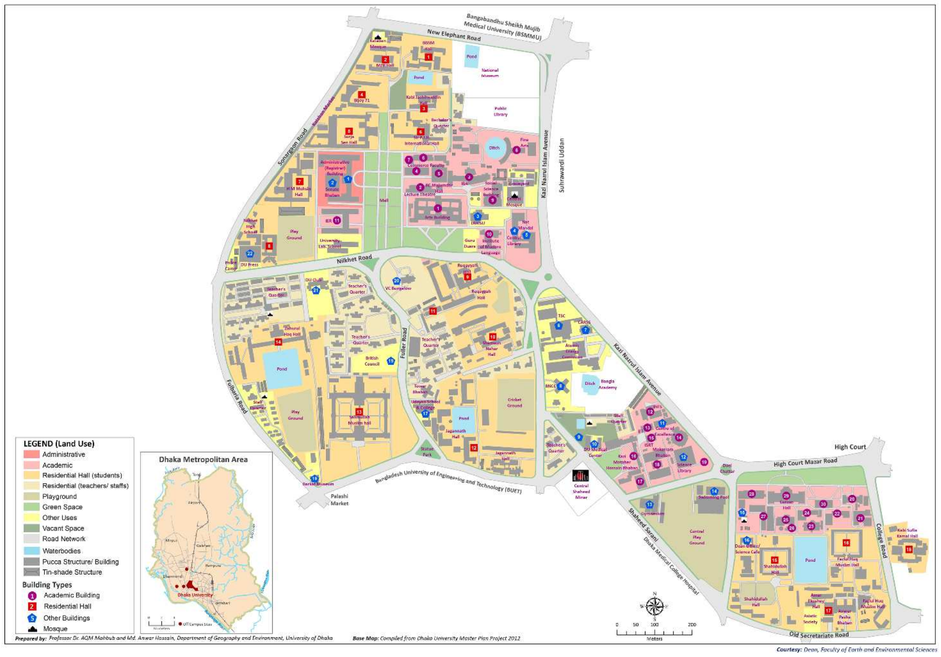

Figure 1. Map of the University of Dhaka campus (Adapted from a map, created by Department of Geography, University of Dhaka)

1851x1306mm (96 x 96 DPI)

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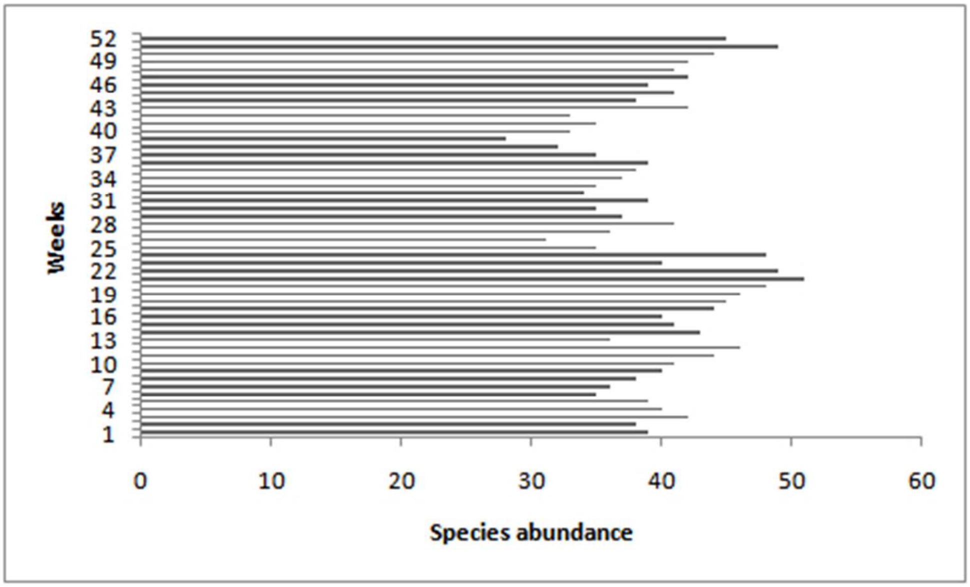

Figure 2. Weekly butterfly species richness at the University of Dhaka campus

41x25mm (300 x 300 DPI)

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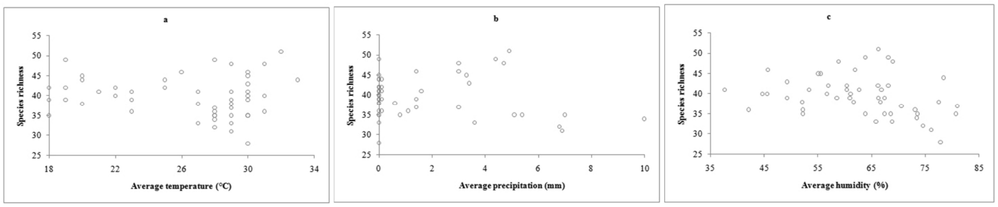

Figure 3. The relationship of abiotic factors to butterfly species richness.

1371x286mm (96 x 96 DPI)

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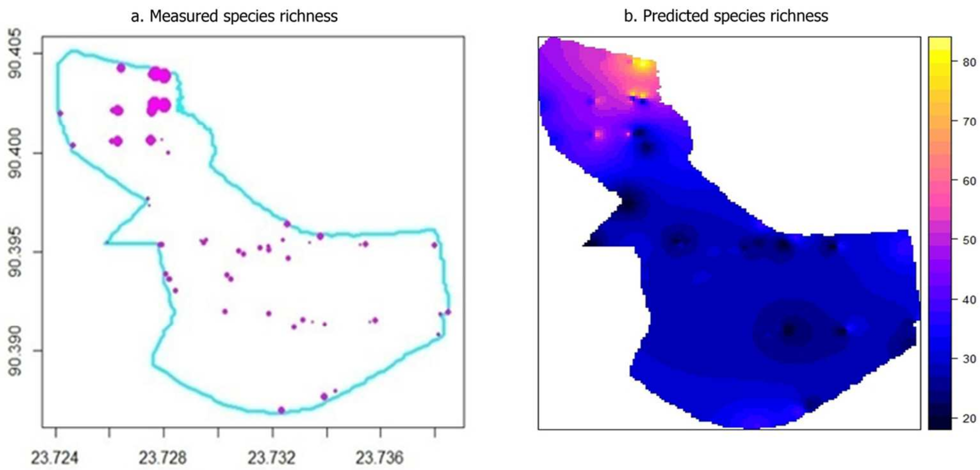

Figure 4. Map of the University of Dhaka campus showing species richness of butterflies using the inverse distance weight interpolation

58x35mm (600 x 600 DPI)

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Table-1: Observed butterfly species and their national red list assessment status

Family	Subfamily	Scientific Name	Author and Published Year	IUCN Red List Category in Bangladesh National Red List
Pieridae	Coliadinae	*Eurema andersoni*	(Moore, 1886)	LC
		Eurema hecabe	(Linnaeus, 1758)	LC
		Eurema blanda	(Boisduval, 1836)	LC
		Catopsilia pomona	(Fabricius, 1775)	LC
		Catopsilia pyranthe	(Linnaeus, 1758)	LC
	Pierinae	*Cepora nerissa*	(Fabricius, 1775)	LC
		Appias libythea	(Fabricius, 1775)	LC
		Appias lyncida	(Cramer, 1777)	LC
		Hebomoia glaucippe	(Linnaeus, 1758)	VU
		Pieris canidia	(Linnaeus, 1768)	LC
		Delias eucharis	(Drury, 1773)	LC
		Delias descombesi	(Boisduval, 1836)	LC
		Leptosia nina	(Fabricius, 1793)	LC
Lycaenidae	Polyommatinae	*Zizula hylax*	(Fabricius, 1775)	LC
		Pseudozizeeriamaha	(Kollar, 1844)	LC
		Zizina otis	(Fabricius, 1787)	LC
		Zizeeria karsandra	(Moore, 1865)	LC
		Jamides celeno	(Cramer, 1775)	LC
		Jamides alecto	(Felder, 1860)	LC
		Chilades pandava	(Horsfield, 1829)	LC

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		Chilades contracta	(Butler, 1880)	EN
		Chilades lajus	(Stoll, 1780)	LC
		Euchrysops cnejus	(Fabricius, 1798)	LC
		Lampides boeticus	(Linnaeus, 1767)	LC
		Catochrysops strabo	(Fabricius, 1793)	VU
		Anthene lycaenina	(Felder, 1868)	EN
		Leptotes plinius	(Fabricius, 1793)	LC
		Castalius rosimon	(Fabricius, 1775)	LC
		Tarucus venosus	(Moore, 1882)	NA
		Tarucus nara	(Kollar, 1848)	EN
		Tarucus callinara	(Butler, 1886)	EN
		Prosotas nora	(Felder, 1860)	LC
		Prosotas dubiosa	(Semper, 1879)	VU
		Neopithecops zalmora	(Butler, 1870)	LC
	Theclinae	*Rapala manea*	(Hewitson, 1863)	LC
		Rathinda amor	(Fabricius, 1775)	VU
		Remelana jangala	(Horsfield, 1829)	VU
	Curetinae	*Curetis thetis*	(Drury, 1773)	LC
	Miletinae	*Spalgis epius*	(Westwood, 1852)	EN
Nymphalidae	Nymphalinae	*Junonia almanac*	(Linnaeus, 1758)	LC
		Junonia hierta	(Fabricius, 1798)	LC
		Junonia lemonias	(Linnaeus, 1758)	LC
		Junonia atlites	(Linnaeus, 1763)	LC
		Junonia orithya	(Linnaeus, 1758)	VU
		Vanessa cardui	(Linnaeus, 1758)	EN
		Hypolimnas bolina	(Linnaeus, 1758)	LC

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		Hypolimnas misippus	(Linnaeus, 1764)	VU
	Limenitidinae	*Neptis hylas*	(Linnaeus, 1758)	LC
		Neptis jumbah	(Moore, 1858)	LC
		Athyma perius	(Linnaeus, 1758)	LC
		Moduza procris	(Cramer, 1777)	LC
		Euthalia aconthea	(Cramer, 1777)	LC
	Heliconiinae	*Cethosia cyane*	(Drury, 1773)	LC
		Acraea violae	(Fabricius, 1793)	LC
		Phalanta phalantha	(Drury, 1773)	LC
	Biblidinae	*Ariadne merione*	(Cramer, 1777)	LC
		Ariadne ariadne	(Linnaeus, 1763)	LC
	Danainae	*Danaus chrysippus*	(Linnaeus, 1758)	LC
		Danaus genutia	(Cramer, 1779)	LC
		Tirumala limniace	(Cramer, 1775)	LC
		Euploea core	(Cramer, 1780)	LC
	Satyrinae	*Elymnias hypermnestra*	(Linnaeus, 1763)	LC
		Mycalesis perseus	(Fabricius, 1775)	VU
		Mycalesis mineus	(Linnaeus, 1758)	LC
		Melanitis leda	(Linnaeus, 1758)	LC
		Melanitis phedima	(Cramer, 1780)	VU
		Lethe europa	(Fabricius, 1775)	VU
Hesperiidae	Hesperiinae	*Cephrenes acalle*	(Hopffer, 1874)	VU
		Telicota ancilla	(Herrich-Schäffer, 1869)	VU
		Telicota colon	(Fabricius, 1775)	LC
		Oriens goloides	(Moore, 1881)	VU

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		Oriens gola	(Moore, 1877)	LC
		Pelopidas agna	(Moore, 1866)	LC
		Pelopidas conjunctus	(Herrich-Schäffer, 1869)	LC
		Pelopidas sinensis	(Mabille, 1877)	NA
		Pelopidas mathias	(Fabricius, 1798)	VU
		Borbo cinnara	(Wallace, 1866)	LC
		Suastus gremius	(Fabricius, 1798)	EN
		Parnara bada	(Moore, 1878)	EN
		Parnara guttatus	(Bremer & Grey, 1852)	LC
		Parnara ganga	Evans, 1937	NA
		Udaspes folus	(Cramer, 1775)	LC
		Hyarotis adrastus	(Stoll, 1780)	VU
		Matapa aria	(Moore, 1866)	LC
	Coeliadinae	*Badamia exclamationis*	(Fabricius, 1775)	VU
		Hasora chromus	(Cramer, 1780)	EN
Papilionidae	Papilioninae	*Papilio polytes*	(Linnaeus, 1758)	LC
		Atrophaneura aristolochiae	(Fabricius, 1775)	LC
		Atrophaneura hector	(Linnaeus, 1758)	EN
		Papilio clytia	(Linnaeus, 1758)	LC
		Papilio demoleus	(Linnaeus, 1758)	LC
		Graphium doson	(Felder, 1864)	LC
		Graphium agamemnon	(Linnaeus, 1758)	LC

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