

First report on checklist, species abundance, seasonal distribution and diversity of moth fauna (Lepidoptera: Heterocera) in Rajshahi University Campus (RUC), Bangladesh

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Abstract

The present study was carried out to make a preliminary checklist and evaluate the species abundance, seasonal distribution and diversity (richness, dominance and evenness) of moth fauna (Lepidoptera: Heterocera) in Rajshahi University Campus (RUC), Bangladesh from December 2017 to November 2018. A total number of 674 individuals of moth were found which belong to 29 species and 27 genera under 8 families. Among the species, the Tropical tiger moth, *Asota caricae* (n= 56) was the most dominant, with 8.31% of the total number of moth fauna, and the lowest population was *Anomis flava* and *Pyrrharctia isabella* (n= 2), and their relative abundance (RA) was 8.32 and 0.30% respectively. There were 3 very common, 6 common, 11 fairly common, 6 rare and 3 very rare species. The maximum diversity was recorded from the family Erebiidae (sp. 11, 37.93%) whereas minimum diversity was from the family Arctiidae, Pyralidae, Sphingidae and Tineidae (sp. 1, 3.47%). About 60% of the total moth fauna were collected in the autumn season (Oct-Dec), while only around 7% was collected in the winter (Dec-Feb) and summer (Mar-May) season. From the monthly samples, the highest prevalence of moth was found in the month of November (n= 220, 32.64%) and lowest in the month of February (n= 4, 0.59%). Diversity indices of Shannon (H') and Simpson (1-D) were 1.39 and 0.98 respectively according to collected individuals. The Margalef (D_{Mg}) and Menhinick (D_{Mn}) richness index were 4.30 and 1.12, and the Berger-Parker dominance (d) and Pielou's evenness index (J') were 0.08 and 0.41 respectively. Perhaps this works is the first report and provides baseline information for checklist and diversity of moths in RUC, Bangladesh.

Keywords: checklist of moths, species abundance, seasonal distribution, species diversity, diversity index, richness, evenness, dominance

Introduction

The order Lepidoptera is potential bio-indicators, mainly with respect to climatic change and increase in agriculture [1]. The broadly recognizable group of butterflies and moths collectively comes under order Lepidoptera. Most species of moth are nocturnal and exhibit higher diversities in population and species sizes as compared to those of butterflies. Moths play significant roles in many ecosystems as pollinators, herbivores and prey for a wide range of species such as birds and bats [2]. Moths (Lepidoptera: Heterocera) have about 1, 35, 700 known species in the world, representing 91% of all lepidopterans [3]. It is reported that the Indian region harbors 12000 species of moth fauna [4].

Recently in West Bengal State University Campus, India has been reported 30 genera under ten families [5]. Yattoo and Gadhikar [6] were studied on diversity and abundance of moths in Baramulla district in Jammu and Kashmir India and recorded eight species belonging to five families. An inventory of moths (Lepidoptera) from Topchanchi wildlife sanctuary, Jharkhand was made, and a total of 74 species under 66 genera of 15 different families of moths were identified [7]. The similar kind of works was done on the diversity, species richness and evenness of moth fauna in the Peshawar City, Pakistan, and 774 moth specimens were collected [8]. There are only a few works have been done on taxonomy, diversity and abundance of moth fauna in

Bangladesh. A preliminary report on the moth fauna was published with their species diversities and seasonal abundance in different areas at Savar, Bangladesh, and a total of 153 moth species belonging to 113 genera under 14 families were recorded [9]. In other work, 77 species were identified in five different districts of Bangladesh, viz. Cox's Bazar, Chittagong, Moulvibazar, Pabna and Dhaka [10]. Ahmad [11] has reported some moths from the family Pyralidae, Noctuidae, Geometridae and Saturniidae. Several reports have been published on checklist, abundance and diversity of the butterflies, grasshoppers and crickets in RUC and Rajshahi District, Bangladesh [12, 13, 14]; but so far no reports have been published yet on the faunal record of moths with their diversity, abundance, richness, dominance and evenness in this area.

The aim of the present research was to make a preliminary checklist, estimate their abundance and seasonal distribution as well as calculate the different diversity indices to know the diversity, richness, dominance and evenness of moth species from Rajshahi University Campus (RUC), Bangladesh which still was lacking fresh documentation of moth fauna.

Materials and Methods

Study site

The present study was conducted in the Rajshahi University Campus (RUC) in Rajshahi District, Bangladesh. The RUC

is located at the northern part of Bangladesh in between 24.370 degree to 88.637 degree. The RUC area is nearly 753 acres (3.05 square kilometers).

Moth collection

Moths were collected for about twelve months from December 2017 to November 2018. Collections and observations were taken from the afternoon to night, and both random catching and light trap were used. For random catching, sweeping net was used. On the other hand moths were collected by light trap in the fields and bushes. Then the moth specimens were transferred within the small jars carefully. Each of habitats was visited one time a week.

Preservation and identification

A piece of chloroform soaked tissue paper was inserted into the jar. The jar was kept for a day. Then the moths were stretched in stretching board. Then the specimen were pinned and labeled in a preservation box. Individual images of moths were photo-documented and identified by cross-checking with standard references and photo guides [15, 16, 17].

Status of the moth species

The collected species were categorized into one of the five categories based on the number of sightings according to the classification given by Chowdhury *et al.* [18]. However, the categories 'few' and 'rare', as found in these articles were changed in the term of 'rare' and 'very rare' respectively in the present observation. Abundances of moth fauna were categorized into five status as VC, Very Common (> 50 sightings); C, Common (31–50 sightings); Fairly Common (16–30 sightings); R, Rare (6–15 sightings) and VR, Very Rare (1-5 sightings).

Seasonal distribution of the moth species

Bangladesh has four distinct seasons from the climatic point of view: the winter season from December to February; the summer pre-monsoon season from March to May; the rainy monsoon season from June to September; and the autumn post-monsoon season which lasts from October to November [19, 20].

Statistics

Collected data were subjected to analysis with the help of Microsoft Excel office 2007. Relative abundance was determined using the formula [21].

$$\text{Relative Abundance (RA)} = \frac{\text{Number of individuals}}{\text{Total number of species}} \times 100$$

To calculate the species diversity of the moth, Shannon diversity index [22] and Simpson diversity index [23] were used. Species richness was calculated by Margalef richness index [24] and Menhinick richness index [25]. The species dominance and evenness were calculated by using the Berger-Parker dominance index [26] and the [27]. Following diversity indices were used to estimate the biodiversity of the moth fauna in the study area.

Shannon diversity index [22]

$$H' = - \sum_{i=1}^s p_i \ln p_i$$

H': Shannon diversity index

p_i: The proportion (n/N) of individuals of one particular species

Ln: The natural logarithm

S: Total number of species

Simpson diversity index [23]

$$1 - D = \sum_{i=1}^s p_i^2$$

D: Simpson diversity index

P_i: Number of individuals belonging to i species

S: Total number of species

Margalef richness index [24]

$$D_{Mg} = \frac{(S - 1)}{\ln N}$$

D_{Mn}: Margalef diversity index

S: Total number of species

N: Total number of individuals

Ln: The natural logarithm

Menhinick richness index [25]

$$D_{Mn} = \frac{S}{\sqrt{N}}$$

D_{Mn}: Menhinick richness index

S: Total number of species

N: Total number of individuals

Berger-Parker Dominance Index [26]

$$d = \frac{N_{max}}{N}$$

d: Berger-Parker dominance index

N_{max}: The number of individuals of the most abundant species

N: Total number of individuals

Pielou's evenness index [27]

$$J' = \frac{H'}{H_{max}}$$

J': Pielou evenness index

H': The observed value of Shannon-Wiener index

H_{max}: ln S

S: Total number of species

Ln: The natural logarithm

Results and Discussion

The present study was done to make a preliminary checklist and assess the species abundance, seasonal distribution and diversity (richness, dominance and evenness) of moth fauna (Lepidoptera: Heterocera) in Rajshahi University Campus (RUC), Bangladesh from December 2017 to November 2018. A total number of 674 individuals of moth were collected during the study period (Table 1). Among them, 29 species were identified belong to 27 genera under 8

families. To our knowledge, for the first time, an inventory of moth fauna in RUC has been made with their common name (Table 1). Among the collected species, the Tropical tiger moth, *Asota caricae* (n= 56) was the most dominant, with 8.31% of the total number of moth fauna. About 8%

were *Cnapholocrocis medinalis* (n= 54) followed by *Athetis pallustris* (n=51, 7.57%). The lowest population was *Anomis flava* and *Pyrrharcia isabella*, and the number and their relative abundance were 2 and 0.30% respectively (Table 1).

Table 1: Checklist, species abundance and relative abundance (RA) of moth fauna in Rajshahi University Campus, Bangladesh.

Family	No.	Individuals/ Species name	Common name	Total	RA (%)
Arctiidae	1	<i>Pareuchaetes insulata</i>	Yellow-winged pareuchaetes	16	2.37
Crambidae	2	<i>Antigastra catalaunalis</i>	Sesame leafroller	44	6.53
	3	<i>Cnapholocrocis medinalis</i>	Rice leafroller	54	8.01
	4	<i>Herpetogramma phaeopteralis</i>	Tropical sod webworm	19	2.82
	5	<i>Scirpophaga excerptalis</i>	Sugarcane top borer	31	4.60
	6	<i>Spoladea recurvalis</i>	Beet webworm moth	20	2.97
	Erebidae	7	<i>Amata cyssea</i>	Handmadian moth	8
8		<i>Anomis flava</i>	Cotton looper	2	0.30
9		<i>Asota caricae</i>	Tropical tiger moth	56	8.31
10		<i>Caenurginae rechtea</i>	Common grass moth	8	1.19
11		<i>Euchaetes egle</i>	Milkweed tiger moth	12	1.78
12		<i>Euproctis plagiata</i>	Tussock moth	24	3.56
13		<i>Grammodes geometrica</i>	Unknown	8	1.19
14		<i>Lophocampa argentata</i>	Silver-spotted tiger moth	22	3.26
15		<i>Spilosoma lubricipeda</i>	White ermine	36	5.34
16		<i>Spirama helicina</i>	Rustic eye moth	18	2.67
17		<i>Pyrrharcia isabella</i>	Isabella tiger moth	2	0.30
Geometridae	18	<i>Diaphania indica</i>	Cucumber moth	34	5.04
	19	<i>Ornithospila lineata</i>	Tribe geometrini	38	5.64
Noctuidae	20	<i>Agrotis ipsilon</i>	Dark sword-grass	22	3.26
	21	<i>Athetis pallustris</i>	Marsh moth	51	7.57
	22	<i>Griposia aprilina</i>	Merveille du jour	4	0.59
	23	<i>Sesamia inferens</i>	Asiatic pink stem borer	12	1.78
	24	<i>Spodoptera cilium</i>	Dark mottled willow	31	4.60
	25	<i>Spodoptera exigua</i>	Beet armyworm	24	3.56
	26	<i>Spodoptera litura</i>	Cotton leafworm	26	3.86
Pyralidae	27	<i>Plodiainter punctata</i>	Indian-meal moth	14	2.08
Sphingidae	28	<i>Theretra oldenlandiae</i>	Impatiens hawkmoth	20	2.97
Tineidae	29	<i>Tineola bisselliella</i>	Clothes moth	18	2.67
Total				674	

The status of the moth fauna was categorized as: 3 were very common (VC), 6 were common (C), 11 were fairly common (FC), 6 were rare (R) and 3 were considered as very rare (VR) (Table 2).

The very common species were *Asota caricae*, *Cnapholocrocis medinalis* and *Athetis pallustris*. Alternatively, the very rare species were *Anomis flava*, *Pyrrharcia Isabella* and *Griposia aprilina* (Table 2).

Table 2: Seasonal and monthly diversity of moth fauna in Rajshahi University Campus. Month: 12, December; 1, January; 2, February; 3, March; 4, April; 5, May; 6, June; 7, July; 8, August; 9, September; 10, October; and 11, November. Status: VC, Very Common (> 50 sightings); C, Common (31–50 sightings); Fairly Common (16–30 sightings); R, Rare (6–15 sightings) and VR, Very Rare (1-5 sightings).

Family	No.	Individuals/ Species	Seasonal and monthly abundance											Total	Status	
			Winter			Summer			Rainy			Autumn				
			12	1	2	3	4	5	6	7	8	9	10			11
Arctiidae	1	<i>Pareuchaetes insulata</i>	1	0	0	3	3	1	1	0	0	0	3	4	16	FC
Crambidae	2	<i>Antigastra catalaunalis</i>	7	3	2	1	4	0	0	0	0	12	15	44	C	
	3	<i>Cnapholocrocis medinalis</i>	5	2	1	1	7	0	6	2	2	0	11	17	54	VC
	4	<i>Herpetogramma phaeopteralis</i>	2	0	1	0	1	0	3	2	3	3	1	3	19	FC
	5	<i>Scirpophaga excerptalis</i>	6	0	0	0	0	0	0	1	4	2	10	8	31	C
	6	<i>Spoladea recurvalis</i>	3	1	0	0	2	0	0	0	0	0	4	10	20	FC
	Erebidae	7	<i>Amata cyssea</i>	0	0	0	0	0	0	0	4	0	3	1	8	R
8		<i>Anomis flava</i>	0	0	0	0	0	0	0	0	1	1	0	2	VR	
9		<i>Asota caricae</i>	0	0	0	0	2	1	4	4	4	1	17	23	56	VC
10		<i>Caenurginae rechtea</i>	0	1	0	0	1	0	0	0	0	0	2	4	8	R
11		<i>Euchaetes egle</i>	0	1	0	1	2	0	0	0	0	0	2	6	12	R
12		<i>Euproctispla giata</i>	0	0	0	0	0	0	3	2	0	2	7	10	24	RC
13		<i>Grammodes geometrica</i>	0	0	0	0	0	0	1	0	0	0	3	4	8	R
14		<i>Lophocampa argentata</i>	0	0	0	0	0	0	1	5	5	0	5	6	22	FC
15		<i>Spilosoma lubricipeda</i>	0	0	0	0	1	3	4	5	5	0	10	8	36	C
16		<i>Spirama helicina</i>	0	0	0	0	0	0	1	1	5	0	4	7	18	FC

	17	<i>Pyrrharctia isabella</i>	0	0	0	0	0	0	0	2	0	0	0	0	2	VR
Geometridae	18	<i>Diaphania indica</i>	0	0	0	0	0	0	3	1	4	6	10	10	34	C
	19	<i>Ornithospila lineata</i>	0	0	0	0	0	0	5	2	3	2	10	16	38	C
	20	<i>Agrotis ipsilon</i>	0	0	0	0	0	0	1	0	2	3	7	9	22	FC
Noctuidae	21	<i>Athetis pallustris</i>	3	0	0	1	2	2	3	4	3	0	15	18	51	VC
	22	<i>Griposia aprilina</i>	0	0	0	0	0	0	0	0	1	1	2	0	4	VR
	23	<i>Sesamia inferens</i>	0	0	0	0	0	0	3	2	0	1	4	2	12	R
	24	<i>Spodoptera ciliium</i>	0	0	0	0	0	0	2	1	3	2	11	12	31	C
	25	<i>Spodoptera exigua</i>	0	0	0	0	0	0	0	1	7	0	7	9	24	FC
	26	<i>Spodoptera litura</i>	3	1	0	1	3	0	4	3	4	1	5	1	26	FC
	27	<i>Plodiainter punctata</i>	1	0	0	1	3	0	0	0	0	0	3	6	14	R
Sphingidae	28	<i>Theretra oldenlandiae</i>	0	0	0	0	0	0	2	1	0	3	9	5	20	FC
Tineidae	29	<i>Tineola bisselliella</i>	4	0	0	1	2	0	0	0	0	0	5	6	18	FC

The number of identified species and their percentage were recorded family-wise as Erebidae (11, 37.93%), Noctuidae (7, 24.14%), Crambidae (5, 17.24%), Geometridae (2, 6.90%), and 1 species belong to the family Arctiidae, Arctiidae, Sphingidae and Tineidae (3.45%) (Fig. 1). According to collected individuals, the maximum diversity

was recorded (number and %) from the family Erebidae (n= 196, 29.08%) followed by Noctuidae (n= 170, 25.22%) and Crambidae (n= 168, 24.93%), and the minimum diversity was recorded in the family Pyralidae (n= 14, 2.08%) (Fig. 1).

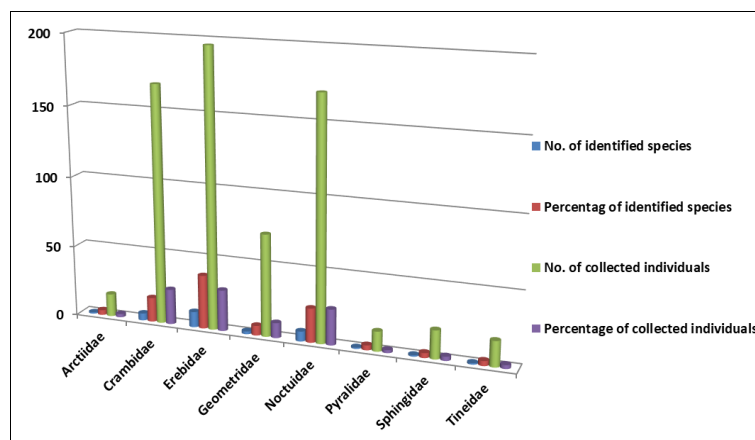


Fig 1: Diversity of moth fauna according to collected individuals and family-wise in Rajshahi University Campus, Bangladesh.

Bangladesh is located in the sub-tropical monsoon climate region, and four distinct seasons can be documented from climatic point of view (Shahid 2010; Khatun *et al.* 2016). About 60% of the total moth fauna were collected in the autumn season (Oct-Dec), and their individual’s number

was 403 out of 674. In addition, only 7.12% and 7.42% were collected in the winter (Dec-Feb) and summer (Mar-May) season respectively. The rainy monsoon season (Jun-Sep) was represented 25.67% (n= 173) (Fig. 2).

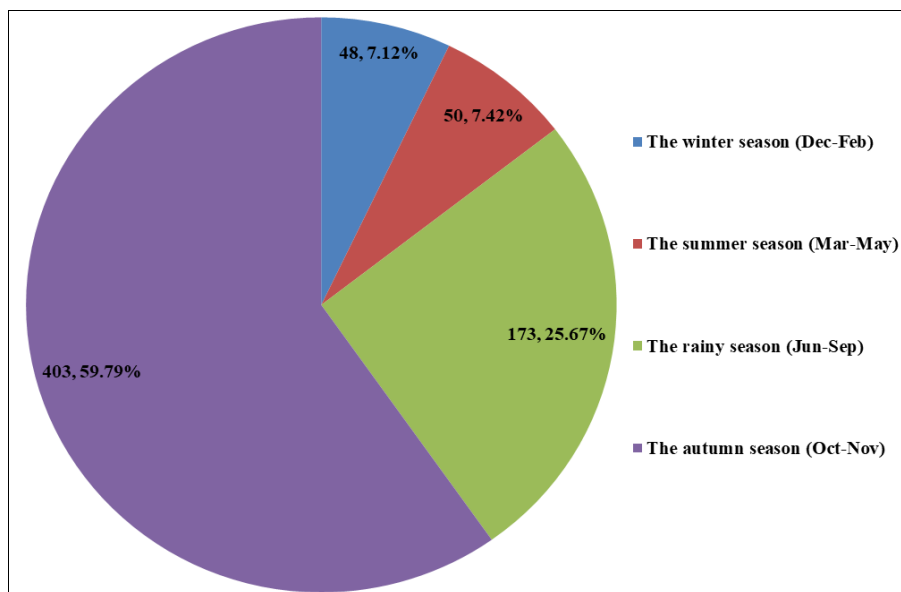


Fig 2: Seasonal diversity of moth fauna in Rajshahi University Campus.

From the monthly samples, the highest prevalence of moth fauna was found in the month of November (n= 220, 32.64%) and lowest in the month of February (n= 4, 0.59%). Furthermore, the month of October was the second in

position in terms of species abundance (n= 183, 27.15%) (Fig. 3). In this study, the month of October and November was considered as the autumn post-monsoon season.

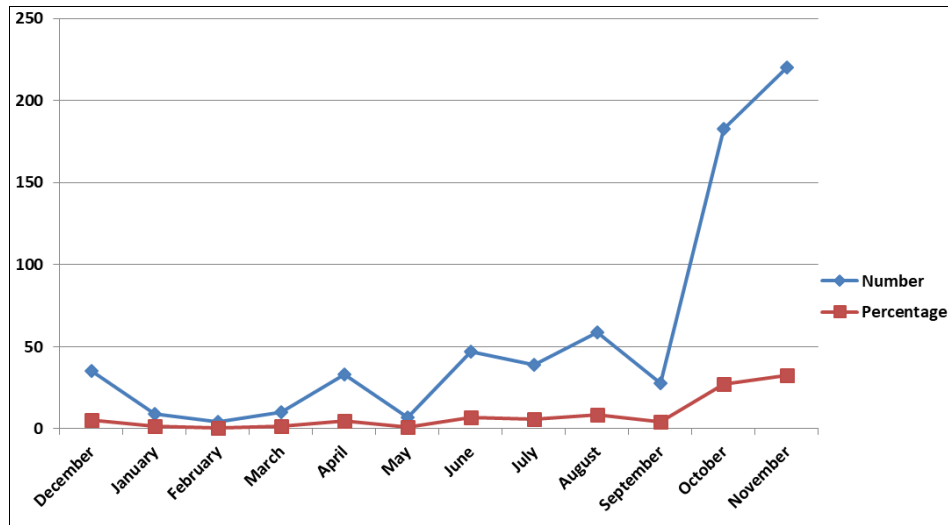


Fig 3: Monthly diversity of moth fauna in Rajshahi University Campus, Bangladesh.

Different diversity indices were used to calculate species diversity, richness, dominance and evenness of moth fauna in RUC according to collected individual-wise and family-wise. This study indicated that the diversity indices of Shannon (H') and Simpson (1-D) were 1.39 and 0.98 according to individual numbers respectively, while the values were 1.66 and 0.77 among the family-wise correspondingly (Fig. 4). Based on the individuals, the

values were comparatively higher in Margalef (D_{Mg}) and Menhinick (D_{Mn}) richness index (4.30 and 1.12), but values were found comparatively lower, 1.07 and 0.31 in proportion to family respectively. The Berger-Parker dominance (d) index was 0.08 and 0.29 for individuals and family respectively. The Pielou's evenness index (J') was 0.41 and 0.85 for individuals, and family correspondingly (Fig. 4).

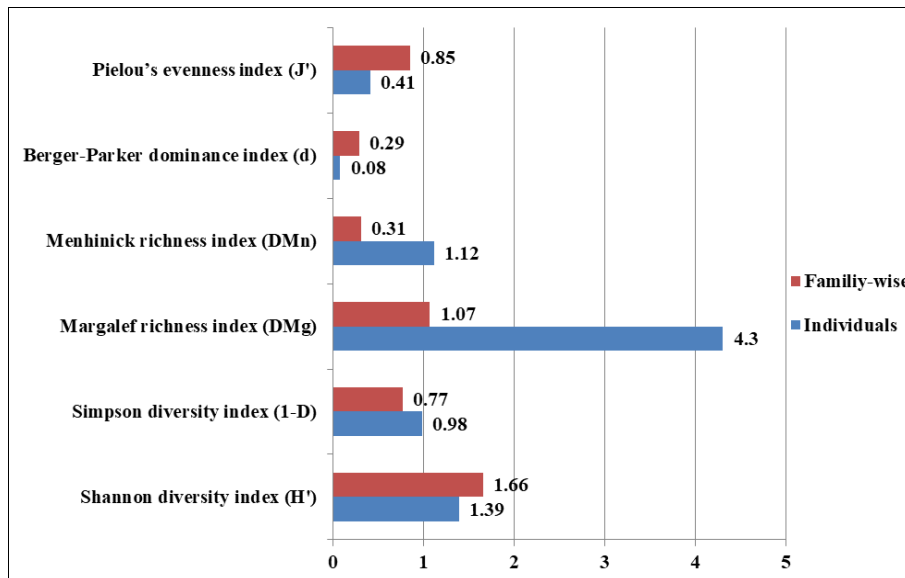


Fig 4: Values of different diversity indices of moth fauna according to individuals and family-wise in Rajshahi University Campus.

The present paper deals with the preliminary data collected from November 2017 to December 2018. A total number of 674 individuals of adult moths were collected and identified in 29 species under 27 genera belonging to 8 different families. Similar statements are also made by [5], Yattoo and Gadhikar [6] and Singh *et al* [7]. About moth fauna of West Bengal, Jammu and Kashmir and Jharkhand of India respectively. The similar kind of works was done on the checklist, diversity and abundance of moth fauna in Saver, Bangladesh, and 153 moth species belonging to 113 genera

under 14 families were confirmed [9]. The most dominant species was the Tropical tiger moth, *Asota caricae* (Erebidae) in this study whereas *Spilosoma obliqua* (Arctiidae) [9] and *Mythimna separate* (Noctuidae) [6] were most abundance in others study. Here, the status of moth fauna was divided into five categories viz. 3 were very common, 6 were common, 11 were fairly common, 6 were e and 3 were very rare species. We did not found these types of status in moths, but references were available on butterflies, grasshoppers and crickets [12, 13, 14, 18, 28, 29]. In our

research, the maximum diversity was recorded from the family Erebidae; other researchers were also found Erebidae as dominant family [5, 6, 7].

From the present work, the highest record of moths was found in the autumn season especially in the month of November. Several similar kinds of work were showed the maximum abundance (seasonal distribution) in the month of July [6, 30]. The reason for the difference in the months seems to be the difference in temperature of all those months in different region. It is reported that the highest survival rate, fecundity per female, and population index trend were observed when the temperature was 27 °C, and about 95% of mature larvae stopped pupating at 18 °C, and about 70% of mature larvae stopped pupating at 21 °C [31]. Another report showed that the mean maximum temperature 24.9 °C and mean minimum temperature of 13.3 °C in the month of July in Jammu and Kashmir India [6]. In the month of November, the minimum and maximum temperature of Bangladesh was on average 19 °C to 29 °C approximately [19, 20].

The Shannon diversity index values are between 0.0 and 5.0, and results are found to fall between 1.5 and 3.5. In this study, the values of the Shannon diversity index were 1.39 and 1.66 for individual-wise and family-wise respectively. It is reported that the Shannon diversity index of moth fauna was 3.14 in Peshawar town of Pakistan [8], 1.71 in Pondicherry, India [32], 2.35 in Ranchi, India [33]. The Simpson diversity values were 0.98 and 0.77 according to collected individuals and family-wise, which was in accordance with the previous study as 0.80 to 0.89 [34]. In addition, the Margalef richness index (D_{Mg}) was 4.3 and 1.07 for individuals and family further supported the richness value notified by Aslam [8]. The Pielou's evenness index was 0.41 and 0.85 according to individual numbers and family-wise; the result was consistent with the previous reports that state about evenness value from 0.96 to 0.99 in Sikkim, India and 0.87 in Peshawar, Pakistan [8, 35].

Conclusion

The present work was a first attempt to make a checklist and describe some aspects of the biodiversity of moth fauna in this area. This work was also evaluated the species abundance, seasonal distribution, species richness, evenness and dominance of moths first time. It is concluded that the diversity of moth fauna in Bangladesh has not been well documented yet. A lot of further work is necessary for getting a taxonomic detailed and faunal diversity of moths in this area. Further study may be required to develop a standard monitoring procedure to observe any change in the diversity of moths. As the moth fauna are excellent bio-indicator, monitoring of their populations at systematic way may provide important biological evidence about the ecological situation of the study area.

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