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Seasonal Abundance and distribution of Nymphalidae butterflies in deciduous forest of kaliakayer at Gazipur District, Bangladesh

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Abstract
In this study was assessed seasonal abundance and distribution of nymphalid butterflies in Kaliakayer deciduous forest at Gazipur District from July 2013 to June 2014. Butterflies were sampled from two habitats, i.e., disturbed habitat and undisturbed habitat using line transect method. A total of 900 specimens were recorded, 19 species were identified belonging to 10 genera. Of those, 12 species preferred both habitats while 5 and 2 species were unique for disturbed and undisturbed habitats, respectively. Seasonal distribution of nymphalid butterfly populations were highest (22.11%) in spring and lowest (12.22%) was found in autumn season. Ten species were found almost all seasons and rest of the 9 species was seasonal. Among the identified species, *Junonia almana* and *Junonia atlites* were found most abundant species in this study areas and their relative abundance (RA) was 30.44% for *J. almana* and 22.56% for *J. atlites*.

Keywords: Seasonal, abundance, distribution, nymphalid, butterflies, deciduous, forest

1. Introduction
Butterfly is a primarily day-flying insect belonging to order Lepidoptera. The world contains approximately 18,000-20,000 species of butterflies [1, 2] and Nymphalidae is the largest family of butterflies (8,400 species) represented the world over [3]. In Bangladesh, 158 species of butterflies belonging 10 families were recorded [4]. Several characters of the butterflies like their wide distribution, species diversity, specific to vegetation type, rapid response to perturbation, taxonomic tractability, statistically significant abundance and ease of sampling made them successful and useful organism to check changes in environmental parameters. Butterflies are diverse animals and sensitive to changes in microclimate and habitat [5, 6, 7] which influences their distribution and abundance [8]. Diversity of butterfly is high in the tropics compared to the temperate region because vegetation diversity is high in tropical region. But now a day's tropical forest ecosystems are under enormous pressure all over the world including Bangladesh. Deforestation by increasing urban features, including roads, building and mowed lawns, correspond with decreases in butterfly species richness, diversity and abundance. The present climatic changes also had adverse effects in butterfly life and ecological balance. In Bangladesh, deforestation rates are highest in several areas around Dhaka City but little is known about the effects of forest disturbance on butterflies. Considering the high deforestation rates and that the fact a combination of ecology and economy is often the only strategy to protect the rich rainforest biodiversity in many developing countries [9]. So it is necessary to save the butterfly species from the threat in order to maintain the biodiversity. Regardless of the potential of the butterflies in measuring biodiversity, health, economic value, social value, ecological value there is little information about this site in our country. Little research work conducted in our country to understand the seasonal abundance, seasonal patterns and distribution of butterfly fauna [4, 10] and also determined the seasonal fluctuation of butterflies and their ecological states of small forest in the Jahangirnagar University campus [11, 12]. The present study was undertaken to assess the abundance, diversity, distribution and seasonal variation of all nymphalid butterfly species found in deciduous forest of Kaliakayer at Gazipur District, Bangladesh.

2. Materials and Methods

2.1. Locality and climate

The Kaliakayer deciduous forest at Gazipur is located in the north- west suburbs of Dhaka City. The climate in the study areas is not reflects the general climatic pattern in Bangladesh. There are six seasons i.e. spring, summer, rainy, autumn, late-autumn and winter. Seasons are classified as tropical climate with a distinct tropical wet season (spring, summer, rainy and autumn) and dry season (late-autumn and winter). The wet season is high temperatures, not heavy rains, accompanied by high humidity. The dry seasons is low humidity and relatively cool temperature. The average temperature was about 30 °C in wet season and about 20 °C in dry season. The maximum 37 °C and minimum 14 °C temperature were recorded in May and January, respectively. Annual rainfall reached 182 mm and 50% of which fall in 3 months (June, July and August) of wet season.

2.2. Vegetation and habitat type

Many butterflies are localized or restricted to specific habitat types. For this survey, butterfly was collected from two different habitats i.e. disturbed habitat and undisturbed (forest habitat). The undisturbed habitats were deciduous "Sal" (*Shorea robusta*) forests with vegetation covers mostly canopy and sub-canopy. This type of forests is sporadically distributed in the sample sites. Disturbed habitat was diverse vegetations. It consists of grasslands, cultivated lands, bushes woodlands, human settlements, i.e. roads, houses, factories etc.

2.3. Butterfly collection and identification

Field survey and butterflies collections were carried out between July 2013 and June 2014 using line transect method described by [13]. Two transects were situated in each of the two habitats: undisturbed and disturbed habitats. All transects were walked once in a month between 9.30 am and 12.30 pm, which was a peak time for butterfly activities under sunny weather condition. Two people were used in capturing/observing the butterflies randomly in each transect line. All the nymphalid butterfly species seen 5m either side of the transect line; above and front were recorded separately for undisturbed and disturbed habitats. Butterfly species were primarily identified directly in the field or, in difficult cases, following capture using a sweep net and that were immobilized and brought back in the laboratory. These were pinned and mounted on stretching board and dried overnight into the oven at 50 °C. Specimens were identified by the specimen book on Thailand butterfly [14].

Table 1: Common name and scientific name of Nymphalid butterflies, their species status, relative abundance and habitat preference

No.	Common Name	Scientific Name	Status	Relative Abundance (RA)	Habitat preference
1	Leopard Lacewing	*Cethosia cyane euanthes* (Fruhstorfer, 1912)	NR	3.11	DH,UDH
2	Common Leopard	*Phalanta phalantha phalantha* (Drury, 1773)	NR	4.44	DH, UDH
3	Chocolate Pansy	*Junonia iphita iphita* (Cramer, 1779)	R	0.33	DH
4	Grey Pansy	*Junonia atlites atlites* (Linnaeus, 1763)	VC	22.56	DH, UDH
5	Peacock Pansy	*Junonia almana almana* (Linnaeus, 1758)	VC	30.44	DH, UDH
6	Lemon Pansy	*Junonia lemonias lemonias* (Linnaeus, 1758)	C	8.44	DH, UDH
7	Yellow Pansy	*Junonia hierta hierta* (Fabricius, 1793)	R	0.67	DH, UDH
8	Blue Pansy	*Junonia orithya ocyale* (Hübner, 1819)	R	0.67	DH, UDH
9	Great Eggfly	*Hypolimnas bolina jacintha* (Drury, 1773)	R	1.44	DH, UDH
10	Common Castor	*Ariadne merione tapestrina* (Moor, 1884)	VC	11.78	DH
11	Common Baron	*Euthalia aconthea gar*uda (Moor, 1858)	NR	3.00	DH, UDH
12	Streaked Baron	*Euthalia alpheda verena* ((Fruhstorfer, 1912)	R	0.22	DH
13	Common Sergeant	*Athyma perius perius*(Linnaeus, 1758)	R	0.22	DH
14	Himalayan Sergeant	*Athyma opalina shan* (Tytler, 1940)	NR	2.56	DH, UDH
15	Color Sergeant	*Athyma inara inara***(**Doubleday, 1850)	R	0.89	DH
16	Chestnut-Streaked Sailer	*Neptis jumbah jumbah* (Moore, 1858)	C	8.22	DH, UDH
17	Common Sailer	*Neptis hylas kamarupa* (Moore, 1874)	R	0.78	DH, UDH
18	Commander	*Moduza procris procris* (Cramer, 1777)	VR	0.11	UDH
19	Tawny Rajah	*Charaxes bernardus hierax* (C & R. Felder, 1867)	VR	0.11	UDH

*DH=Disturbed Habitat and UDH= Undisturbed Habitat

3. Results

3.1. Species diversity of nymphalid butterfly

From one-year (six seasons) investigation, a total of 900 individuals of nymphalid butterflies belonging to 19 species under 10 genera were recorded from the selected areas. Among the 19 identified species, *Moduza procris* and *Charaxes bernardus* was considered as very rare (VR) species since less than 2 individuals were observed per species and these species occupied only 0.22% of nymphalid butterfly communities in this study area. *Junonia iphita*, *Junonia hierta*, *Junonia orithya*, *Hypolimnas bolina*, *Euthalia alpheda*, *Athyma perius*, *Athyma inara* and *Neptis hylas*was referred as rare (R) species in which 2-15 individuals were observed per species. They occupied 5.22% at nymphalid butterfly communities in the study areas. Similarly *Cethosia cynae*, *Phalanta phalantha*, *Euthalia aconthea* and *Athyma opalina* was referred as not rare (NR) species in which 15-50 individuals were recorded per species. *Junonia lemonias* and *Neptis jumbah* was considered as common (C) species in which 50-100 individuals were observed in each species. Very common (VC) species was considered when more than 100 individuals were recorder per species [15, 16]. Accordingly 3 very common species was found, those were *Junonia atlites*, *Junonia almana* and *Ariadne merione*. The NR, C and VC species occupied 13.11%, 16.67% and 64.78% of total nymphalid butterfly communities in this study area (Table 1).

3.2. Habitat preference

In this study, 7 species was found habitat specific. Among them 5 species, *J. iphita*, *A. merione*, *E. alpheda*, *A. perius* and *A. inara* were observed only in disturbed habitat, whereas only 2 species *M. procris* and *C. bernardus* were found in undisturbed habitat. Rest of the 12 species was found in both habitats (Table 1).

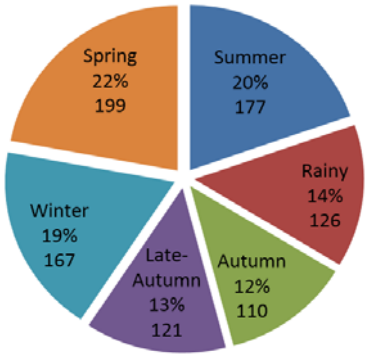

Fig 1: Seasonal distribution of nymphalid butterfly population at Kaliakayer deciduous forest

3.3. Seasonal distribution of nymphalid butterfly population

Figure 1 showed seasonal distribution of nymphalid butterfly populations in this study area. Out of 900 individuals, 177 (19.67%) were recorded in summer (April-May), 126 (14.00%) in rainy (June- July) and 110 (12.22%) individuals found in autumn season (August-September). While 121 (13.44%), 167 (18.56%) and 199 (22.11%) individuals were observed in late-autumn (October-November), winter (December-January) and spring (February-March), respectively. The highest nymphalid butterflies were recorded in spring and lowest was recorded in autumn season (Figure 1).

3.4. Seasonal abundance and fluctuation of nymphalid butterfly species

The following figure 2, 3, 4 and 5 showed seasonal abundance and fluctuation of nymphalid butterfly species as well as figure 1 showed relative abundance (RA) of nymphalid butterfly population.

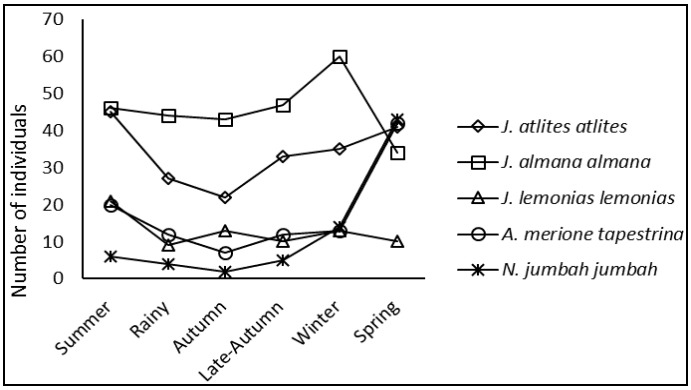

Fig 2: Seasonal abundance of nymphalid butterfly individuals and species

3.4.1. Grey Pansy (*Junonia atlites atlites*)

This species was most abundant (RA was 22.56%) and it is distributed all over the year with high population. Their abundance became higher twice throughout this study period. First peak of *J. atlites* was found in summer, subsequently decline and remained in that condition until autumn season. At the end of autumn their population rise again and became second peak in spring. The first peak was slightly higher than second peak (Figure 2).

3.4.2. Peacock Pansy (*Junonia almana almana*)

J. almana was also most abundant (RA was 30.44%) throughout the study period and found all the year round with very high population. Their abundance increase from summer and remained in that condition until late-autumn and occurred a large peak in winter. End of the winter the population was drastically decreased and lowest abundance was found in spring (Figure 2).

3.4.3. Lemon Pansy (*Junonia lemonias lemonias*)

It was moderately abundant species (RA was 8.44%) and found all the year round with short population. Their peak season was summer and sparsely distributed all over the season with minute fluctuation (Figure 2).

3.4.4. Common Castor (*Ariadne merione tapestrina*)

This species was moderately abundant (RA was 11.78%) and found all the year round with short population. Their abundance became higher twice throughout the study period. First peak of *A. merione* was found in summer, subsequently decline and remained in that condition until autumn season. At the end of autumn their population rise again and became second peak in spring. The second peak was much larger than first peak (Figure 2).

3.4.5. Chestnut-Streaked Sailer (*Neptis jumbah jumbah*)

It was also moderately abundant (RA was 8.22%) and sparsely distributed all over the season with minute fluctuation. Population started increase from late-autumn and showed a peak in spring season (Figure 2).

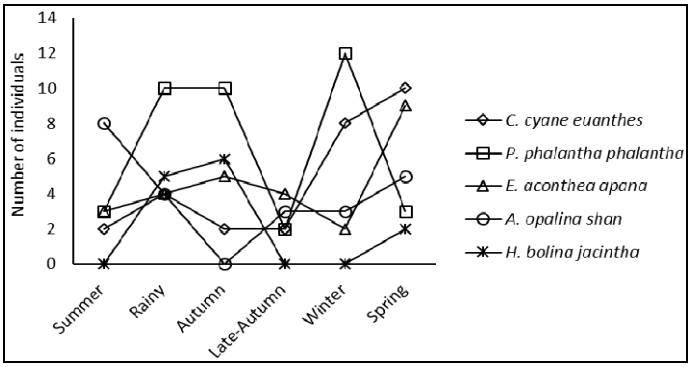

Fig 3: Seasonal abundance of nymphalid butterfly individuals and species

3.4.6. Leopard Lacewing (*Cethosia cyane euanthes*)

C. cyane was less abundant (RA was 3.11%) and few number found all over the season with very short population. Their population started to increase from late-autumn and formed a peak in spring and that time only 10 individual were recorded (Figure 3).

3.4.7. Common Leopard (*Phalanta phalantha phalantha*)

This species was less abundant (RA was 4.44%) and distributed all over the season with very short population. Their population began rise from summer and showed first in rainy season and remained in that condition until autumn. At

the end of autumn their population decreased and their presence started to rise again and formed a second peak in winter that time 12 individuals were observed. Only 2 to 3 individuals were recorded in summer, late-autumn and spring season (Figure 3).

3.4.8. Common Baron (*Euthalia aconthea apana*)
It was less abundant (RA was 3.00%) and few number of this species was found all over the seasons. Highest number (9 species) was found in spring and lowest (2 species) was found in winter season (Figure 3).

3.4.9. Himalayan Sergeant (*Athyma opalina Shan*)
This species was less abundant (RA was 2.56%) throughout the study period. Peak season was summer subsequently drastically decreased and population was absent whole autumn season in the study areas. Thereafter population slightly increased and showed a small peak in spring (Figure 3).

3.4.10. Great Egg fly (*Hypolimnas bolina jacintha*)
Hypolimnas bolina was very less abundant (RA was 1.44%). This species was few during the study period and only 13 individuals were found in rainy, autumn and spring season. Highest 6 individuals was found in autumn season, but it was totally absent during summer, late-autumn and winter season (Figure 3).

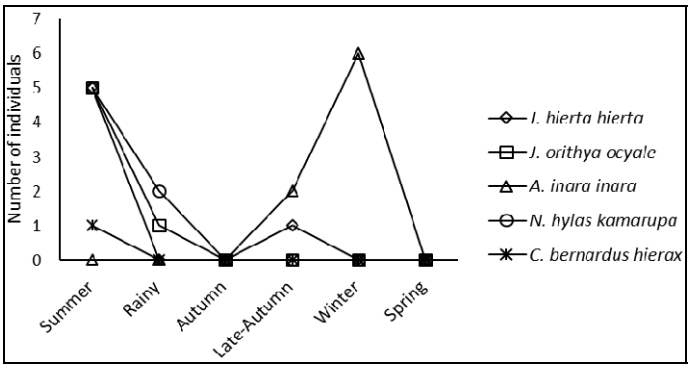

Fig 4: Seasonal abundance of nymphalid butterfly individuals and species

3.4.11. Yellow Pansy (*Junonia hierta hierta*)
It was very few (RA was 0.67%) and not distributed all over the season. Only five species was found during summer season and one species found in late-autumn season. This species was absent during other four seasons in study areas (Figure 4).

3.4.12. Blue Pansy (*Junonia orithya ocyale*)
Junonia orithya was very few (RA was 0.67%) and only five species was found in summer and one species was recorded in rainy season. This species was absent from autumn to spring season (Figure 4).

3.4.13. Color Sergeant (*Athyma inara inara*)
This species was very few (RA was 0.89%) and found only two individuals in late-autumn and 6 individuals in winter season (Figure 4).

3.4.14. Common Sailer (*Neptis hylas kamarupa*)
It was also very few (RA was 0.78%) and only 7 individuals was found during the study period. Five individuals were found in summer and two individuals were found in rainy season (Figure 4).

3.4.15. Tawny Rajah (*Charaxes bernardus hierax*)
Only one individual was found in summer season during study period and its RA was 0.11% (Figure 4)

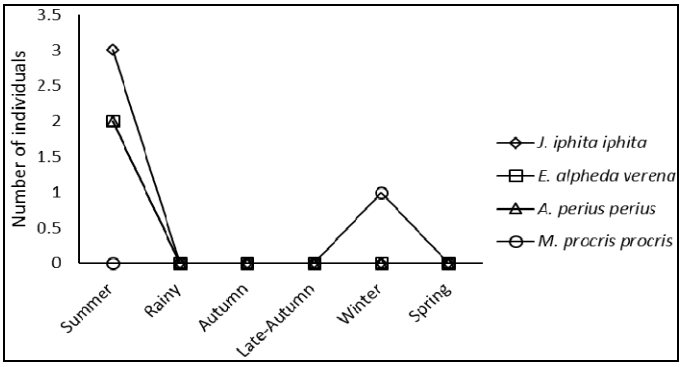

Fig 5: Seasonal abundance of nymphalid butterfly individuals and species

3.4.16. Chocolate Pansy (*Junonia iphita iphita*)
Only three individuals of this species were recorded in summer season and other season it was absent. Their RA was 0.33% (Figure 5).

3.4.17. Streaked Baron (*Euthalia alpheda verena*)
Only two individuals were recorded in summer season during the study period and their RA was 0.22% (Figure 5).

3.4.18. Common Sergeant (*Athyma perius perius*)
Only two individuals were recorded in summer season and other season it was absent. Their RA was 0.22% (Figure 5).

3.4.19. Commander (*Moduza procris procris*)
Only one individual was found in winter season during the study period and its RA was 0.11% (Figure 5).

4. Discussion
Total 900 individuals of nymphalid butterfly were observed during the study period in deciduous forest of Kaliakayer, Gazipur and19 species belonging to 10 genera was identified. Six and three species was identified under the genera *Junonia* and *Athyma*, respectively. Two species was recorded under the genera *Neptis* and *Euthalia* whereas only one species was found in each genus *Hypolimnas*, *Phalanta*, *Cethosia*, *Moduza*, *Ariadne* and *Charaxes*. Most of the species recorded in both habitats because of available native vegetation in disturbed and undisturbed habitat. All identified species were classified into 5 categorized, i.e., VR, R, NR, C and VC which are presented in Table 1. Eight and four species were classified into R and NR species, respectively. Whereas 2 species were found in each categorized of VR and C and other 3 species were classified into VC species. Majority of the individuals were found under very common (VC) species in study areas and they occupied 68.78% of nymphalid butterfly communities.
Abundance of nymphalid butterfly in different seasons at study areas were assessed and result revealed that the higher (61%) population was recorded in winter, spring and summer season in the month of December to May; the highest (22%) being in spring (February-March). Lower (39%) population abundance was found in rainy, autumn and late-autumn seasons in the month of June to November; the lowest (12%) being in autumn season (August-September).This result indicating that the most of the nymphalid butterflies love to bask in the sun

because the winter, spring and summer seasons were comparatively shiny, less rainy, less cloudy and less humid than other seasons at study areas.

Among those identified species, *J. almana* and *J. atlites* was found most abundant in the study areas. Three species, *J. lemonias*, *A. merione* and *N. jumbah* were moderately abundant. Four species, *C. cyane*, *P. phalantha*, *E. aconthea* and *A. opalina* were less abundant. Those of the most abundant, moderately abundant and less abundant species representing 53.00%, 28.44% and 13.11% of the total number of individuals observed, respectively. Only one species, *H. bolina* was found very less abundant, representing 1.44% of the total number of individuals observed. Rest of the nine species was considered as minor since only 1 individual was observed in each species and those were representing 4.00% of total number of individuals recorded. It was mentioned that most dominancy of *J. almana* and *J. atlites* species in the study areas might be the abundant larval host plant and the weather suited to composition their life cycle. Distributions of nineteen identified species in different seasons were also assessed and result mentioned that the ten species were found almost all seasons. The rest of the 9 species were seasonal i. e. they were either found only summer, winter or in spring and some were appeared in both of these seasons. Accordingly *J. iphita*, *E. alpheda*, *A. perius*, *M. procris* found only summer season and *C. bernardus* found only winter season. Considering this result, those species were might be univoltine species in these study areas.

In the present study seasonal peaks of nymphalid butterflies were recorded for both categories, found in all season and specific season. For most of the species seasonal peaks was appeared in spring and summer. Some species showed a short peak in winter and some species either absent or rare in other season. Almost all butterflies have very short seasonal peaks and they are either absent or rare in other seasons [14]. Some species occur throughout the year with a short population peak in a specific season, and some species occur only for a few months [17]. Butterfly species presenting in all season may be able to alter their developmental pathways according to the season change. Host plant is a vital factor for the survivability of butterfly larvae. If host plants exist in the habitat through the year, then they will be able to complete multiple generation, which is essential to subsist all the year round. Thus, it seems that, species foraging all the year round may have their host plant in all season and seasonal species may have host plant specific season. Cause of increasing abundance in spring and summer affluent number of tender leaves appeared in trees, herbs and shrubs, which are essential for caterpillars. In contrast, this ideal vegetation and moist-deciduous forest mostly at the opening in the canopy where sunlight reaches the ground vegetation attracts the nymphalid butterflies for feeding and roaming. So in spring and summer was higher number of nymphalid butterfly found in these areas. In winter, flowering occurs in man-made flower garden and wild flowering plants, which is the prime source of nectar for adult butterfly. Response to seasonality is an important aspect of life history characteristics of insects [18]. To response seasonality many species may enter diapauses; others migrate while others are able to develop seasonal forms [19].

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